POLICY RESEARCH WORKING PAPER 4663

# Assessing the Impact of Public Spending on Growth

## An Empirical Analysis for Seven Fast Growing Countries

*Blanca Moreno-Dodson*

The World Bank
Poverty Reduction and Economic Management Network
Vice President's Office
July 2008

Policy Research Working Paper 4663


## Abstract

The goal of this paper is to understand better, at the empirical level, how public spending contributes to growth by focusing on both the level and composition of public spending, in connection to the dynamics of GDP per capita growth. It attempts to answer two specific questions: (a) What are the policy conditions under which public spending contributes positively to growth? and (b) What are the public spending components that have a stronger and longer-lasting impact on growth?

The analysis is applied to a sample of seven fast-growing developing countries: Korea, Singapore, Malaysia, Thailand, Indonesia, Botswana, and Mauritius, which have been among the top performers in the world in terms of GDP per capita growth during the period (1960-2006).

The rationale for this country sample selection is twofold. The first hypothesis is that, given their positive growth achievements over a relatively long time period, perhaps it is more straightforward to establish a link to public spending in those countries. Second, it is expected that the findings of the analysis will provide lessons regarding the level and composition of public spending that can be useful for other countries where growth has been less rapid. Assessing what role public spending has played in a dynamic growth context may indeed be enlightening for other cases as well.

The paper is structured as follows. The first section is an introduction that provides relevant facts and information about the seven countries during the period of analysis, based on seven individual country case studies. Section II presents the theoretical background behind the empirical analysis. Section III focuses on the empirical methodology, function specification, and variables selected. Section IV is dedicated to the results obtained with the cross-country analysis and some specific country results, as well as some comparisons with previous findings by other authors. Finally, Section V draws policy implications and concludes.


---

This paper—a product of the Poverty Reduction and Economic Management Network, Vice President's Office—is part of a broader effort to expand our knowledge on fiscal policy issues and, in particular, to enrich the dialogue with country teams on how public spending can affect growth. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at bmorenododson@worldbank.org.

# ASSESSING THE IMPACT OF PUBLIC SPENDING ON GROWTH

## An Empirical Analysis for Seven Fast Growing Countries

**Blanca Moreno-Dodson**[1]
**World Bank**

*Since 1959, when Richard Musgrave published The Theory of Public Finance, it has been customary for economists to classify governmental objectives in the three categories of stabilization, allocation, and redistribution proposed by Musgrave. In 1959 growth was not recognized as a governmental objective requiring explicit policy action. The pursuit of the other three objectives was assumed to automatically generate a natural long run rate of growth. However, in recent decades growth has acquired great prominence in many countries. As a consequence, various policies that do not easily fit into Musgrave's classification have been introduced. It is high time to recognize growth as an explicit, fourth objective to be added to Musgrave's trio. It is an objective that many countries now try to promote with good and, at times, bad policies.*

*VITO TANZI, 2008*

## INTRODUCTION

Much of the variation in growth rates among countries and over time remains still not fully understood. Although recent cross-country studies, based on dynamic panel data techniques, have been able to correct some of the methodological problems that plagued the earlier literature (such as measurement and specification errors, simultaneity bias, and the potential for bidirectional causality), few empirical regularities have emerged.

Consider, in particular, the relationship between public spending and growth. Since the seminal contribution by Barro (1990), there have been a number of analytical studies highlighting the various channels through which public expenditure may affect growth, as the next section will discuss in more detail.

However, at the empirical level, robust relationships have been difficult to establish. Much of the evidence on the effects of government expenditure on growth appears to be inconclusive. Although there are strong analytical reasons to believe that public spending is one of the important variables that influence growth, there remains significant uncertainty about its actual degree of influence.

[1] The author is grateful to Pierre-Richard Agénor, University of Manchester and Centre for Growth and Business Cycles Research, Homi Kharas, Brookings Institution, Danny Leipziger, World Bank, and Vito Tanzi, former IMF Director, for their helpful guidance and feedback. Comments by Carlos Braga, Brian Pinto, Eduardo Ley, and Vivek Suri, World Bank, are also greatly appreciated. Last but not least, this analysis would not have been possible without the excellent research assistance of Nihal Bayraktar, Pennsylvania State University, for the econometric work, and Borja de Escalada, World Bank, for the data collection.

Understanding and quantifying those effects remains important from a policy perspective, particularly in view of the fact that fiscal adjustments in some countries have led, in practice, to large reductions in public spending, in order to achieve certain fiscal targets[2] (see Calderón, Easterly, and Servén, 2004, for the case of Latin America). In that respect, it is not clear whether such reductions have contributed to higher growth by promoting macroeconomic stability or, on the contrary, they have hampered it by leading to excessive cuts in some productive components of public spending. It is also plausible that both effects could have occurred simultaneously.

The goal of this paper is to understand better, at the empirical level, how public spending contributes to growth by focusing on both the level and composition of public spending, in connection to the dynamics of GDP per capita growth. It attempts to answer two specific questions: (a) What are the policy conditions under which public spending contributes positively to growth?, and (b) What are the public spending components that have a stronger and longer-lasting impact on growth?

The analysis is applied to a sample of seven fast-growing developing countries: Korea, Singapore, Malaysia, Thailand, Indonesia, Botswana, and Mauritius, which have been among the top performers in the world in terms of GDP per capita growth during the period (1960-2006) [3].

The rationale for this country sample selection is twofold. The first hypothesis is that, given their positive growth achievements over a relatively long time period, perhaps it is more straightforward to establish a link to public spending in those countries. Second, it is expected that the findings of the analysis will provide lessons regarding the level and composition of public spending that can be useful for other countries where growth has been less rapid. Assessing what role public spending has played in a dynamic growth context may indeed be enlightening for other cases as well.

The paper is structured as follows. The first section is an introduction that provides relevant facts and information about the seven countries during the period of analysis, based on seven individual country case studies[4]. Section II presents the theoretical background behind the empirical analysis. Section III focuses on the empirical methodology, function specification, and variables selected. Section IV is dedicated to the results obtained with the cross-country analysis and some specific country results, as well as some comparisons with previous findings by other authors. Finally, Section V draws policy implications and concludes.

[2] Although fiscal adjustment could have taken place by creating fiscal space through the revenue side of the government equation, for example by raising additional tax revenues, the fact of the matter is that in some countries particular spending categories have been actually reduced to meet the fiscal balance target.

[3] All the countries selected in the sample have sustained GDP per capita growth rates of at least 3% (by decade average) during 1960-2006.

[4] For the country case analysis and the comparative study conclusions see "How Public Spending Can Help you Grow. Lessons from Seven Fast Growing Countries", Moreno-Dodson, forthcoming 2008.

## I. COUNTRY COMPARATIVE ANALYSIS

The purpose of this section is to present some country facts and findings[5] that are relevant for the interpretation of the subsequent empirical results[6].

First, a simple growth accounting exercise[7] focused on how capital, labor, and total factor productivity (TFP) have contributed to growth reveals that in the seven countries production factors, in particular capital and labor, have been the main growth drivers. However, as all of them have witnessed their economic transformation towards higher value added activities in the secondary and tertiary sectors, relying more on innovation, the contribution of TFP growth has been gradually increasing through the years[8], to reach the highest levels in Korea and Singapore where it is around 25%[9]. These results are relevant for our analysis since, as discussed on page 6, according to growth theory, public spending could influence growth not only through labor and capital, but also through TFP.

In terms of government effectiveness[10], all countries in the sample, with the exception of Indonesia, rank quite favorably when compared with the rest of the world. Many differences persist, however, notably in the functions attributed to the government, which reflect diverse economic strategies and degrees of intervention, as well as their approaches to successfully promote transparency and fight corruption. While Singapore is considered among the most effective governments in the world, with a 99.5 ranking position[11] and a leader fighting corruption which awards it a 98.1 ranking in 2006, Indonesia has the lowest ranking in our sample on both government effectiveness, at 43.4, and corruption control at 23.3 in 2006. All other countries are somehow in between, with Korea being the second most effective government in our sample at 82.9 and Thailand being at 64.9 in the ranking.

Regarding the size of the government budget, with the exception of Botswana, all countries in our sample have managed to keep a relatively small size of total public spending, which is below 30% of GDP[12]. Botswana's ratios are not only the highest in the sample but also show an upward trend from 25.53% of GDP in the 1970s to 38.83%

[5] See comparative tables at the end of the paper.
[6] See individual country case studies for details.
[7] The analysis is based on existing growth accounting data for all seven countries.
[8] The only country where TFP growth does not appear to have increased through the years, but rather shows a downward trend, is Botswana. Coincidentally, Botswana is the country where fewer synergies have been found with the private sector and the dependence on government spending is the strongest.
[9] This is still lower than the average for OECD countries.
[10] According to the KKM indicators, government effectiveness measures the quality of public services, the quality of the civil service, the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
[11] Kray, Kauffman and Mastruzzi (KKM) indicators using a (0-100) percentile rank, World Bank. No data exist before 1996.
[12] The definition used here refers to the consolidated central government only, which includes the central government plus all government entities associated to it, and excludes all public spending at sub-national level, GFS IMF statistics. It was not feasible to construct a reliable database for the consolidated general government including all countries in the sample.

of GDP during 2000-2005, reflecting an increasingly predominant role of the public sector through the decades. However, since Botswana is ranked very highly, at 73.9 in 2006, on government effectiveness and 78.2 on control of corruption, it can be inferred that, despite the predominant role of the government in the economy, transparency and good governance have not been undermined.

On the opposite side of the spectrum we find Singapore which has managed to maintain a small share of public spending to GDP during the four decades of analysis, reaching an average ratio of 16.58% in 2000-2005, one of the lowest and most stable ratios in the world, despite continuous increases in GDP per capita.

With respect to government spending composition, according to the traditional functional classification of expenditures, it is interesting to notice that while economic spending[13], including infrastructure, agriculture, energy, etc., predominated in the first decades, the percentage of the total budget allocated to social expenditures[14] has been rising over time in all seven countries, with no exceptions, to represent the highest share of the total budget by 2000. Such increases are particularly significant in Botswana, Indonesia, Korea, Singapore, and Thailand.

In the cases of Botswana and Indonesia, a priority switch towards social spending has been achieved through a decrease in economic and other categories of expenditures which were higher at earlier stages of development, particularly during the 1970s when building physical capital through basic infrastructure was required to jump start the growth process. In the other five countries we observe parallel decreases in defense and general services spending, while economic spending continues being important, although not predominant.

When using the definition of Bleany at al.[15], which distinguishes *a priori* between productive and unproductive expenditures, all countries in our sample show a clear predominance of productive spending, which is sustained through the decades of analysis, with some fluctuations by country as expected.

Regarding fiscal stability, none of the above countries is characterized by relatively large fiscal deficits[16], at least when using the conventional approach to measuring it[17]. Despite their spending increases at times of low private investment flows, some interventionist approaches to industrial policy, financial crises, ad hoc countercyclical spending, and

[13] Economic public spending includes: fuel and energy; agriculture, forestry, fishing, and hunting; mining, mineral resources, manufacturing, and construction; transportation and communication; and other economic affairs and services. For the central government. IMF GFS.
[14] Social public spending includes: education; health; social security and welfare; housing and community amenities; and recreational, cultural, and religious affairs. For the central government. IMF GFS
[15] According to this definition, productive spending includes: general public services; defense; education; health; housing; and transportation and communication. See Section III.
[16] Malaysia shows the highest fiscal deficits at 5.40% of GDP in 2000-2005
[17] This definition of fiscal deficit refers only to the difference between total revenues (including grants) and expenditures net of lending for the consolidated central government. It does not include flows at sub-national levels and contingent liabilities that have not been reflected in the government budget.

other circumstances, it can be said that they all have managed to maintain certain fiscal discipline over time.

In terms of equality, high GDP per capita growth rates sustained through almost half a century have certainly led to a decline in absolute income poverty in all seven countries. However, on improving income and non-income distribution, the evidence found points to rather mixed results[18].

In this respect, a gradual increased emphasis on public spending on social sectors in all seven countries seems to have been motivated in most of them precisely by the need to further reduce inequality and facilitate the social insertion of those less qualified or equipped to work in higher value added sectors, due to a perceived risk that persistent inequalities could jeopardize growth in the medium-term. At the same time, previous achievements in basic infrastructure and a stronger role of the private sector, reflected in higher private investments and FDI, perhaps with the exception of Botswana where public spending still plays a predominant role, have allowed for the transition towards a public sector more heavily focused on reducing income and non-income disparities.

## II. THEORETICAL BACKGROUND

In the growth literature, several analytical and empirical studies have focused on the traditional and new channels through which different types of public spending can affect growth[19].

A *direct* effect relates to an increase in the economy's capital stock (physical or human) reflecting higher flows of public funds, especially when they are complementary to those privately financed. For example, public spending in education and health contribute to an increase in the stock of human capital. Similarly, to the extent that they trigger an accumulation of physical capital, most public expenditures in infrastructure fall in this category as having a direct impact on growth.

In addition, public funds can also contribute to growth *indirectly* by increasing the marginal productivity of both publicly and privately supplied production factors. For example, public expenditures on research and development (R&D) promote higher productivity in the interaction between physical and human capital factors, in a similar way as adopting private sector financed foreign technologies.

Similarly, other components of public spending, related for instance to the enforcement of property rights and maintenance of public order, can also exert a positive indirect effect on growth by contributing to better use of existing capital and labor assets. For instance, in countries where crime and violence are endemic, increased public spending

[18] This issue is, however, not addressed in the empirical analysis of this paper.

[19] See Barro and Sala-i-Martin (2003), Zagler and Durnecker (2003), and Agénor (2004) for overviews of this literature, and Agénor and Moreno-Dodson (2007) for a particular focus on public spending on infrastructure. Noteworthy empirical studies include Devarajan, Swaroop, and Zou, 1996; Tanzi and Zee, 1997; Bleaney, Gemmel, and Kneller, 2001; and Bose, Haque, and Osborn, 2007, to which we shall return.

on security can lead to lower production costs by reducing the need to protect employees and physical assets, increasing worker productivity, and stimulating private physical investment (through an increased in expected rates of return on capital).

There is also growing evidence suggesting that in developing countries externalities associated with infrastructure spending may be more important that commonly thought. Indeed, it has been found that infrastructure may have a sizable impact on human capital as well. As discussed by Agénor and Moreno-Dodson (2007), public spending in infrastructure affects growth not only through its direct impact on investment and the productivity of factors in the private sector, but also through health and education outcomes.

For instance, access to clean water and sanitation helps to improve health and thereby productivity. By reducing the cost of boiling water and reducing the need to rely on smoky traditional fuels for cooking, access to electricity also helps to improve hygiene and health. Availability of electricity is essential for the functioning of hospitals and the delivery of health services. Better transportation networks also contribute to easier access to health care, particularly in rural areas.

