FROM PUBLIC INFRASTRUCTURE TO NATIONAL ECONOMIC GROWTH: DO SYSTEMATIC INVESTMENT PRACTICES MATTER?

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ABSTRACT

This paper investigates the path effects of systematic government investment on national growth. We build a theory where government investment practices, along with other institutional variables, affect the quality of a country's core public infrastructure system. This, in turn, positively affects national productivity. Using the path analysis method, we test our theoretical framework on a sample of data drawn from 25 developing economies during the period from 1990 to 2000. The results suggest that a unit increase in systematic public investment practices indirectly enhances national productivity with an increase of about $10-$15 in a country's real per capita GDP through the better condition and service capacity of a country's core public infrastructure.

Keywords *- Developing Countries, Economic Growth, Public Capital Budgeting, Public Investment, Systematic Management*

INTRODUCTION

In the public budgeting and finance literature, systematic capital spending has been recommended to government practitioners for several reasons. First, capital budgets may be larger than operating budgets. Second, public capital spending will result in public infrastructure whose quality and service are visible to the citizens and last for several decades. Third, public infrastructure has potential economic effects on national productivity. This study examines the third point: *Is there any significant effect of systematic public investment on national economic growth through the quality and accessibility of the public infrastructure system?*

The empirical results from the international development literature indicate that for low income countries, public capital expenditure exhibits negative effects on growth (Davarajan, Swaroop & Zou, 1996), while the quality of the public infrastructure system correlates with a country's national growth (Kumar-Jha, 2005: Dabla-Norris, Brumby, Kyobe, Mills, & Papageorgiou, 2011; Calderon and Serven, 2010 and 2008). In order to

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improve the quality of the public infrastructure system in these countries, the International Monetary Fund (IMF) (2005; 2010) recommends that a government adopt systematic investment approaches, including capital and fiscal planning, program budgeting, and investment evaluations.

The above practices are promising given that in the countries where resources are limited, waste and fraud should be eliminated and every dollar spent should be tied to meaningful, socially-desirable outcomes. Comprehensive planning and rational budgeting are keys to enhancing the economic growth in developing countries (Caiden & Wildavsky, 1974). Caidan and Wildavsky (1971) defined comprehensive planning and rational budgeting as "*government effort and activity to understand how different elements of the economic system including public and private consumption, saving, investment, and demand for good and service interact*." Accordingly, if the interrelationships among these factors are known, it is possible to determine national spending and taxing policies so as to enhance economic growth. Based on this concept, our study hypothesizes that systematic public investment practices can enhance a country's national productivity by providing quality public infrastructure services to the citizens in efficient and effective management approaches.

Given the above assumption, this paper examines the direct and indirect impact of government capital investment practices on national growth through the quality and service capacity of a country's core public infrastructure system. The unit of analysis is developing countries whose real annual per capita Gross National Income is less than $3,725 per person (The World Bank, 2011). To the authors' knowledge, development study that focuses on the complete linkage from government capital spending practices to public infrastructure outputs (in terms of quality and accessibility) and from infrastructure outputs to economic growth in a single study is rare.

Recently, Dabla-Norris, Brumby, Kyobe, Mills, and Papageorgiou (2011) produced a Public Investment Management Index (PIMI) based on four criteria: i) systematic guidance and project appraisal, ii) project selection and budgeting, iii) project implementation, and iv) project evaluation and audit. The index focuses on measuring a country's government efficiency in public infrastructure provision and services. The PIMI were built based on extensive data collected from multiple sources of a country's public infrastructure practices.[1] The PIMI appears to perform well in terms of both construct validity and internal validity. The construct validity requires that the four compositions of the index are relevant and thus reflect all dimensions of the efficiency provision concept. The construct validity of PIMI is justified by the reliability statistics for the sub-index correlation. The internal validity of the PIMI is shown through relatively high correlation between the country's real per capita GDP level and the efficiency index.

Dabla-Norris et al. (2011) suggest that the next step is to investigate whether PIMI as a country's institutional practices for public investment enhance economic growth in the middle and low-income countries (p.21). We adopted Dabla-Norris et al.'s (2011) suggestion in taking the next steps by linking public investment practices with their output (which is infrastructure quality and accessibility) and outcome (which is a country's economic growth rate). However, in this study, we use our own self-constructed indicators that are time variant focus on the aspect of fiscal planning relative to a country's

fiscal health and macro-economy, rather than the entire process in infrastructure investment, as PIMI does. In this aspect, our index could be considered as a sub-set of the entire investment process. The empirical results thus reflect the partial effect of good investment practices on growth path.

This study is also different from previous developmental research in that, for the second step in linking infrastructure output to outcome, it examines two different dimensions of public infrastructure provisions, namely, the quality of public infrastructure and citizen access to infrastructure, rather than simply examining public infrastructure spending level. The former is a meaningful performance indicator of public capital spending outcome, while the latter is simply an indicator of government activity. Recently, Calderon and Serven (2010 and 2008) used a similar measurement in investigating the relationship between public infrastructure outputs, namely the quality and quantity of public infrastructure and growth, in Latin American countries