There is also evidence of direct linkages between infrastructure and education. Electricity allows for more studying and greater access to learning technologies. Enrollment rates and the quality of education tend to improve with better transportation networks, particularly in rural areas. Greater access to sanitation and clean water in schools also tend to raise attendance rates[20].

The growth accounting framework evolving from the neoclassical Solow-Swan model (1956) consists of adding the basic contributions of capital and labor to growth, and an unexplained residual capturing improvements in technology (also known as the Solow residual or the rate of growth of total factor productivity, TFP)[21].

Within this framework, public spending could, in principle, impact growth by affecting capital and/or labor, as well as the generation and/or assimilation of technological progress reflected in TFP. However, since it is assumed in the model that the long-run growth rate is driven only by the population growth and the rate of technical progress, which is considered to be exogenous, the effect of public spending on growth through the production factors is considered to be only transitional.

On the contrary, endogenous growth models, such a those of Barro (1990); King and Rebelo (1990); and Barro and Sala-i-Martin (1992, 1995), predict that "productive" public spending will indeed affect the long-run growth rate and not only its transitional

[20]The implications of this literature for the optimal allocation of public expenditure in a growth context is discussed by Agénor (2008), Agénor and Neanidis (2006), and Agénor and Moreno-Dodson (2007).

[21] The experience of industrial countries seems to suggest that the accumulation of physical capital is a very important source of growth in the early stages of development and that technological progress becomes the principal driving force once a relatively high level of capital intensity (measured by the capital to labor ratio) has been reached, see Agénor, 2004.

changes. In such scenario, it is possible to envisage that public spending may change the growth path, by affecting the production factors and/or TFP.

Empirically, the relationship between public spending and growth in support of either neoclassical or endogenous models has been difficult to establish for several reasons. A large part of the recent empirical literature on growth has examined the impact on growth of both the level and composition of government expenditures. Overall the evidence on the nature of this relationship is mixed. First of all, not all the public funds that appear in government budgets as having been spent were actually used according to budget allocations; any leakages or deviations from the original budget plan diminish the impact of public spending and distort its relationship with growth[22].

Second, efficiency constraints affect the share of the public spending flows actually used in creating new capital (physical and human) stocks, which affect growth directly[23]. Thus, by considering the total amounts of public spending financed, without any efficiency considerations, we may anticipate a higher impact on growth than what can be realistically expected.

Third, while some public spending may be, by itself, growth-promoting, the way through which the government chooses to finance it (inflationary financing, distortionary taxes, public debt leading to high interest rates resulting in crowding out of private investment, etc.) may have the opposite influence on growth. Since the two effects are difficult to disentangle, the impact of public spending on growth depends on its source of financing[24]. Yet, many empirical studies fail to include the implicit financial assumptions, or revenue side of the equation, when testing for the impact of public spending on growth.

Fourth, since not all categories of public spending are expected to have the same growth impact, classifying them according to different criteria may be essential to differentiate those items that are truly "productive" from those whose growth impact is negligible. However, data availability does not always allow for such classification[25].

[22] Quantitative techniques such as Public Expenditure Tracking Surveys (PETS) that are being currently conducted in many developing countries show that the percentage of spending actually reaching the population is much lower than what was recorded in the budget as being spent, due to leakages and inadequate budget implementation.

[23] This issue was raised by Pritchet in 1996 who reckoned that only about 50% of public investments flows in developing countries contribute to creating new capital stock (see Pritchet, 2000). The idea has been further developed and tested by Hurlin and Arestoff, 2006.

[24] In Barro's (1990) model, growth increases with expenditures and taxation at low levels, and then decreases as the distortionary effects of taxation exceed the beneficial effects of public spending. In addition, at higher levels of public spending inefficiency may increase. That is the main conclusion of Afonso, Schuknecht, and Tanzi in reference to new EU members (forthcoming 2008).

[25] While aggregated expenditures are easier to find on an annual basis for a relatively long period of time, not all the sectors report data every year and therefore functional classifications are not always possible. In addition, some countries have introduced recent changes in the budget nomenclature, which make sectoral comparisons less meaningful.

Finally, initial country conditions, reflecting the level of country development and living standards (such as life expectancy and/or human capital indexes), influence the effects of different public spending categories on growth[26]. Therefore, omitting initial conditioning variables in the analysis could distort the final results[27].

Other issues arise from methodological problems[28] associated with separating short-run and long-run effects of public spending on growth, as well as testing for the endogeneity[29] of public spending with respect to growth, and the existence of nonlinearities[30].

The objective of this paper is to conduct a quantitative assessment of the impact of public spending on growth using an endogenous growth framework. The main issue is to test whether the historical evidence reflected in GDP per capita growth rates of around 3% or more for almost half a century (1960-2006) in the selected country sample supports the theoretical background underlying endogenous growth models with respect to the role of public spending. Knowing more about how the effects of public spending on growth have crystallized and evolved over time in those fast growing countries could be helpful for other parts of the world.

## III. EMPIRICAL METHODOLOGY

*Function Specification and Variable Definitions*

The quantitative analysis is conducted using panel data for the selected seven countries[31] during the period 1970-2006[32], focusing mainly on the effect of public spending on growth (See Appendix I for data information)[33].

Different function specification forms were first considered, following Barro and Sala-i-Martin, Bleaney et al., 2001; and Bose et al. 2007. The model chosen for the study is similar to the ones presented in previous papers but introduces some specific characteristics and innovations to fit the country sample and the objectives of the broader analysis.

Initially, the direct sensitivity of GDP per capita growth to public spending is tested using a function specification in which the rate of growth of GDP per capita is the dependent

[26] Intuitively, building basic physical and social infrastructure should trigger a much more significant growth effect in low income settings than in countries where a certain threshold has already been reached.
[27] Levine and Renelt, 1992.
[28] Bleany, Gemmel, and Kneller, 2001.
[29] Public spending may affect growth positively but faster growth may also induce larger government spending.
[30] See Barro, 1990.
[31] These seven fast-growing countries were considered as "developing" countries at the beginning of the period of analysis.
[32] Although the qualitative analysis starts in 1960, compatible data are not available before 1970 and therefore the econometric work focuses on the period 1970-2006.
[33] Annual data are used in some of the regressions. Three-year averages are also calculated and used for some others.

variable and the ratios of fiscal variables to GDP are the key explanatory variables, controlling for other non-fiscal, growth-promoting determinants.

The basic model is as follows:

$$\hat{y}_{it} = b_1 \hat{y}_{it-1} + b_2 p_{it} + b_3 HC_i + b_4 FR_{it} + b_5 PE_{it} + b_6 FS_{it} + b_7 CPIINF$$

where:

*i* is the country index

*t* is the year index

$\hat{y}$ is the rate of growth of GDP per capita

*p* is the ratio of private investment to GDP[34]

*HC* is the initial human capital

*FR* is the ratio of total Fiscal Revenues to GDP[35]

*PE* is the ratio of total Public Expenditures to GDP[36]

*FS* is the ratio of the Fiscal Balance (Surplus) to GDP,

*CPIINF* is the inflation rate,

and $b_1$, $b_2$, $b_3$, $b_4$, $b_5$, $b_6$, and $b_7$ are the coefficients assigned to the independent variables.

Three groups of independent variables are considered: control variables (other, non-fiscal, determinants of growth), initial conditioning variables, and fiscal variables.

The selection of control variables was made taking into account lessons from both the growth literature and the individual country case studies. In particular, the ratio of private sector investment to GDP is retained on the grounds that, during the period of analysis, in all countries (except for Botswana) the largest share of total investment was

[34] In some regressions, openness has been used, instead of the private investment-to-GDP ratio, as a control variable.
[35] In some function specifications total fiscal revenues are disaggregated into tax and non-tax revenues.
[36] In a different function specification, total public spending is disaggregated according to functional categories into social and economic spending (criterion 1); see Page 7 and Annex I. Then, the distinction has been made between productive and unproductive public expenditures, using an *a priori* definition (criterion 2). Finally, a last specification has consisted of focusing only on expenditures in education, health, and transportation, which are expected to be critical for development (criterion 3). In all cases we are referring to the central government only.

financed by the private sector, and some complementarity effects between private and public investment were detected.

Since one of the goals of the analysis is to understand better under which policy circumstances public spending affects growth, the inflation rate is introduced as a measure of the degree of macroeconomic instability, attempting to capture both monetary and fiscal policymaking[37].

In addition, an openness variable (OPEN, measured in standard fashion as the sum of exports plus imports divided by GDP) is also introduced based on the fact that in most of the selected countries growth has occurred in connection with export-led development strategies[38].

Finally, the lagged value of the dependent variable (GDP per capita growth rate in period t-1) is included to take into account growth inertia factors[39]. This provides a natural way to distinguish between short- and medium-run effects on growth.

As in other similar studies, the initial conditioning variables that were initially selected were the initial life expectancy, the initial level of human capital, and/or the initial GDP per capita. For instance, Bloom, Canning, and Sevilla (2004) found that life expectancy has a sizable, positive effect on economic growth; a one-year improvement in the population's life expectancy contributes to an increase in the long-run growth rate of up to 4 percentage points. Sala-i-Martin, Doppelhofer, and Miller (2004) also found that initial life expectancy has a positive effect on growth. Regarding the other two variables, Sala-i-Martin et al. found that the initial level of human capital (as proxied by primary schooling enrollment rates) and initial GDP per capita were also significant. As human capital was more significant than the other two initial conditioning variables in all regressions, in the end it is the only one retained.

Regarding the fiscal variables, the government budget constraint is considered in the specification function, for methodological reasons, by introducing total fiscal revenues (tax and non-tax) plus the fiscal balance variable[40] (defined as total fiscal revenue, tax and non-tax, plus grants, minus total public spending net of lending), both variables as ratios to GDP, for the central government.

[37] In another function specification, the ratio of external debt to GDP was introduced as a debt sustainability variable. However, due to lack of sufficient data for all countries, such specification was not retained for the analysis. Results are available upon request.

[38] The basic model in page 9 does not show the openness variable, OPEN, since it has been considered only in some forms of the regression.

[39] See also endogeneity effects in page 13.

[40] It is important to notice that lagged values of public expenditure ratios are used (t-1) while the fiscal deficit is taken at its current value (t). The rationale is that while it takes some time for (executed) public spending to influence growth, the impact of fiscal stability can be observed within the same year since it affects investors' confidence and inflation expectations. In addition there could be a timing measurement issue since, in some countries, public spending spread over two calendar years (fiscal year ends in June), whereas the fiscal deficit is measured for statistical purposes at the end of the calendar year.

In addition, given the importance of good governance on the growth impact of total public spending, an index of governance is introduced. In order to assess these effects, a governance interactive variable is constructed by multiplying the selected country governance indicator by the ratio of public spending to GDP[41]. Finally, another innovation of this paper consists of adding a coefficient of technical efficiency[42] of spending, based on the notion that not all public expenditures that are executed contribute to increase the stock of human/physical capital and therefore the analysis of their potential impact on growth needs to take efficiency considerations into account[43]. For this purpose, an ICOR is calculated for total public investment and then multiplied by the different ratios of total public spending to GDP[44]

*Expenditure Classifications*

Unlike other studies testing only the impact of public investment on growth while ignoring completely current spending, this analysis includes total public spending, capital and current, without specifically separating them. The rationale for this decision is based on the evidence that some categories of current spending items are indeed critical to ensure the profitability of investments.

For example, operations and maintenance expenditures, which are considered as current spending items, are critical to ensure the profitability of infrastructure investments since they can facilitate access and prevent accidents, permitting citizens to arrive safely to markets, schools, hospitals or any other destinations. Similarly, salaries of teachers, usually classified under the current spending rubric, are closely connected to the quality of education provided. In addition, it would not be realistic to try and isolate public investments completely since in many countries capital budgets include *de facto*, explicitly or implicitly, salaries and current spending items.

In order to examine trade-offs across expenditure functions and categories, public expenditures are grouped according to three main different criteria. Criterion (1) corresponds to the GFS classification for functional expenditures which distinguishes among economic[45] and social[46] expenditures; the rest of the budget includes defense, general public services, and others.

[41] Since the World Bank Kauffman-Kray-Mastruzzi indicators are not available before 1996, an index of government effectiveness, which is measured by the level of bureaucratic quality from the Political Risk Indicators database (PRS), is used since 1986. No other governance indicators are available before that date.

[42] This concept of efficiency is defined as an input-output concept which focuses strictly on the contribution of public spending flows to creating stocks of human/physical capital.

[43] See Agénor, Nabli, and Yousef, 2007 for a more detailed description of this methodology.

[44] The governance and efficiency variables are not included in the basic model of page 9.

[45] Economic public spending includes: fuel and energy; agriculture, forestry, fishing, and hunting; mining, mineral resources, manufacturing, and construction; transportation and communication; and other economic affairs and services. For the central government.

[46] Social public spending includes: education; health; social security and welfare; housing and community amenities; and recreational, cultural, and religious affairs. For the central government.

Criterion (2) presents a classification[47] of expenditures split in two categories, "productive"[48] and "unproductive"[49], based on an *a priori* judgment regarding their expected impact on growth.

Criterion (3) presents a sectoral classification which is only used in some regressions, specifically for education, health, and transport and communications public expenditures, only to analyze individual country effects.

With Criterion (1), the rationale behind using broad categories of expenditures, rather than sectoral ones (such as education, health…) is twofold. First, when observing the patterns of evolution of public spending in all seven countries, two clearly differentiated paths are observed for economic and social spending categories, respectively[50]. In other words, governments tend to increase either economic or social expenditures as shares of total spending depending on the effects that they want to trigger[51]. Second, from an econometric viewpoint, using broad aggregates avoids potential colinearity problems that may result from using individually the sectoral items included within each functional category.

As mentioned before, Criterion (2) implies an *a priori* judgment about the expected impact of different public spending categories on growth, which is later tested. An implicit assumption behind this classification is that, regardless of their evolution as shares of total spending, public expenditures in economic, social sectors, and others, may have a greater impact on growth when estimated jointly. Using a normative notion of "integrated" development, governments should not plan expenditures by categories but rather taking into account synergies across sectors[52] to have higher impact on growth. Under such scenario, it would be more reasonable to group public expenditures under broader labels according to their expected impact on growth without distinguishing whether they are economic, social, or other types of expenditures. As in the case of Criterion (1), this approach also attempts to avoid colinearity among individual spending categories[53].

Finally, when using Criterion (3), the goal is to estimate the effect of public expenditures in three critical sectors (education, health, and transport and communications) on GDP

[47] This categorization was introduced by Bleany, Gammel, and Kneller in 2001, and it is consistent with the theory behind endogenous growth models according to which only "productive" spending should be expected to have an impact on growth; see the discussion above.
[48] Productive spending includes: general public services; defense; education; health; housing; and transportation and communication.
[49] Unproductive spending includes: social security and welfare, recreation, and other economic services.
[50] Other expenditures, such as defense and general public services, do not follow such clear patterns.
[51] For example Thailand, Korea, and Singapore increased economic spending all together in periods when they wanted to stimulate growth while they raised social spending when equity and inclusiveness concerns were more acute.
[52] For example, taking into account access to hospitals and schools when designing the road network investment plans.
[53] Anyway, in both cases, Criteria (1) and Criteria (2), some public spending categories are left out of the regression to avoid collinearity problems.

per capita growth at the country level and compare the results with previous econometric work based on a similar sectoral classification.

*Econometric Methods*

Three econometric methods are used (OLS, SURE, and GMM) and their results are then compared[54]. For the selected country sample, the short and medium-term growth impacts of public spending on GDP per capita growth (dependant variable) are analyzed. First, using annual data, the focus is on the short-term effect. Second, the same regressions are run using three-year average data to "smooth out" cyclical effects[55] and the results of both exercises are compared using OLS and SURE methods. Finally, a dynamic panel technique (GMM) is used and the results are compared with those obtained with the static panel regressions (OLS and SURE).

The SURE methodology is a type of ordinary least squares (OLS) specification which can be used to account for various patterns of correlation among the residuals. There are four basic variance structures: period specific heteroskedasticity, contemporaneous covariances, between period covariances, and cross-section specific heteroskedasticity (SURE), which is the one used in this paper. This methodology is used to check whether or not our results with ordinary least square change when we introduced cross-section specific heteroskedasticity, given that in the data set we include countries that are quite different from each other.

Regarding the endogeneity of public spending with respect to growth, first of all we observe that in none of the sample countries (except for Botswana) the size of total government spending as ratio of GDP grew more than the rate of GDP growth during the period of analysis, which may indicate that public spending has contributed to growth more than growth has contributed to increased public spending.

Nevertheless, in the econometric analysis the possible endogeneity of public spending with respect to growth is taken into account when using the three econometric methods. Initially[56], the lagged values (year t-1) of GDP per capita growth and public spending to GDP ratios are introduced as regressors, in order to isolate the effects of public spending on GDP per capita growth.

Since, as recognized in the literature, this is an imperfect technique, our third econometric method, the GMM dynamic panel method, is used to allow for a more rigorous treatment of the endogeneity of public spending with respect to growth and leads to consistent estimates. GMM is, with no doubt, the best methodology to estimate the empirical

[54] See Appendix II for a detailed description of the three methods.
[55] Given the lack of degrees of freedom, it was not feasible to use five-year averages, as is commonly done in cross-country growth regressions. It should be noted, however, that the use of five-year averages has been criticized as being somewhat arbitrary; there is no strong reason to believe, a priori, that applying a common moving average filter is the correct procedure for extracting the cyclical component of all variables. There is also a potential loss of information that is hard to quantify.
[56] When using OLS and SURE techniques.

specification. However, in the presence of lagged instrumental variables, data availability restricts our ability to use this methodology consistently. Therefore we continue relying on OLS and confirm that the results obtained are consistent with the SURE methodology, and, when possible, with GMM. As indicated in the next section, OLS and SURE methodologies produced similar results[57], and GMM confirmed most of them.

## IV. ESTIMATION RESULTS

The overall results show that, in the selected countries, total public spending[58] has an economically and statistically significant positive effect on the GDP per capita growth rate, after having taken into account the effects of total fiscal revenues and the fiscal balance, and after controlling for other variables, in particular the inflation rate and the ratio of private sector investment to GDP or the degree of openness, OPEN. In all regression using this specification, the statistical significance of the results increases when the lagged value of GDP per capita growth is added, which may indicate that public spending is exerting a positive influence on growth and not vice versa.

Tables 1 (OLS and SURE) and 2 (GMM) present the results obtained with the three econometric methods used, regressing GDP per capita growth with respect to the ratio of total public spending to GDP, using annual data and the basic model described before.

Both the OLS and SURE methodologies indicate that **total public spending and the fiscal surplus have a significant impact on GDP per capita growth at 1 percent. The negative effects of inflation (macroeconomic instability) and total fiscal revenues are significant also at 1 percent**. The lagged valued of the dependant variable has a positive sign and a highly significant coefficient, indicating strong growth dynamics from year to year.

The GMM results are consistent with the previous two methods but some of the variables lose significance, particularly the budget surplus and total fiscal revenues. **Total public spending remains significant at 5 percent** and the negative effect of inflation dominates, indicating that perhaps **in a dynamic setting macroeconomic stability becomes the most important condition for GDP per capita growth**[59].

[57] A Granger causality test was also conducted between productive public expenditures and growth. The results (available upon request) indicate that there is no such causality relation, which probably indicates that other variables are affecting both. However, the test indicates that growth leads to higher amount of productive expenditures in Botswana, Mauritania, and Thailand. On the other hand, productive expenditures lead to growth only in Botswana.

[58] We aggregate productive and unproductive public spending, which in most countries add up to about 80% of total public spending. The only category left is "others" which includes only unclassified spending.

[59] Initial conditions and non-fiscal control variables are not included in this regression since in a dynamic cross-country setting they may have non-linear effects on growth.

Criterion (1)

When separating economic and social spending as ratios of GDP, according to Criterion 1, only economic spending appears to be positive for growth. The results are presented in Tables 3 and 4[60].

Table 3 (OLS with annual data) shows that the coefficients for both economic and social expenditures are positive but only the one of economic public spending is statistically significant at 10 percent, indicating **a positive effect on growth of economic public spending in the short term**.

The results also indicate that there is a strong positive effect of macroeconomic stability on growth as the coefficient obtained for inflation is negative and statistically very significant at a 1 percent level.

Table 4 (OLS and SURE with 3-year average) presents similar results in terms of coefficients with economic public expenditures being statistically significant at 5 percent and 1 percent, respectively. This may indicate that **economic public expenditures not only have a transitional effect on growth but also affect its path over the medium-term**[61].

Regarding the positive effect of macroeconomic stability on growth, the coefficients obtained using three-years averages corroborate those reported in Table 3. The negative sign for inflation is statistically significant at a 5 and 1 percent level respectively, **indicating the vital importance of maintaining macroeconomic stability to sustain growth over the medium-term**.

Finally, it is interesting to notice that the negative effect of total fiscal revenues on growth that was detected in earlier regressions becomes particularly significant for non-tax revenues when using this specification. It is possible to interpret this result on the basis of country evidence indicating that non-tax fees levied by the government in both economic and social sectors may have been more detrimental to growth that tax compliance obligations[62].

Criterion (2)

When disaggregating total public spending to distinguish between *a priori* productive and unproductive spending (Criterion 2), the results indicate that, in fact, it is productive

[60] Due to the small sample and data limitations, it is not possible to obtain coherent findings using the GMM method with this criterion. Better results are later found using Criteria 2.

[61] These results should, however, be interpreted with some caution, given that the sample size drops significantly as a result of data averaging.

[62] For example, this may be particularly relevant in Singapore where a formal welfare system has never been established and the government has used a compulsory savings scheme to allocate funds to some workers' compensation benefits.

expenditures that have the most statistically significant positive effect on growth. The results using this criterion are shown in Tables 5, 6, and 7.

Table 5 (OLS with annual data) reinforce the results found with Criterion (1) regarding the budget surplus and macroeconomic stability (inflation), and also shows positive and statistically significant coefficients for both categories of expenditures, productive and unproductive (lower values), with the highest significance level of 1 percent for productive expenditure and 10 percent for unproductive expenditure.

Table 6 (OLS and SURE with 3-year averages) shows, however, that unproductive expenditures do not have any impact on growth anymore, which could indicate that the effects observed in Table 5 are just transitional and do not affect the medium-term path of growth. But productive expenditures are still statistically significant at the highest 1 percent level.

Table 7 (GMM) confirms that **in a dynamic panel, only productive expenditures have a positive effect on growth** that is statistically relevant at 1 percent level. Unproductive expenditures also have a positive coefficient, but the results are not statistically significant.

The results obtained using this criterion, using the OLS methodology and three-year average data, are also presented in Table 8 in comparison with the results found by the same authors who defined the productive-unproductive *a priori* expenditure classification (Bleaney, Kneller, and Glemmell in 2001)[63] using also OLS but with five-year average data. We find some similar findings, notably **the statistical relevance of the productive expenditures ratio** with a positive coefficient[64].

Finally, the results reported above seem to present a strong linear relationship between economic growth and productive expenditures. Given this information, we could still ask whether or not this relationship has any nonlinear components. To answer this question, we add a square term of productive expenditures in our regression specification[65]. While the coefficient of the linear term captures the direction of the link between economic growth and productive expenditures, the square term explains whether the link is concave or convex.

The results are presented in Table 9. When we add the nonlinear term in our regression equation, the linear term of productive expenditures still has a positive coefficient and it is statistically significant at 10 percent (down from 1 percent without the nonlinear term).

[63] Their data set covers twenty-two "developed" countries during 1970-1995.

[64] Unlike the work done by Bleaney et al., in this paper fiscal revenues are introduced as the sum of tax plus non-tax revenues in the function specification. No differentiation is made between distortionary and non-distortionary taxation. The main reason is that the focus of this paper is strictly the impact of public spending on growth, and not on how the structure of the tax system affects growth.

[65] If the coefficient of the square term is positive, it indicates a convex relationship between two variables. It means an increasing slope of the function. The negative coefficient of the square term indicates a concave relationship between variables, meaning a decreasing slope of the function.

On the other hand, the coefficient of the square term of productive expenditures is negative showing a concave relationship between growth and productive expenditures, but this coefficient is not statistically significant. Thus, we can conclude that **nonlinearities—at least as measured by adding a quadratic term to the base regression—are not statistically important for our regression specification**.

Other Results

Although the main focus of the analysis is on public spending, based on the regressions presented before, it is also relevant to extract some conclusions regarding the other independent variables:

- The initial conditioning variables do not seem to have been binding determinants of the growth dynamics process. The level of initial human capital appears, however, as a positive conditioning factor, with the right sign but not always statistically significant[66].

- The private sector investment ratio to GDP, when used as control variable, has in most cases a positive sign and is statistically significant; this confirms the fact that private capital accumulation has been one of the main engines of growth in the selected countries[67].

- The openness variable also exhibits a positive sign, indicating its influence on growth. However, it is interesting to notice that such effect becomes most visible when the dynamic panel GMM technique is used, which implies that there are other indirect effects among the independent variables that are better captured through this, more sophisticated, method.

- The total fiscal revenue to GDP ratio exhibits a negative sign and is, for most regressions, statistically significant; the fiscal surplus to GDP ratio is always positive and statistically significant. These results are theoretically correct and attest to the fact that there is a downside to financing public spending. In addition, the positive effect of the fiscal surplus may reflect its contribution to lowering interest rates thus promoting more private investment which is proven to be conducive to growth.

- When total fiscal revenues are disaggregated into tax and non-tax revenues, non-tax revenues appear to be more statistically significant than tax revenues. This result could indicate that, while the tax burden has remained relatively light in

[66] This result can be compared with one of the empirical findings of Romer (NBER Working Paper 1989) who indicates that the initial level of literacy does help predict the subsequent rate of investment and, indirectly, the rate of growth.

[67] However, due to a possible correlation with the inflation variable, the private sector investment to GDP ratio is not always included in the function specification and it is replaced by openness in some regressions (see for example the GMM method presented in table 7).

many of these countries, other charges and fees (often for the use of government services) have been levied on the population with a negative impact on growth.

- The net effect of fiscal policy has also been estimated by calculating the sum of the coefficients of expenditures, revenues, and the fiscal surplus in Table 5 (using productive and non-productive expenditures with OLS). The sum of all fiscal variable coefficients in this regression is 0.694 and its standard deviation is 0.193. This result produces a t-statistics almost equal to 3.6 which indicates a statistical significance at 5 percent of the joint effect of all fiscal variables. Thus, it can be concluded that **the net effect of fiscal policy is positive and statistically significant**.

- Unfortunately, the results obtained when using the interactive governance variable are not significant[68]. Part of the reason is surely the lack of a sufficiently long series of relevant governance indexes—a problem that could be overcome in future work by using a larger country sample.

- Similarly, the public spending efficiency effects are not fully captured, given data limitations[69].

## RESULTS WITH COUNTRY EFFECTS

The results reported in the previous section are obtained by pooling all data information for each country without taking into account specific country effects. Since it is expected that the effects of economic and social, or productive and unproductive, public expenditures on growth may vary per country, in this section the growth equation is estimated including country-specific variables. This approach is particularly useful here, given that the sample of countries is relatively small. Due to constraints related to degrees of freedom, however, the country-specific effects are estimated one by one.

Table 10 (OLS) reports the results using Criteria (1) and annual data. The interactive dummy variables are constructed, for instance for economic expenditure in Botswana, as follows[70]:

Interactive dummy for economic expenditure in Botswana =
- 1*economic expenditure if the country is Botswana
- 0 otherwise.

[68] Results are available upon request.
[69] Results are also available upon request.
[70] A separate interactive dummy variable was not introduced for Indonesia to prevent the perfect multicollinearity problem.

The interactive dummy variables for economic expenditures (abstracting from country differences in terms of social expenditures) have an expected positive sign for each country except for Indonesia[71].

The estimated coefficients are statistically significant at 5 percent for Botswana, and at 10 percent for Malaysia. The value of the coefficient is highest for these two countries, indicating where economic public expenditure had the strongest effect on growth.

One explanation for the negative sign in Indonesia could be the fact that, due to data limitations, only central government expenditures are included in the analysis. General government expenditure would have been more appropriate due to the high degree of decentralization of government activities in the country.

The results with the interactive dummy for social public expenditure (abstracting from country differences in terms of economic expenditures) suggest that these expenditures also have a positive impact on growth for each country except for Indonesia, Korea, and Thailand, and is not statistically significant for Singapore (despite having the correct sign). The coefficients are statistically significant for the other countries. Their significance level is 1 percent for Botswana, 5 percent for Mauritius, and 10 percent for Malaysia. These results indicate that, in several countries of the sample (Botswana, Malaysia, and Mauritius), social expenditures are as essential as economic expenditures for economic growth, particularly in the short term. However, for Singapore, the impact of social expenditures appears to be less than the impact of economic expenditures, as measured by the coefficients of both variables.

As in the previous section, the same specifications are rerun using 3-year averages in an attempt to capture better the medium-run effects of different components of public expenditure on growth. Table 11 shows the results with economic versus social expenditure for each country. The coefficients for economic expenditures (abstracting from country differences in terms of social expenditures) are positive but not statistically significant; they remain negative for Indonesia. This indicates that the effects detected in Table 10 are only transitional.

Table 12 (OLS) reports the regression results when interactive country dummies are introduced for productive and unproductive public expenditure using Criterion (2) and annual data. When looking at the results in the first column, we can see that for productive expenditures (abstracting from country differences in terms of unproductive expenditures) all coefficients have the expected positive sign and they are statistically significant at a 5 percent level for Botswana, Malaysia, and Mauritius. These results indicate that the effect of productive public expenditure on growth is stronger in those three countries. In addition, in the regression with the lagged dependent variables, the coefficients for Korea and Singapore are borderline significant at 10 percent level.

[71] One country must be dropped, because the original variable appears as well in the equation; otherwise, there would be perfect colinearity among regressors. The results for Indonesia are therefore captured by the difference between the coefficient of the original variable in the regression and the country-specific coefficients.

The coefficient for Indonesia is calculated as the difference between the coefficient of the original variable and the country-specific coefficients. It has a negative sign even though it is statistically insignificant.

It is important to notice that in the regression results with country effects, the coefficients of the other variables do not change with respect to the results presented in the previous sections. Similarly, the exclusion of the lagged growth rate as a regressor does not change the initial findings[72].

The results with the country-specific effects introduced for unproductive expenditure (abstracting from country differences in terms of productive expenditures) are also presented in Table 12. The coefficients have a positive sign for Botswana, Malaysia, Mauritius, and Thailand. But none of them is statistically significant. These results imply that unproductive expenditures do not seem to exert any significant effect on economic growth.

Overall, as expected, it can be concluded that **at the country level productive public expenditures are clearly much more relevant in explaining growth changes than unproductive ones even in the short term**.

Table 13 shows the results of the same regression but using the OLS method and 3-year averages. In general, the sign of coefficients remain similar, but the statistical significance of the country-specific variables drops significantly.

Finally, in order to further understand the effects of some critical sectoral components of public expenditure for each country, different regression specifications are run with the interactive country dummies for: education, health, and transportation (Criterion 3, see Page 8). The results are presented in Table 14, in each case focusing, as before, on country-specific effects associated with one sectoral component at a time, to preserve degrees of freedom. The interactive dummy variables are constructed, for example for education expenditure in Botswana, as follows:

Interactive dummy for education expenditure in Botswana =
- 1*education expenditure if the country is Botswana
- 0 otherwise.

When looking at the results with the interactive dummy for education, all countries have the expected positive sign**,** again except Indonesia[73].

[72]This is to be expected, given that averaging reduces the need to capture persistence (and short-run dynamics) by adding the lagged dependent variable. Results are not presented in the paper, but remain available upon request

[73] As before, this result can be partially explained by the fact that only central government expenditures are included. In Indonesia some of the government services in these sectors are delivered at the sub-national level.

The coefficients are statistically significant at 1 percent for Botswana, 5 percent for Botswana, Mauritius, and Thailand. The large values of these coefficients indicate the importance of education expenditures in determining growth. These results are consistent with those previously established by Bose, Haque, and Osborn (2007), who also estimated the coefficient of education expenditure as being positive and statistically significant[74].

Similarly, public expenditures in health have a positive and significant impact on growth in each country except for Indonesia, as can be seen in Table 14. The interactive dummy variable for health expenditure is significant at 1 percent for Botswana, Malaysia, Mauritius, Singapore, and Thailand. As was the case for education, the estimated values of the coefficients are high, indicating the importance of health expenditure on growth at the individual country level.

The last sectoral component of public expenditures included using the interactive dummy variable is public expenditure in transportation. It has also highly significant coefficients and all positive, except for Indonesia[75].

Table 15 reports the results for public expenditure in the three (education, health, and transport and communications), using 3-year averages. The estimated coefficients of education are much higher under this classification, and are significant at a 1 percent level for Botswana, and at a 5 percent level for Malaysia, Singapore, and Thailand. The reason could be that, compared to other sectors, **it takes a longer time for education expenditures to impact growth**.

The estimated coefficients of public expenditure in health are positive only for Botswana and Malaysia. The negative coefficient for Indonesia was somehow expected due to the exclusion of expenditures at a decentralized level, which (as mentioned earlier) are quite important in Indonesia. But the negative coefficient in Korea was not expected at all. One (econometric) reason might be having lower degrees of freedom due to the small number of observations available and the large number of regressors included in the specification. It could also be possible that in some countries, such as Korea, public expenditures in health have not been able to cope with the emerging needs of a growing population. In any case, these country results are somehow consistent with the findings of the cross-country analysis, which showed that health expenditures do not appear to have a direct effect on GDP growth in the medium-term.

Table 15 also shows that the impact of public expenditure in transport and communication on economic growth appears to be statistically insignificant almost for each country, when using the OLS method with 3-year averages. Botswana has a level of significance at 10 percent. But expenditure on transportation does not have any statistically significant effect on growth in other countries.

[74] They use data from thirty developing countries during the period 1970-1990.

[75] For comparison purposes, the estimated value of transportation and communication expenditures by Bose, Haque, and Osborn (2003) is negative in one specification and positive in another specification, but none of them is statistically significant, as it can be seen in Table 3 of their paper.

Finally, Table 16, using SURE and 3-year averages, shows that while education has a positive and significant impact on growth in the medium-run in all countries (expect for Indonesia), the effects are rather mixed for the other two spending categories. Korea has an unexpected and statistically significant negative sign for health, but insignificant coefficient for transportation expenditures. Thailand has similarly an unexpected negative sign for health and transportation expenditures, but both of which are statistically insignificant. Similarly, the coefficient of health expenditures in Mauritius is negative but insignificant[76].

Overall, we can conclude that, except for Indonesia, **public expenditures in education are the only ones to clearly show both short and medium-run effects on growth.**

## V. CONCLUSIONS AND POLICY IMPLICATIONS

The analysis presented in this paper leads to establishing an empirically robust relationship between public spending and GDP per capita growth. Furthermore, in consistency with endogenous growth models, some medium-term effects of public spending on growth are also identified, particularly when differentiating by categories of spending. Using a sample of seven fast-growing developing countries during the period 1970-2006, several conclusions are drawn at the cross-country and individual country levels.

Introducing the full government budget constraint has been essential to isolate the (positive) effect of public spending on growth while taking into account its sources of financing and their (negative) implications for growth. When looking at the coefficients of public spending ratios together with the fiscal revenue and fiscal surplus ratios, it becomes clear that the net effect of public spending on growth has been positive in this country sample.

Another strong conclusion relates to the importance of maintaining macroeconomic stability in order to ensure this positive contribution of public spending to growth. In all functional specifications, the negative link between inflation and growth is strong, indicating that no trade-off exists between the need to maintain macroeconomic stability and changes in the composition of public spending.

Besides the fiscal variables, private sector investment—which may have been positively influenced by government spending, particularly on infrastructure, as documented in other studies— appears to have been an important engine of growth in these countries. Similarly, the openness variable, when added to the regression, also exhibits a positive sign, indicating its influence on growth[77].

[76] We excluded Indonesia to prevent any near singularity problem that might be caused by inclusion of interactive variables for each country and cross-section SURE weights at the same time.

[77] This result is consistent with Romer's findings (WB Working Paper 1989) indicating that policies to encourage more open trading may be as important to growth and technological change as additional foreign lending. In many of the sample countries, open trade has become a crucial vehicle for the transfer of technologies, capital goods, and innovation policies.

Several expenditure classifications, according to three different criteria defined for the purpose of the analysis, have permitted a thorough assessment of the short and medium-term effects on growth in our group of countries. When dividing public expenditures between economic and social components (Criterion 1), a significant positive effect of economic expenditures is found both in the short and medium-term[78]. On the contrary, social expenditures do not appear to be as critical for growth.

When using the expenditure classification criteria defined by Bleaney et al., expenditures considered *a priori* as being productive (which include education and health expenditures, in addition to some economic expenditures such as transport and communications) are confirmed to be, indeed, the categories of spending that are most relevant for growth, particularly in the medium-run when unproductive spending is not significant at all. According to this finding, reallocating 1% of unproductive spending towards the productive spending categories would lead to a 0.35 % increase in GDP per capita growth[79], everything else being equal.

This result is particularly relevant for policymakers as it implies that, when considered jointly with the bulk of economic expenditures, education and health have a positive impact on growth, both in the short and the medium-term. The immediate policy implication is that for education and health expenditures to influence growth over the medium and long-term, they would have to be executed (and planned) in conjunction with most economic expenditures, and not in isolation from them[80]. It is important to note, however, that the positive effect of public spending on education and health may be capturing an indirect effect of spending on infrastructure, given the importance of externalities (discussed in Section II) associated with the latter category of spending for education and health outcomes.

The results obtained at the individual country level seem to confirm the findings of the cross-country analysis, with some peculiarities for each country. Indonesia is an exception, most likely due to the omission of expenditures at a decentralized level. Some country-specific results are particularly worth noticing, most notably the confirmation that in all the selected countries public spending in education has been critical to affect the path of GDP growth in the medium-term[81].

Our econometric results have important implications for the debate on the design of fiscal rules in a growth context[82]. Some economists have advocated the use of a "golden rule", whereby the focus is on maintaining a balance or surplus on the current fiscal account (that is, current revenues less current expenditures), with net capital expenditure financed

[78] This result is however not confirmed by GMM.
[79] 0.35 is calculated by subtracting the coefficient of non-productive expenditures (0.312) from the coefficient for productive expenditures (0.664). See Table 5.
[80] For example, education and health public spending strategies should take into consideration transportation access and, vice versa, infrastructure strategies should be planned taking into account health and education needs.
[81] This result is consistent with the existing literature on the links between human capital accumulation and growth. See for example Aghion, Meghir, and Vandenbussche (2004).
[82] See Agénor and Yilmaz (2006), and Servén (2007).

from government savings and borrowing (see Giavazzi and Blanchard (2004))[83]. A common criticism of this rule is that it is vulnerable to creative accounting.

Another important limitation, as implied by our results, is that a preferential treatment of physical investment could bias expenditure decisions against spending on other potentially productive components, such as current expenditures in education and health—with therefore a detrimental effect on growth. Moreover, some components of current spending, such as maintenance of roads, schools, and hospitals, may be equally important to maintain the quality of the services financed by public capital. Our results regarding the growth effects of total (capital and current) public spending on education and health support this view. The key question therefore is where to "draw the line" in the design of growth-enhancing fiscal rules.

Our analysis has been mainly "positive", trying to explain what happened in the seven selected countries during the period of analysis. If we now attempt to modestly move to a rather "normative" mode, trying to explore the lessons that these seven fast growing countries could offer to other parts of the world, several conclusions can be drawn. Based on qualitative facts and the empirical results, it would be fair to say that public spending exerts a positive impact on GDP per capita growth in a policy context where:

- Macroeconomic stability is sustained.

- The size of the government budget remains relatively small[84] in order to avoid jeopardizing fiscal stability and government effectiveness[85].

- The composition of public spending evolves as growth dynamics unfold to focus on those productive sectors/activities that are more conducive to growth. In this respect, policy makers should plan and implement jointly social and economic spending, as part of an integrated strategy, and attempt to gradually reduce allocations to unproductive spending—despite the fact that distinguishing *a priori* between productive and unproductive outlays may not always be easy.

- The government continues relying on the private domestic sector and foreign transactions (for example imports of capital goods), in order to leverage domestic human and physical capital, and to allow public spending to focus on sectors/activities where it is contributing to growth the most[86].

[83] More precisely, under the Blanchard-Giavazzi rule, governments should borrow in net terms on a continuous basis only to the extent that this net borrowing finances net public investment, that is, gross investment less capital depreciation (which counts as current spending). This rule therefore would allow gross borrowing for the purpose of refinancing maturing debt, thereby leaving net debt unaffected.

[84] This result is consistent with Barro's 1990 model and Tanzi's 2008 conclusions (see page 9).

[85] Although the empirical analysis does not demonstrate it, the qualitative country case studies indicate how essential it is that temporary increases in government spending (for countercyclical purposes, industrial policy interventionist episodes, crisis recovery, or others) do not undermine government effectiveness, transparency, and good governance.

[86] This implication is derived from the significance found for the variables private sector investment and openness with respect to growth, in addition to the positive effect of productive public spending.

## ISSUES FOR FUTURE RESEARCH

Despite the relevance of the results presented, it is important to mention three main caveats:

a) In future work, it would be important to extend the sample size to further tests for the robustness of the results; in particular introducing a comparison group including less good performers in terms of GDP per capita growth would allow us to explore further the extent to which public expenditure contribute to growth, and whether there are clear differences between fast and slow-growing economies;

b) The quality of public spending should be taken into account more accurately in connection with the governance variable, in light of recent results showing that governance can largely explain differences in the impact of public spending on human development indicators (see Rajkumar and Swaroop (2008)); and

c) Finally, although in the focus of this paper is solely on measuring the impact of public spending on growth, an important issue to address in future research is what determines governments' decisions to allocate spending among various components--in particular, the role of demographic factors and the nature of the political process. Surprisingly enough, there has been limited analytical and empirical research on these two possible determinants of government spending behavior. Much of the existing literature (alluded to earlier) on the optimal allocation of public expenditure in a growth context has ignored demographic and political considerations. At the same time, there is robust evidence suggesting that the composition of public spending depends on the demographic structure of the population and political factors as well.

For instance, using data for a large group of industrial and developing countries, Shelton (2007) found that a greater fraction of the population above 65 tends to be accompanied by higher levels of government expenditure on health care, public order and safety—possibly a reflection of the ability of the "old" to exploit the political process to their advantage. But such bias, to the extent that it is systematic, may result in large adverse effects on infrastructure investment and growth--and eventually the welfare of old and young generations alike. Thus, an important avenue for future research could be to extend our growth regression framework to a multi-equation setting, so as to account for the endogeneity of government spending choices.

# TABLES

## Country Comparison Tables

| Country | Year | GDP Per Capita Growth | Public Spending % GDP | Fiscal Balance % GDP | Gini Coefficient Year | |
|---|---|---|---|---|---|---|
| Botswana | 1970-1979 | 11.93% | 25.53% | -4.53% | | |
| | 1980-1989 | 8.00% | 32.53% | 9.65% | 1986 | 54.21 |
| | 1990-1999 | 3.74% | 36.91% | 5.32% | 1993 | 60.507 |
| | 2000-2005 | 5.60% | 38.83% | 0.44% | | |
| Indonesia | 1970-1979 | 5.27% | 14.69% | -2.68% | 1987 | 33.12 |
| | 1980-1989 | 4.18% | 21.17% | -3.59% | 1993 | 34.36 |
| | 1990-1999 | 2.84% | 17.23% | -0.85% | 1998 | 38.36 |
| | 2000-2005 | 3.37% | 18.33% | -1.09% | 2005 | 39.41 |
| Korea, Rep. | 1970-1979 | 6.35% | 15.48% | -0.79% | | |
| | 1980-1989 | 7.43% | 15.91% | 0.19% | | |
| | 1990-1999 | 4.52% | 16.39% | 0.97% | 1998 | 31.59 |
| | 2000-2005 | 4.60% | 20.71% | 1.52% | | |
| Malaysia | 1970-1979 | 5.39% | 18.96% | -5.06% | 1984 | 48.63 |
| | 1980-1989 | 3.18% | 30.58% | -7.64% | 1989 | 46.17 |
| | 1990-1999 | 4.52% | 24.23% | 0.00% | 1995 | 48.52 |
| | 2000-2005 | 3.15% | 26.99% | -5.40% | 1997 | 49.15 |
| Mauritius | 1970-1979 | 0.00% | 30.16% | -11.28% | | |
| | 1980-1989 | 4.90% | 26.81% | -6.62% | | None |
| | 1990-1999 | 4.24% | 23.59% | -3.26% | | |
| | 2000-2005 | 3.15% | 24.36% | -3.32% | | |
| Singapore | 1970-1979 | 7.55% | 18.07% | 0.69% | | |
| | 1980-1989 | 5.32% | 24.99% | 2.68% | | |
| | 1990-1999 | 4.39% | 15.60% | 7.80% | 1998 | 42.476 |
| | 2000-2005 | 4.13% | 16.58% | 4.73% | | |
| Thailand | 1970-1979 | 4.83% | 12.39% | -2.17% | 1981 | 45.22 |
| | 1980-1989 | 5.48% | 18.39% | -3.53% | 1992 | 46.22 |
| | 1990-1999 | 3.99% | 17.61% | -0.25% | 1996 | 43.39 |
| | 2000-2005 | 4.08% | 16.33% | -1.14% | 2002 | 41.978 |

| Public Spending Composition | | | | | | | |
|---|---|---|---|---|---|---|---|
| Country | Year | *PRODUCTIVE* | *SOCIAL* | *ECONOMIC* | Education | Health | Transport |
| Botswana | 1970-1979 | 70.87% | 35.67% | 31.37% | 16.54% | 5.66% | 13.71% |
| | 1980-1989 | 74.55% | 35.59% | 26.32% | 19.23% | 5.52% | 9.92% |
| | 1990-1999 | 79.43% | 39.97% | 15.46% | 23.01% | 5.22% | 6.76% |
| | 2000-2005 | 76.12% | 32.00% | | 23.52% | 8.48% | |
| Indonesia | 1970-1979 | 42.61% | 12.67% | 34.55% | 8.42% | 2.03% | 12.24% |
| | 1980-1989 | 72.20% | 13.68% | 30.52% | 9.24% | 2.14% | 8.88% |
| | 1990-1999 | 67.50% | 28.81% | 22.21% | 8.68% | 2.55% | 7.06% |
| | 2000-2005 | 65.47% | 6.76% | 1.87% | 2.93% | 1.33% | 1.09% |
| Korea, Rep. | 1970-1979 | 75.92% | 24.54% | 21.04% | 16.05% | 1.28% | 5.15% |
| | 1980-1989 | 68.31% | 29.08% | 16.10% | 18.83% | 1.70% | 3.68% |
| | 1990-1999 | 56.54% | 33.63% | 21.97% | 19.22% | 0.80% | 6.96% |
| | 2000-2005 | 61.73% | 35.01% | 24.96% | 15.38% | 0.45% | 6.67% |
| Malaysia | 1970-1979 | 61.65% | 34.74% | 15.65% | 22.45% | 6.71% | 5.87% |
| | 1980-1989 | 54.69% | 31.49% | 25.39% | 18.80% | 4.85% | 8.36% |
| | 1990-1999 | 49.44% | | 20.43% | 20.95% | 5.85% | 8.02% |
| | 2000-2005 | 63.50% | | 18.36% | 24.60% | 7.06% | 8.03% |
| Mauritius | 1970-1979 | 53.37% | 47.68% | 15.98% | 14.10% | 8.50% | 4.30% |
| | 1980-1989 | 50.86% | 43.36% | 14.96% | 14.86% | 7.78% | 4.50% |
| | 1990-1999 | 50.59% | 48.97% | 14.43% | 15.95% | 8.56% | 4.37% |
| | 2000-2005 | 53.56% | 52.34% | 12.32% | 15.74% | 8.70% | 3.40% |
| Singapore | 1970-1979 | 83.24% | 33.78% | 11.04% | 16.74% | 7.89% | 5.31% |
| | 1980-1989 | 72.95% | 34.96% | 16.58% | 18.62% | 5.72% | 8.01% |
| | 1990-1999 | 69.41% | 46.13% | 16.00% | 24.24% | 7.67% | 6.02% |
| | 2000-2005 | 86.79% | 45.43% | 15.38% | 23.70% | 6.65% | 7.82% |
| Thailand | 1970-1979 | 70.32% | 32.15% | 23.25% | 20.70% | 4.11% | 10.29% |
| | 1980-1989 | 67.23% | 30.41% | 22.24% | 19.64% | 5.41% | 7.02% |
| | 1990-1999 | 65.78% | 36.12% | 30.92% | 20.38% | 7.51% | 11.28% |
| | 2000-2005 | 71.52% | 43.09% | 26.27% | 21.15% | 8.97% | 7.11% |

| Country | Year | Corruption Control | | Government Efficiency | |
|---|---|---|---|---|---|
| | | Percentile Rank | Governance Score | Percentile Rank | Governance Score |
| Botswana | 1996 | 68.9 | 0.38 | 67.3 | 0.24 |
| | 2006 | 78.2 | 0.81 | 73.9 | 0.74 |
| Indonesia | 1996 | 31.1 | -0.55 | 64 | 0.14 |
| | 2006 | 23.3 | -0.77 | 40.8 | -0.38 |
| Korea, Rep. | 1996 | 73.8 | 0.52 | 80.6 | 0.92 |
| | 2006 | 64.6 | 0.31 | 82.9 | 1.05 |
| Malaysia | 1996 | 73.3 | 0.49 | 79.6 | 0.85 |
| | 2006 | 68 | 0.38 | 80.6 | 1.02 |
| Mauritius | 1996 | 71.8 | 0.45 | 73.5 | 0.46 |
| | 2006 | 66.5 | 0.37 | 71.6 | 0.63 |
| Singapore | 1996 | 97.6 | 2.25 | 99.5 | 2.28 |
| | 2006 | 98.1 | 2.3 | 99.5 | 2.2 |
| Thailand | 1996 | 38.3 | -0.39 | 72.5 | 0.44 |
| | 2006 | 50.5 | -0.26 | 64.9 | 0.29 |

# Table 1: Results with Total Public Expenditures (panel OLS and SURE)

***Dependent variable: Growth rate of GDP per capita***

| | **OLS** | **SURE** |
|---|---|---|
| Private investment<br>(% of GDP) | 0.107<br>(1.917)* | 0.115<br>(2.698)*** |
| Initial human capital | 0.007<br>(0.96) | 0.006<br>(0.931) |
| Total fiscal revenues<br>(% of GDP) | -0.323<br>(-3.884)*** | -0.296<br>(-4.175)*** |
| Productive plus unproductive expenditures (-1)<br>(% of GDP) | 0.477<br>(3.876)*** | 0.448<br>(4.263)*** |
| Budget surplus<br>(% of GDP) | 0.341<br>(3.668)*** | 0.304<br>(3.942)*** |
| Inflation - consumer price index | -0.205<br>(-5.65)*** | -0.177<br>(-4.908)*** |
| Growth rate of GDP per capita (-1) | 0.406<br>(3.928)*** | 0.378<br>(4.11)*** |
| No. of observations<br>Adjusted R2 | 120<br>0.443 | 120<br>0.473 |

Note: The estimation method is the ordinary least squares for panel data in the first column and the cross-section seeminly unrelated regression for panel data in the second column. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

# Table 2: Results with Total Public Expenditures (Dynamic Panel - GMM)

| ***Dependent variable: Growth rate of GDP per capita*** | |
|---|---|
| Total fiscal revenue<br>(% of GDP) | -0.214<br>(-0.521) |
| Total fiscal expenditures (-1)<br>(% of GDP) | 0.387<br>(1.774)* |
| Budget surplus<br>(% of GDP) | 0.014<br>(0.062) |
| Inflation - consumer price index | -0.327<br>(-3.511)*** |
| Growth rate of GDP per capita (-1) | 0.167<br>(0.899) |
| No. of observations | 94 |
| J-statistics | 7.542 |

Note: The estimation method is a dynamic GMM. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients. J-test is for overidentification problem where H0: there is no overidentification problem. We fail to reject in each case.

# Table 3: Results with Economic and Social Expenditures (panel OLS)

***Dependent variable: Growth rate of GDP per capita***

| | |
|---|---|
| Private investment (% of GDP) | 0.098<br>(1.594) |
| Initial human capital | 0.007<br>(0.704) |
| Tax revenue (% of GDP) | -0.106<br>(-0.93) |
| Other revenue (% of GDP) | -0.089<br>(-1.077) |
| Economic expenditure (-1) (% of GDP) | 0.33<br>(1.722)* |
| Social expenditure (-1) (% of GDP) | 0.09<br>(0.568) |
| Budget surplus (% of GDP) | 0.17<br>(1.734)* |
| Inflation - consumer price index | -0.207<br>(-5.322)*** |
| Growth rate of GDP per capita (-1) | 0.39<br>(3.499)*** |
| No. of observations | 122 |
| Adjusted R2 | 0.37 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

# Table 4: Results with Economic and Social Expenditures (panel OLS and SURE with 3-year averages)

***Dependent variable: Growth rate of GDP per capita***

| | **OLS** | **SURE** |
|---|---|---|
| Initial human capital | 0.028<br>(1.764)* | 0.022<br>(1.532) |
| Tax revenue<br>(% of GDP) | -0.230<br>(-0.972) | -0.165<br>(-1.084) |
| Other revenue<br>(% of GDP) | -0.299<br>(-2.462)** | -0.284<br>(-3.449)*** |
| Economic expenditure (-1)<br>(% of GDP) | 1.083<br>(2.613)** | 0.988<br>(3.161)*** |
| Social expenditure (-1)<br>(% of GDP) | 0.194<br>(0.679) | 0.063<br>(0.314) |
| Budget surplus<br>(% of GDP) | 0.495<br>(3.135)*** | 0.462<br>(3.707)*** |
| Inflation - consumer price index | -0.002<br>(-2.711)** | -0.002<br>(-3.642)*** |
| Growth rate of GDP per capita (-1) | 0.05<br>(0.192) | 0.007<br>(0.045) |
| No. of observations | 35 | 35 |
| Adjusted R2 | 0.279 | 0.525 |

Note: The estimation method is the ordinary least squares for panel data in the first column and the cross-section seeminly unrelated regression for panel data in the second column. 3-year averages are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

# Table 5: Results with Productive and Non-productive Expenditures (panel OLS)

***Dependent variable: Growth rate of GDP per capita***

| | **OLS** |
|---|---|
| Private investment<br>(% of GDP) | 0.071<br>(1.235) |
| Initial human capital | 0.007<br>(0.987) |
| Tax revenue<br>(% of GDP) | -0.201<br>(-1.877)* |
| Other revenue<br>(% of GDP) | -0.531<br>(-4.051)*** |
| Productive expenditure (-1)<br>(% of GDP) | 0.664<br>(4.314)*** |
| Non-productive expenditure (-1)<br>(% of GDP) | 0.312<br>(1.786)* |
| Budget surplus<br>(% of GDP) | 0.450<br>(4.182)*** |
| Inflation - consumer price index | -0.208<br>(-5.76)*** |
| Growth rate of GDP per capita (-1) | 0.377<br>(3.644)*** |
| No. of observations<br>Adjusted R2 | 120<br>0.454 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

# Table 6: Results with Productive and Non-productive Expenditures (panel OLS and SURE with 3-year averages)

***Dependent variable: Growth rate of GDP per capita***

| | **OLS** | **SURE** |
|---|---|---|
| Initial human capital | 0.016<br>(1.524) | 0.015<br>(1.685) |
| Tax revenue<br>(% of GDP) | -0.039<br>(-0.166) | 0.004<br>(0.029) |
| Other revenue<br>(% of GDP) | -0.644<br>(-4.256)*** | -0.583<br>(-5.456)*** |
| Productive expenditure (-1)<br>(% of GDP) | 0.720<br>(3.176)*** | 0.669<br>(4.071)*** |
| Non-productive expenditure (-1)<br>(% of GDP) | 0.082<br>(0.222) | -0.007<br>(-0.037) |
| Budget surplus<br>(% of GDP) | 0.630<br>(4.971)*** | 0.529<br>(5.981)*** |
| Inflation - consumer price index | -0.232<br>(-3.318)*** | -0.188<br>(-3.664)*** |
| Growth rate of GDP per capita (-1) | -0.053<br>(-0.205) | -0.098<br>(-0.576) |
| No. of observations | 34 | 34 |
| Adjusted R2 | 0.475 | 0.579 |

Note: The estimation method is the ordinary least squares for panel data in the first column and the cross-section seeminly unrelated regression for panel data in the second column. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

# Table 7: Results with Productive and Non-productive Expenditures (Dynamic Panel - GMM)

***Dependent variable: Growth rate of GDP per capita***

| | With openness |
|---|---|
| Initial human capital | -0.030<br>(-0.151) |
| Openness<br>(% of GDP) | 0.058<br>(1.834)* |
| Tax revenue<br>(% of GDP) | -0.153<br>(-0.355) |
| Other revenue<br>(% of GDP) | -0.400<br>(-0.905) |
| Productive expenditure (-1)<br>(% of GDP) | 0.777<br>(1.673)* |
| Non-productive expenditure (-1)<br>(% of GDP) | -0.890<br>(-1.301) |
| Budget surplus<br>(% of GDP) | 0.126<br>(0.316) |
| Inflation - consumer price index | -0.375<br>(-3.12)*** |
| Growth rate of GDP per capita (-1) | -0.03<br>(-0.151) |
| No. of observations | 98 |
| J-test | 1.993 |

Note: The estimation method is a dynamic GMM. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients. J-test is for overidentification problem where H0: there is no overidentification problem. We fail to reject in each case.

**Table 8 - Comparison with Bleaney, Gemmell, and Kneller (2001) Table 1 on page 44 (OLS methdology)**

***Dependent variable: Growth rate of GDP per capita***

| | Bleaney, Gemmell, and Kneller (2001) Table 1 on page 44 (Column 1) (5-year averages) | Our results with initial human capital index and lagged budget variables (3-year averages) |
|---|---|---|
| Investment | 0.020<br>(0.32) | -0.004<br>(-3.53) |
| Labor force growth | -0.015<br>(-0.05) | --- |
| Initial human capital index | --- | 0.011<br>(1.09) |
| Taxation | | -0.222 (lagged)<br>(-1.17) |
| Non-tax revenues | -0.101<br>(-0.51) | -0.425<br>(-2.60) |
| Other expenditures | 0.301<br>(1.82) | --- |
| Budget surplus | 0.357<br>(2.17) | 0.504<br>(4.51) |
| Distortionary taxation | -0.427<br>(-2.36) | --- |
| Productive expenditure | 0.273<br>(1.77) | 0.481 (lagged)<br>(2.27) |
| Non-productive expenditure | -0.039<br>(-0.23) | 0.223 (lagged)<br>(0.76) |
| Net lending | 0.314<br>(1.32) | --- |
| No of observations | 98 | 34 |
| Adj-R2 | 0.574 | 0.508 |

Note: The estimation method is the ordinary least squares for panel data. In our case, the lagged values of some budget variables are used, specified as (lagged). t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

# Table 9: Nonlinearity of Productive Expenditures (panel OLS)

| ***Dependent variable: Growth rate of GDP per capita*** | |
|---|---|
| Private investment<br>(% of GDP) | 0.072<br>(1.238) |
| Initial human capital | 0.006<br>(0.791) |
| Tax revenue<br>(% of GDP) | -0.213<br>(-1.895)* |
| Other revenue<br>(% of GDP) | -0.540<br>(-4.039)*** |
| Productive expenditure (-1)<br>(% of GDP) | 0.826<br>(1.756)* |
| Square term of Productive expenditure (-1)<br>(% of GDP) | -0.464<br>(-0.365) |
| Non-productive expenditure (-1)<br>(% of GDP) | 0.316<br>(1.799)* |
| Budget surplus<br>(% of GDP) | 0.463<br>(4.073)*** |
| Inflation - consumer price index | -0.205<br>(-5.456)*** |
| Growth rate of GDP per capita (-1) | 0.376<br>(3.617)*** |
| No. of observations | 120 |
| Adjusted R2 | 0.449 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 10: Results with Economic and Social Expenditures with country effects (panel OLS)**

***Dependent variable: Growth rate of GDP per capita***

| | With Economic expenditure country effects | With Social expenditure country effects |
|---|---|---|
| Private investment (% of GDP) | 0.090<br>(1.287) | 0.118<br>(1.726)* |
| Initial human capital | 0.006<br>(0.24) | 0.037<br>(0.976) |
| Tax revenue (% of GDP) | -0.267<br>(-1.974)* | -0.259<br>(-2.077)** |
| Other revenue (% of GDP) | -0.181<br>(-1.207) | -0.329<br>(-2.182)** |
| Economic expenditure (-1) (% of GDP) | -0.664<br>(-1.307) | 0.325<br>(1.84)* |
| Social expenditure (-1) (% of GDP) | -0.130<br>(-0.575) | -1.340<br>(-3.251)*** |
| Budget surplus (% of GDP) | 0.255<br>(1.946)* | 0.263<br>(2.299)** |
| Inflation - consumer price index | -0.242<br>(-5.976)*** | -0.288<br>(-7.168)*** |
| Growth rate of GDP per capita (-1) | 0.212<br>(1.84)* | 0.151<br>(1.422) |
| Botswana-Economic expenditure (-1) (% of GDP) | 1.259<br>(2.549)** | … |
| Korea-Economic expenditure (-1) (% of GDP) | 0.331<br>(0.409) | … |
| Malaysia-Economic expenditure (-1) (% of GDP) | 1.093<br>(1.879)* | … |
| Mauritius-Economic expenditure (-1) (% of GDP) | 0.929<br>(1.552) | … |
| Singapore-Economic expenditure (-1) (% of GDP) | 0.202<br>(0.179) | … |
| Thailand-Economic expenditure (-1) (% of GDP) | 0.282<br>(0.661) | … |
| Botswana-Social expenditure (-1) (% of GDP) | … | 1.438<br>(4.506)*** |
| Korea-Social expenditure (-1) (% of GDP) | … | -0.651<br>(-0.862) |
| Malaysia-Social expenditure (-1) (% of GDP) | … | 0.741<br>(1.871)* |
| Mauritius-Social expenditure (-1) (% of GDP) | … | 0.773<br>(2.16)** |
| Singapore-Social expenditure (-1) (% of GDP) | … | 0.105<br>(0.151) |
| Thailand-Social expenditure (-1) (% of GDP) | … | -0.078<br>(-0.298) |
| No. of observations<br>Adjusted R2 | 122<br>0.441 | 122<br>0.526 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 11: Results with Economic and Social Expenditures with country effects (panel OLS with 3-year averages)**

***Dependent variable: Growth rate of GDP per capita***

| | With Economic expenditure country effects | With Social expenditure country effects |
|---|---|---|
| Private investment (% of GDP) | 0.092<br>(0.816) | 0.121<br>(0.939) |
| Tax revenue (% of GDP) | -0.31<br>(-1.279) | -0.428<br>(-1.616) |
| Other revenue (% of GDP) | -0.469<br>(-2.045)* | -0.441<br>(-1.471) |
| Economic expenditure (-1) (% of GDP) | -49.776<br>(-0.864) | 0.472<br>(1.161) |
| Social expenditure (-1) (% of GDP) | -0.29<br>(-0.698) | -41.124<br>(-0.988) |
| Budget surplus (% of GDP) | 0.513<br>(2.396)** | 0.541<br>(2.321)** |
| Inflation - consumer price index | -0.001<br>(-0.876) | -0.002<br>(-1.899)* |
| Growth rate of GDP per capita (-1) | -0.491<br>(-1.965)* | -0.293<br>(-1.198) |
| Botswana-Economic expenditure (-1) (% of GDP) | 50.525<br>(0.881) | … |
| Korea-Economic expenditure (-1) (% of GDP) | 48.358<br>(0.842) | … |
| Malaysia-Economic expenditure (-1) (% of GDP) | 50.175<br>(0.873) | … |
| Mauritius-Economic expenditure (-1) (% of GDP) | 49.431<br>(0.859) | … |
| Singapore-Economic expenditure (-1) (% of GDP) | 49.767<br>(0.874) | … |
| Thailand-Economic expenditure (-1) (% of GDP) | 48.526<br>(0.843) | … |
| Botswana-Social expenditure (-1) (% of GDP) | … | 40.965<br>(0.989) |
| Korea-Social expenditure (-1) (% of GDP) | … | 39.327<br>(0.948) |
| Malaysia-Social expenditure (-1) (% of GDP) | … | 40.752<br>(0.98) |
| Mauritius-Social expenditure (-1) (% of GDP) | … | 40.55<br>(0.975) |
| Singapore-Social expenditure (-1) (% of GDP) | … | 40.348<br>(0.98) |
| Thailand-Social expenditure (-1) (% of GDP) | … | 39.336<br>(0.946) |
| No. of observations | 35 | 35 |
| Adjusted R2 | 0.624 | 0.641 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 12: Results with Productive and Non-productive Expenditures with country effects (panel OLS)**

***Dependent variable: Growth rate of GDP per capita***

| | With productive expenditure country effects and lagged growth rate of GDP per capita | With non-productive expenditure country effects and lagged growth rate of GDP per capita |
|---|---|---|
| Private investment (% of GDP) | 0.087 (1.261) | 0.133 (1.864)* |
| Initial human capital | -0.068 (-1.28) | 0.032 (1.172) |
| Tax revenue (% of GDP) | -0.377 (-2.623)*** | -0.371 (-2.693)*** |
| Other revenue (% of GDP) | -0.578 (-3.883)*** | -0.451 (-2.766)*** |
| Productive expenditure (-1) (% of GDP) | -0.410 (-0.869) | 0.529 (2.955)*** |
| Non-productive expenditure (-1) (% of GDP) | 0.190 (0.802) | -0.250 (-0.515) |
| Budget surplus (% of GDP) | 0.464 (3.512)*** | 0.444 (3.095)*** |
| Inflation - consumer price index | -0.223 (-5.61)*** | -0.221 (-5.617)*** |
| Growth rate of GDP per capita (-1) | 0.247 (2.28)** | 0.254 (2.33)** |
| Botswana-Productive expenditure (-1) (% of GDP) | 0.728 (2.36)** | … |
| Korea-Productive expenditure (-1) (% of GDP) | 0.958 (1.75)* | … |
| Malaysia-Productive expenditure (-1) (% of GDP) | 0.888 (2.513)** | … |
| Mauritius-Productive expenditure (-1) (% of GDP) | 0.760 (2.248)** | … |
| Singapore-Productive expenditure (-1) (% of GDP) | 1.003 (1.882)* | … |
| Thailand-Productive expenditure (-1) (% of GDP) | 0.289 (1.391) | … |
| Botswana-Non-productive expenditure (-1) (% of GDP) | … | 0.880 (1.508) |
| Korea-Non-productive expenditure (-1) (% of GDP) | … | -0.361 (-0.463) |
| Malaysia-Non-productive expenditure (-1) (% of GDP) | … | 0.662 (1.131) |
| Mauritius-Non-productive expenditure (-1) (% of GDP) | … | 0.394 (0.82) |
| Singapore-Non-productive expenditure (-1) (% of GDP) | … | -1.468 (-0.937) |
| Thailand-Non-productive expenditure (-1) (% of GDP) | … | 0.067 (0.165) |
| No. of observations | 120 | 120 |
| Adjusted R2 | 0.481 | 0.478 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 13: Results with Productive and Non-productive Expenditures with country effects (OLS with 3-year averages)**

***Dependent variable: Growth rate of GDP per capita***

| | With productive expenditure country effects and lagged growth rate of GDP per capita | With non-productive expenditure country effects and lagged growth rate of GDP per capita |
|---|---|---|
| Private investment<br>(% of GDP) | 0.136<br>(1.088) | 0.112<br>(0.956) |
| Tax revenue<br>(% of GDP) | -0.218<br>(-0.697) | -0.270<br>(-0.935) |
| Other revenue<br>(% of GDP) | -0.519<br>(-2.095)** | -0.597<br>(-2.417)** |
| Productive expenditure (-1)<br>(% of GDP) | -32.555<br>(-1.126) | 0.101<br>(0.34) |
| Non-productive expenditure (-1)<br>(% of GDP) | 0.306<br>(0.474) | -57.457<br>(-0.991) |
| Budget surplus<br>(% of GDP) | 0.593<br>(2.86)*** | 0.595<br>(2.85)** |
| Inflation - consumer price index | -0.001<br>(-0.632) | -0.001<br>(-0.788) |
| Growth rate of GDP per capita (-1) | -0.416<br>(-1.393) | -0.421<br>(-1.493) |
| Botswana-Productive expenditure (-1)<br>(% of GDP) | 32.805<br>(1.137) | … |
| Korea-Productive expenditure (-1)<br>(% of GDP) | 32.493<br>(1.12) | … |
| Malaysia-Productive expenditure (-1)<br>(% of GDP) | 32.871<br>(1.132) | … |
| Mauritius-Productive expenditure (-1)<br>(% of GDP) | 32.512<br>(1.116) | … |
| Singapore-Productive expenditure (-1)<br>(% of GDP) | 32.764<br>(1.137) | … |
| Thailand-Productive expenditure (-1)<br>(% of GDP) | 32.431<br>(1.117) | … |
| Botswana-Non-productive expenditure (-1)<br>(% of GDP) | … | 58.492<br>(1.015) |
| Korea-Non-productive expenditure (-1)<br>(% of GDP) | … | 56.875<br>(0.984) |
| Malaysia-Non-productive expenditure (-1)<br>(% of GDP) | … | 58.147<br>(1.004) |
| Mauritius-Non-productive expenditure (-1)<br>(% of GDP) | … | 57.355<br>(0.99) |
| Singapore-Non-productive expenditure (-1)<br>(% of GDP) | … | 58.511<br>(1.028) |
| Thailand-Non-productive expenditure (-1)<br>(% of GDP) | … | 56.587<br>(0.978) |
| No. of observations<br>Adjusted R2 | 34<br>0.548 | 34<br>0.58 |

Note: The estimation method is the ordinary least squares for panel data. 3-year averages are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 14: Results with Components of Productive Expenditures (panel OLS)**

***Dependent variable: Growth rate of GDP per capita***

| | Components of productive expenditure and lagged growth rate of GDP per capita | Education expenditure with country effects | Health expenditure with country effects | Trasportation expenditure with country effects |
|---|---|---|---|---|
| Private investment (% of GDP) | 0.087 (1.438) | 0.177 (2.478)** | 0.139 (2.074)** | 0.121 (1.95)* |
| Initial human capital | -0.002 (-0.15) | -0.005 (-0.104) | -0.026 (-1.004) | -0.040 (-1.883)* |
| Tax revenue (% of GDP) | -0.161 (-1.355) | -0.377 (-2.667)*** | -0.332 (-2.429)** | -0.402 (-2.975)*** |
| Other revenue (% of GDP) | -0.537 (-3.975)*** | -0.484 (-2.986)*** | -0.509 (-3.346)*** | -0.529 (-3.599)*** |
| Education expenditure (-1) (% of GDP) | 0.442 (1.013) | -5.981 (-2.193)** | -1.447 (-2.319)** | -0.791 (-1.329) |
| Health expenditure (-1) (% of GDP) | 0.349 (0.537) | -1.328 (-0.928) | -17.460 (-3.271)*** | 0.273 (0.253) |
| Transportation expenditure (-1) (% of GDP) | 0.317 (0.763) | 0.342 (0.707) | -0.120 (-0.266) | -5.932 (-2.931)*** |
| Other productive expenditure (-1) (% of GDP) | 0.829 (3.781)*** | 0.967 (3.488)*** | 0.793 (2.897)*** | 0.870 (3.52)*** |
| Non-productive expenditure (-1) (% of GDP) | 0.389 (2.08)** | 0.413 (1.587) | 0.419 (1.671)* | 0.238 (1.047) |
| Budget surplus (% of GDP) | 0.410 (3.52)*** | 0.428 (3.278)*** | 0.347 (2.797)*** | 0.464 (3.47)*** |
| Inflation - consumer price index | -0.227 (-5.521)*** | -0.274 (-6.61)*** | -0.283 (-7.198)*** | -0.254 (-6.402)*** |
| Growth rate of GDP per capita (-1) | 0.357 (3.391)*** | 0.169 (1.572) | 0.159 (1.536) | 0.135 (1.238) |
| Botswana-Education expenditure (-1) (% of GDP) | … | 5.577 (2.636)*** | … | … |
| Korea-Education expenditure (-1) (% of GDP) | … | 3.602 (1.249) | … | … |
| Malaysia-Education expenditure (-1) (% of GDP) | … | 5.805 (2.489)** | … | … |
| Mauritius-Education expenditure (-1) (% of GDP) | … | 5.448 (2.486)** | … | … |
| Singapore-Education expenditure (-1) (% of GDP) | … | 4.407 (1.54) | … | … |
| Thailand-Education expenditure (-1) (% of GDP) | … | 4.385 (2.359)** | … | … |
| Botswana-Health expenditure (-1) (% of GDP) | … | … | 20.872 (4.046)*** | … |
| Korea-Health expenditure (-1) (% of GDP) | … | … | 10.741 (1.18) | … |
| Malaysia-Health expenditure (-1) (% of GDP) | … | … | 20.165 (3.705)*** | … |
| Mauritius-Health expenditure (-1) (% of GDP) | … | … | 17.541 (3.434)*** | … |
| Singapore-Health expenditure (-1) (% of GDP) | … | … | 17.519 (3.009)*** | … |
| Thailand-Health expenditure (-1) (% of GDP) | … | … | 14.857 (3.158)*** | … |
| Botswana-Transportation expenditure (-1) (% of GDP) | … | … | … | 6.538 (3.384)*** |
| Korea-Transportation expenditure (-1) (% of GDP) | … | … | … | 5.172 (1.933)* |
| Malaysia-Transportation expenditure (-1) (% of GDP) | … | … | … | 8.181 (3.735)*** |
| Mauritius-Transportation expenditure (-1) (% of GDP) | … | … | … | 6.731 (3.316)*** |
| Singapore-Transportation expenditure (-1) (% of GDP) | … | … | … | 6.084 (2.337)** |
| Thailand-Transportation expenditure (-1) (% of GDP) | … | … | … | 4.112 (2.455)** |
| No. of observations | 120 | 120 | 120 | 120 |
| Adjusted R2 | 0.447 | 0.519 | 0.549 | 0.521 |

Note: The estimation method is the ordinary least squares for panel data. Annual data are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 15: Results with Components of Productive Expenditures (panel OLS with 3-year averages)**

***Dependent variable: Growth rate of GDP per capita***

| | Components of productive expenditure and lagged growth rate of GDP per capita | Education expenditure with country effects | Health expenditure with country effects | Trasportation expenditure with country effects |
|---|---|---|---|---|
| Initial human capital | 0.043<br>(2.224)** | 0.018<br>(0.294) | 0.078<br>(1.555) | 0.014<br>(0.372) |
| Tax revenue<br>(% of GDP) | -0.078<br>(-0.329) | -0.18<br>(-0.586) | -0.490<br>(-1.494) | -0.186<br>(-0.556) |
| Other revenue<br>(% of GDP) | -0.654<br>(-4.252)*** | -1.013<br>(-4.593)*** | -0.649<br>(-3.767)*** | -0.493<br>(-2.574)** |
| Education expenditure (-1)<br>(% of GDP) | 2.687<br>(2.526)** | … | … | … |
| Health expenditure (-1)<br>(% of GDP) | 0.321<br>(0.296) | … | … | … |
| Transportation expenditure (-1)<br>(% of GDP) | 0.916<br>(1.176) | … | … | … |
| Other productive expenditure (-1)<br>(% of GDP) | -0.075<br>(-0.157) | -0.432<br>(-0.853) | 0.137<br>(0.316) | 0.211<br>(0.42) |
| Non-productive expenditure (-1)<br>(% of GDP) | -0.208<br>(-0.478) | 0.624<br>(1.051) | 0.368<br>(0.609) | -0.295<br>(-0.498) |
| Budget surplus<br>(% of GDP) | 0.783<br>(4.741)*** | 0.91<br>(4.801)*** | 0.706<br>(3.897)*** | 0.608<br>(2.922)*** |
| Inflation - consumer price index | -0.001<br>(-0.55) | 0<br>(-0.129) | -0.003<br>(-2.948)*** | -0.003<br>(-2.647)** |
| Growth rate of GDP per capita (-1) | -0.140<br>(-0.527) | -0.309<br>(-1.141) | 0.107<br>(0.356) | -0.189<br>(-0.585) |
| Botswana-Education expenditure (-1)<br>(% of GDP) | … | 3.681<br>(3.716)*** | … | … |
| Korea-Education expenditure (-1)<br>(% of GDP) | … | 2.451<br>(1.177) | … | … |
| Malaysia-Education expenditure (-1)<br>(% of GDP) | … | 2.845<br>(2.83)** | … | … |
| Mauritius-Education expenditure (-1)<br>(% of GDP) | … | 1.727<br>(1.403) | … | … |
| Singapore-Education expenditure (-1)<br>(% of GDP) | … | 4.75<br>(2.361)** | … | … |
| Thailand-Education expenditure (-1)<br>(% of GDP) | … | 2.145<br>(2.244)** | … | … |
| Botswana-Health expenditure (-1)<br>(% of GDP) | … | … | 7.817<br>(3.086)*** | … |
| Korea-Health expenditure (-1)<br>(% of GDP) | … | … | -24.400<br>(-1.339) | … |
| Malaysia-Health expenditure (-1)<br>(% of GDP) | … | … | 2.898<br>(1.072) | … |
| Mauritius-Health expenditure (-1)<br>(% of GDP) | … | … | -0.477<br>(-0.288) | … |
| Singapore-Health expenditure (-1)<br>(% of GDP) | … | … | -1.303<br>(-0.339) | … |
| Thailand-Health expenditure (-1)<br>(% of GDP) | … | … | -0.938<br>(-0.387) | … |
| Botswana-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 2.140<br>(2.088)* |
| Korea-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | -0.428<br>(-0.144) |
| Malaysia-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 2.366<br>(1.344) |
| Mauritius-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 1.547<br>(0.782) |
| Singapore-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 0.355<br>(0.152) |
| Thailand-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | -0.634<br>(-0.416) |
| No. of observations | 34 | 34 | 34 | 34 |
| Adjusted R2 | 0.492 | 0.576 | 0.532 | 0.349 |

Note: The estimation method is the ordinary least squares for panel data. 3-year averages are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

**Table 16: Results with Components of Productive Expenditures (Cross-Section SURE with 3-year averages)**

***Dependent variable: Growth rate of GDP per capita***

| | Components of productive expenditure and lagged growth rate of GDP per capita | Education expenditure with country effects | Health expenditure with country effects | Trasportation expenditure with country effects |
|---|---|---|---|---|
| Initial human capital | 0.036<br>(2.964)*** | 0.014<br>(0.37) | 0.071<br>(2.779)** | 0.003<br>(0.106) |
| Tax revenue<br>(% of GDP) | -0.028<br>(-0.192) | -0.088<br>(-0.432) | -0.464<br>(-2.469)** | -0.103<br>(-0.577) |
| Other revenue<br>(% of GDP) | -0.659<br>(-6.596)*** | -0.967<br>(-5.825)*** | -0.617<br>(-5.833)*** | -0.478<br>(-4.519)*** |
| Education expenditure (-1)<br>(% of GDP) | 2.295<br>(3.729)*** | … | … | … |
| Health expenditure (-1)<br>(% of GDP) | 0.537<br>(0.832) | … | … | … |
| Transportation expenditure (-1)<br>(% of GDP) | 0.796<br>(1.476) | … | … | … |
| Other productive expenditure (-1)<br>(% of GDP) | 0.159<br>(0.625) | -0.36<br>(-1.067) | 0.138<br>(0.553) | 0.163<br>(0.591) |
| Non-productive expenditure (-1)<br>(% of GDP) | -0.195<br>(-0.885) | 0.581<br>(1.461) | 0.468<br>(1.585) | -0.225<br>(-1.212) |
| Budget surplus<br>(% of GDP) | 0.699<br>(6.664)*** | 0.861<br>(5.805)*** | 0.635<br>(4.85)*** | 0.586<br>(3.518)*** |
| Inflation - consumer price index | -0.001<br>(-1.524) | 0.000<br>(-0.1) | -0.002<br>(-5.034)*** | -0.002<br>(-2.567)** |
| Growth rate of GDP per capita (-1) | -0.083<br>(-0.464) | -0.253<br>(-1.386) | 0.168<br>(0.983) | -0.230<br>(-1.216) |
| Botswana-Education expenditure (-1)<br>(% of GDP) | … | 3.451<br>(5.057)*** | … | … |
| Korea-Education expenditure (-1)<br>(% of GDP) | … | 2.632<br>(1.862)* | … | … |
| Malaysia-Education expenditure (-1)<br>(% of GDP) | … | 2.814<br>(3.923)*** | … | … |
| Mauritius-Education expenditure (-1)<br>(% of GDP) | … | 1.849<br>(2.274)** | … | … |
| Singapore-Education expenditure (-1)<br>(% of GDP) | … | 4.669<br>(3.252)*** | … | … |
| Thailand-Education expenditure (-1)<br>(% of GDP) | … | 2.290<br>(3.565)*** | … | … |
| Botswana-Health expenditure (-1)<br>(% of GDP) | … | … | 7.502<br>(4.514)*** | … |
| Korea-Health expenditure (-1)<br>(% of GDP) | … | … | -21.882<br>(-2.836)** | … |
| Malaysia-Health expenditure (-1)<br>(% of GDP) | … | … | 2.747<br>(1.984)* | … |
| Mauritius-Health expenditure (-1)<br>(% of GDP) | … | … | -0.507<br>(-0.612) | … |
| Singapore-Health expenditure (-1)<br>(% of GDP) | … | … | -0.816<br>(-0.472) | … |
| Thailand-Health expenditure (-1)<br>(% of GDP) | … | … | -0.623<br>(-0.36) | … |
| Botswana-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 1.476<br>(1.682) |
| Korea-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | -0.533<br>(-0.336) |
| Malaysia-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 1.949<br>(1.933)* |
| Mauritius-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 0.692<br>(0.574) |
| Singapore-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | 0.630<br>(0.544) |
| Thailand-Transportation expenditure (-1)<br>(% of GDP) | … | … | … | -0.883<br>(-0.797) |
| No. of observations | 34 | 34 | 34 | 34 |
| Adjusted R2 | 0.393 | 0.665 | 0.708 | 0.549 |

Note: The estimation method is the cross-section seeminly unrelated regression. 3-year averages are used. (-1) indicates variables lagged one period. t-statistics are given in parenthesis. * indicates 10% significance level, ** indicates 5% significance level, and *** indicates 1% significance level. These significance levels are equal to one minus the probability of rejecting the null hypothesis of zero coefficients.

## REFERENCES


Afonso, Schuknecht, and Tanzi, "Public Sector Efficiency. Evidence for New EU Member States and Emerging Markets", forthcoming in *Applied Economics*, 2008.

Agénor, Pierre-Richard, *The Economics of Adjustment and Growth*, Harvard University Press (Cambridge, Mass.: 2004).

Agénor, Pierre-Richard, "Fiscal Policy and Endogenous Growth with Public Infrastructure," *Oxford Economic Papers*, 60 (January 2008), 57-88.

Agénor, Pierre-Richard, and Moreno-Dodson, Blanca, "Public Infrastructure and Growth: New Channels and Policy Implications," in Public Expenditure, ed. By Maura Francese, Daniele Franco, and Raffaela Giordano, Banca d'Italia (Rome: 2007); and WB Working Paper.

Agénor, Pierre-Richard, Mustapha Nabli, and Tarik Yousef, "Public Infrastructure and Private Investment in the Middle East and North Africa," in *Breaking the Barriers for Higher Economic Growth*, ed. By Mustapha K. Nabli, World Bank (Washington DC: 2007).

Agénor, Pierre-Richard, and Kyriakos Neanidis, "The Allocation of Public Expenditure and Economic Growth," Working Paper No. 69, Centre for Growth and Business Cycle Research, University of Manchester (March 2006).

Agénor, Pierre-Richard, and Devrim Yilmaz, "The Tyranny of Rules: Fiscal Discipline, Productive Spending, and Growth," Working Paper No. 73, Centre for Growth and Business Cycle Research, University of Manchester (May 2006).

Aghion, Philippe, Meghir Costas, and Vandenbussche Jerome, "Growth, Distance to Frontier and Composition of Human Capital", JEL No. 120.

Arellano, M. and S. Bond, 1991, "Some Tests of Specification for Panel Data: Montecarlo Evidence and Application to Employment Equations," *Review of Economic Studies* 58(2), 277-297.

Barro, Robert J., "Government Spending in a Simple Model of Endogenous Growth," Journal of Political Economy, 98 (October 1990), s103-s25.

Barro, Robert J., and Xavier Sala-i-Martin, *Economic Growth*, 2nd. ed., McGraw-Hill (New York: 2003).

Blanchard, Olivier J., and Francesco Giavazzi, "Improving the SGP through a Proper Accounting of Public Investment," Discussion Paper No. 4220, Centre for Economic Policy Research (February 2004).

Bleaney, Gemmel, and Kneller, "Testing the Endogenous Growth Model: Public Expenditure, Taxation, and Growth Over the Long Run," Canadian Journal of Economics (2001)

Bloom, David E., David Canning, and Jaypee Sevilla, "The Effect of Health on Economic Growth: A Production Function Approach," *World Development*, 32 (January 2004), 1-13.

Bose, Niloy, M. Emranul Haque, and Denise R. Osborn, "Public Expenditure and Economic Growth: A Disaggregated Analysis for Developing Countries," *Manchester School*, 75 (September 2007), 533.56.

Calderón, Cesar, William Easterly, and Luis Servén, "Latin America's Infrastructure in the Era of Macroeconomic Crises," Chapter 2 in *The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America*, World Bank (Washington DC: 2004).

Devarajan, Swaroop, and Zou, "What Do Governments Buy? The Composition of Public Spending and Economic Performance," World Bank Policy Research Working Paper Series 1082, (February 1993)

Levine, Ross, and David Renelt, "A Sensitivity Analysis of Cross-Country Growth Regressions," American Economic Review, 82 (September 1992), 942-63.

Pritchett, Lant, "The Tyranny of Concepts: CUDIE (Cumulated, Depreciated, Investment Effort) is not Capital," *Journal of Economic Growth*, 5 (December 2000), 361-84.

Rajkumar, Andrew S., and Vinaya Swaroop, "Public Spending and Outcomes: Does Governance Matter?," forthcoming, *Journal of Development Economics* (June 2008).

Romer, Paul, "What Determines the Rate of Growth and Technological Change", World Bank Working Paper (1989).

Romer, Paul, "Human Capital and Growth: Theory and Evidence", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 40, 47-57

Sala-i-Martin, Xavier, Gernot Doppelhofer, and Ronald I. Miller, "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach," *American Economic Review*, 94 (September 2004), 813-35.

Servén, Luis, "Fiscal Rules, Public Investment, and Growth," World Bank Policy Research Paper Nol. 4382 (November 2007).

Shelton, Cameron A., "The Size and Composition of Government Expenditure," Journal of Public Economics, Vol. 91 (2007), 2230-60.

Tanzi and Zee, "Fiscal Policy and Long-Run Growth," International Monetary Fund Staff Papers, (June 1997)

Zagler, Martin, and Georg Durnecker, "Fiscal Policy and Economic Growth," *Journal of Economic Surveys*, 17 (July 2003), 397-418.

## APPENDIX I – INFORMATION ON DATA

### COUNTRIES INCLUDED

Botswana, Indonesia, Korea, Malaysia, Mauritius, Singapore, Thailand

### YEARS INCLUDED BY COUNTRIES

The years included are according to the data availability of government budget items.

Botswana: 1970-96 and 2001-2005
Indonesia: 1972-1999 and 2001-2005
Korea: 1970-97 and 2001-2005
Malaysia: 1972-87 and 2001-2005
Mauritius: 1973-2005
Singapore: 1972-2005
Thailand: 1972-2001

### LIST OF VARIABLES

**1. Control Variables**

**Private Investment**: Gross fixed capital formation by the private sector includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.
Source: WDI and IFC working paper.

**Imports of goods and services (% of GDP)**: Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude labor and property income (formerly called factor services) as well as transfer payments.
Source: WDI.

**Exports of goods and services (% of GDP)**: Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude labor and property income (formerly called factor services) as well as transfer payments.
Source: WDI.

**Openness (% of GDP)**: Exports of goods and services (% of GDP) plus imports of goods and services (% of GDP).

**Labor force (total)**: Total labor force comprises people who meet the International Labour Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed. While national practices vary in the treatment of such groups as the armed forces and seasonal or part-time workers, in general the labor force includes the armed forces, the unemployed, and first-time job-seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector.
Source: WDI.

**Bureaucracy Index**: Indexed series between 1 and 4 measuring the quality of bureaucracy. Higher numbers indicate higher quality.
Source: *International Country Risk Guide*.

**2. Initial Condition Variables**

**GDP per capita in constant 2000 U.S. dollar**: GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant U.S. dollars.
Source: WDI.

**Initial Human Inde**x: Following Bose, Haque, and Osborn (2007), we construct the initial human capital variable as the weighted sum of the initial enrolment ratios (%) in primary and secondary schools and in higher education. The weights are 1 for primary school enrolment ratio, 2 for secondary school and 3 for enrolment in higher education. The weights are approximations to the relative values of three types of education. The initial year is 1970.
Source: Barro and Sala-i-Martin (1995, 1999).

**Initial life expectancy**: Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. The initial year is 1970.
Source: Barro and Sala-i-Martin (1995, 1999).

**3. Government Budget Items**

**Tax Revenue**: Tax revenue refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue. For central government.
Source: GFS.

**Total Government Revenue**: Revenue is cash receipts from taxes, social contributions, and other revenues such as fines, fees, rent, and income from property or sales. Grants are also excluded here. For central government.
Source: GFS.

**Other Revenue**: Total government revenue minus tax revenues. For central government.
Source: Calculated by author.

**Total Government expenditure**: Total central government expenditure: economic plus social, plus general public services, plus defense, plus other expenditure.
Source: GFS.

**Budget balance**: Before 2001, it is calculated as total government revenue plus grants minus total expenditure minus net lending. After 2001, it is total revenue plus grants minus total expenditure. For central government.
Source: Calculated by author.

**Productive expenditure**:
General public services expenditure
Defense expenditure
Educational expenditure
Health expenditure
Housing expenditure
Transportation and communication expenditure
Source: Calculated by author.

**Unproductive expenditure**:
Social security and welfare expenditure
Expenditure on recreation
Expenditure on fuel and energy
Expenditure on agriculture, forestry, fishing and hunting
Expenditure on mining, mineral resources, manufacturing, and construction
Expenditure on other economic affairs and services
Source: Calculated by author.

**Economic Expenditure**:
Fuel and energy expenditure
Agriculture, Forestry, Fishing and Hunting
Mining and mineral resources, manufacturing and construction
Transportation and communication
Other economic affairs and services.
Source: Calculated by author.

**Social Expenditure**:
Education
Heath
Social Security and welfare
Housing and community amenities
Recreational, cultural and religious affairs.
Source: Calculated by author.

**4. Interactive variables**

**Interactive dummy variables with productive expenditure:** For example, in Botswana,

Interactive dummy for productive expenditure in Botswana =

1*productive expenditure if the country is Botswana

0 otherwise.

**Interactive dummy variables with economic expenditure:** For example, in Botswana,

Interactive dummy for economic expenditure in Botswana =

1*economic expenditure if the country is Botswana

0 otherwise.

**Interactive dummy variables for education expenditure:** For example, in Botswana,

Interactive dummy for economic expenditure in Botswana =

1*economic expenditure if the country is Botswana

0 otherwise.

## APPENDIX II – ESTIMATION TECHNIQUES

### 1. Panel data least squares (OLS)

This methodology is a basic panel data (cross section and time series) regression. [87] The general form of a model that can be estimated using a panel regression may be written as:

$$Y_{it} = \alpha + X_{it}'\beta_{it} + \delta_i + \gamma_t + \epsilon_{it},$$

where $Y_{it}$ is the dependent variable, and $X_{it}$ is a $k$-vector of independent variables, and $\epsilon_{it}$ are the error terms for $i = 1,2,...K$ cross-sectional units observed for dated periods $t = 1, 2, ..., T$. The $\alpha$ parameter stands for the overall constant term in the model, while the $\delta_i$ and $\gamma_t$ represent cross-section (fixed effects) or period specific effects. For identification, the $\beta$ coefficients have restrictions placed upon them. They can be divided into sets of common (across cross-section units and time periods), cross-section specific, and period specific regressor parameters.

In the paper, we have introduced fixed effects if initial variables i.e. initial life expectancy, initial human capital or initial GDP per capita are not included. To calculate country specific values of some β parameters, especially for economic and social expenditure, and productive and unproductive expenditure, we have used country dummies such that 1 is used for a specific country, 0 otherwise.

The data set can be in principle unbalanced or balanced. In this paper, our data set is unbalanced meaning that the time series dimension may change from country to country. We show the panel data as a set of cross-section specific regressions so that we have $K$ cross-sectional equations each with $T$ observations stacked on top of one another:

$$Y_i = \alpha i_T + X_i'\beta_{it} + \delta_i i_T + I_T\gamma + \epsilon_i$$

[87] The User Guide for E-views software program version 6 was used to prepare these sections.

for $i = 1,2,...K$, where $l_T$ is a $T$-element unit vector, $I_T$ is the $T$-element identity matrix, and $\gamma$ is a vector containing all of the period effects $\gamma' = (\gamma_1, \gamma_2, ..., \gamma_T)$.

In a similar way, we may write the specification as a set of $T$ period specific equations, each with *K* observations stacked on top of one another.

$$Y_t = \alpha \cdot I_K + X_t^{'} \cdot \beta_{it} + I_K \delta + \gamma_t \cdot l_K + \in_t$$

for $t = 1, ..., T$, where $l_K$ is a *K*-element unit vector, $I_K$ is the *K*-element identity matrix, and $\delta$ is a vector containing all of the cross-section effects, $\delta' = (\delta_1, \delta_1, ..., \delta_K)$.

The stacked representation of the equation given above helps us understand the methodology better. There are two possibilities: cross-section representation or time-series representation. First, for the specification organized as a set of cross-section equations, we have:

$$Y = \alpha \cdot I_{KT} + X \cdot \beta + (I_K \otimes l_T)\delta + (l_K \otimes I_T)\gamma + \in$$

where the matrices $\beta$ and $X$ are constructed to impose any restrictions on the data and parameters between cross-sectional units and time periods, and where the general form of the unconditional error covariance matrix is given by:

$$\Omega = E(\in \in') = E\begin{pmatrix} \in_1 \in_1^{'} & \in_1 \in_1^{'} & \cdots & \in_K \in_1^{'} \\ \in_2 \in_1^{'} & \in_2 \in_2^{'} & & \vdots \\ & & \ddots & \\ \in_K \in_1^{'} & & \cdots & \in_K \in_K^{'} \end{pmatrix}$$

When the specification is treated as a set of time-period specific equations, the stacked representation by period is given by,

$$Y = \alpha \cdot l_{KT} + X \cdot \beta + (l_K \otimes I_T)\delta + (I_K \otimes l_T)\gamma + \in$$

with error covariance of,

$$\Omega = E(\in \in') = E\begin{pmatrix} \in_1 \in_1^{'} & \in_1 \in_1^{'} & \cdots & \in_T \in_1^{'} \\ \in_2 \in_1^{'} & \in_2 \in_2^{'} & & \vdots \\ & & \ddots & \\ \in_T \in_1^{'} & & \cdots & \in_T \in_T^{'} \end{pmatrix}$$

**Significance level of coefficients**

In the tables, the statistical significance levels of coefficients are reported. They are 1 minus the probability of rejecting the null hypothesis of a zero coefficient. Assume that *b* is one of the estimated coefficients and the null and alternative hypothesis are defined as follow:

$$H_0: b = 0$$

$$H_1: b \neq 0$$

In this case, the significance level of 1% indicates that we reject $H_0$ with at least 99% probability; the significance level of 5% indicates that we reject $H_0$ with at least 95% and at most 99% probability; the significance level of 10% indicates that we reject $H_0$ with at least 90% and at most 95% probability.

**2. Cross- Section Seemingly Unrelated Regression**
**(Generalized Least Squares, GLS)**

GLS specifications can be estimated in a way that they account for various patterns of correlation between the residuals. There are four basic variance structures: cross-section specific heteroskedasticity, period specific heteroskedasticity, contemporaneous covariances, and between period covariances. The one used in this paper is cross-section specific heteroskedasticity (SURE). This methodology is used to check whether our results with ordinary least square change when we introduced cross-section specific

heteroskedasticity, given that in the data set we included countries quite different from each other.

The SURE covariance structures allow for conditional correlation between the contemporaneous residuals for cross-section $i$ and $j$, but restrict residuals in different periods to be uncorrelated. More specifically, it is assumed that:

$$E(\epsilon_{it}\epsilon_{jt}|X_t^*) = \sigma_{ij}$$
$$E(\epsilon_{it}\epsilon_{js}|X_t^*) = 0$$

for all $i$, $j$, $s$ and $t$ with $s \neq t$. It should be noted that the contemporaneous covariances do not vary over $t$.

When we use the time period specific residual vectors, we can specify the assumption above as,

$$E(\epsilon_t\epsilon_t'|X_t^*) = \Omega_M$$

for all $t$, where,

$$\Omega_M = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{12} & \sigma_{22} & & \vdots \\ & & \ddots & \\ \sigma_{M1} & \cdots & & \sigma_{MM} \end{pmatrix}$$

This variance is named as Cross-section SURE specification since it involves covariances across cross-sections as in a seemingly unrelated regressions type framework. Here each equation corresponds to a cross-section.

Cross-section SURE weighted general least squares on this specification, which are also referred as Parks estimator, is the feasible GLS estimator for systems where the

innovations are both cross-sectionally heteroskedastic and contemporaneously correlated. While constructing $\Omega_M$, residuals from first stage estimates are used. In the second stage, feasible GLS is performed.

This method can be used for a small number of cross-sections and a large number of time periods. Thus, for example, if you have a cross-section SURE specification with a large number of cross-sections and a small number of time periods, it is most likely that the estimated innovation correlation matrix will be nonsingular which suggests that feasible GLS methodology cannot be used.

**3. Dynamic Panel Data**

Since the lagged value of the growth rate of GDP per capita, which is the lagged value of dependent variable has been introduced as a regressor in our regressions, we also run our model with dynamic panel methodology, which is introduced by Arellano and Bond (1991). It is also named dynamic general method of moments (GMM). More specifically, we used two-step GMM methodology, taking first differences of the variables. Since a set of instrumental variables is used with this technique, it also helps us control for possible endogenity among regressors.

The methodology can be represented with the following linear dynamic panel data specification[88]:

$$Y_{it} = \sum_{j=1}^{p} \rho_j Y_{it-j} + X_{it}'\beta + \delta_i + \varepsilon_{it}$$

where *Y* is the dependent variable and *X* is the set of regressors or independent variables. First-differencing the equation above eliminates the individual effects and produces an equation of the form:

$$\Delta Y_{it} = \sum_{j=1}^{p} \rho_j \Delta Y_{it-j} + \Delta X_{it}'\beta + \Delta \varepsilon_{it}$$

[88] While preparing this section, we benefited from the User Guide for E-views software program version 6.

which may be estimated using GMM techniques.

The efficient GMM estimation of the equation require a different number of instruments for each period, with the period-specific instruments corresponding to the different numbers of lagged dependent and predetermined variables available at a given time period. Thus, in addition to any strictly exogenous variables, one can also use period-specific sets of instruments corresponding to lagged values of the dependent and other predetermined variables. In the regression results given in the paper, the set of instruments are defined as lagged values of dependent and independent variables. The complete set of instrumental variables in our case is

- the second and third lags of the growth rate of GDP per capita, initial human capital (or initial life expectancy or initial GDP per capita),
- the first, second and third lags of private investment as a % of GDP,
- the second and third lags of tax revenue, productive expenditure (or economic expenditure), unproductive expenditure (or social expenditure),
- the first, second and third lags of other revenue and budget balance, all as a share of GDP.

As it can be seen in the list, the lagged values of the dependent variable are also included as instruments. The motivation behind the use of the lagged values of the dependent variable as instruments can be explained as follows. If the innovations in the original equation are i.i.d., then in $t = 3$, which is the first period available for analysis of the specification, it is clear that $Y_{i1}$ is a valid instrument since it is correlated with $\Delta Y_{i2}$, but uncorrelated with innovation $\Delta \varepsilon_{i3}$. Similarly, in $t = 4$, which is the second available for the analysis, both $Y_{i2}$ and $Y_{i1}$ are potential instruments. Continuing in this way, we can form a set of predetermined instruments for individual $i$ using lags of the dependent variable, $Z_i$

$$= \begin{bmatrix} Y_{i1} & 0 & 0 & \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & Y_{i1} & Y_{i2} & \cdots & \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & 0 & \cdots & Y_{i1} & Y_{i2} & \cdots & Y_{iT_i-2} \end{bmatrix}$$

In a similar way, instruments can be formed for each predetermined variable or regressor.

If we assume that the residuals, $\epsilon_{it}$, are not autocorrelated, the optimal GMM weighting matrix for the first-differenced specification is given by,

$$W^1 = \left( M^{-1} \sum_{i=1}^{M} Z_i' \Xi Z_i \right)^{-1}$$

where $M$ is number of cross-sections and $\Xi$ is the matrix,

$$\Xi = \frac{1}{2} \begin{bmatrix} 2 & -1 & 0 & \dots & 0 & 0 \\ -1 & 2 & 0 & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & 2 & -1 \\ 0 & 0 & 0 & \dots & -1 & 2 \end{bmatrix} \sigma^2$$

and where $Z_i$ contains a set of instruments, which is lagged values of dependent and independent variables in our specification. $\sigma^2$ is the standard error of regression. It should be noted that this weighting matrix is the one used in the one-step Arellano-Bond estimator.

It changes slightly for a two-step estimator, which is the one used in the paper. After calculating the estimates of the residuals from the one-step estimator, we can replace the $W^1$ weighting matrix with the one estimated using a form similar to White period covariance estimation:

$$W = \left( M^{-1} \sum_{i=1}^{M} Z_i' \Delta e_i \Delta e_i' Z_i \right)^{-1}$$

This weighting matrix is used in the Arellano-Bond two-step estimator.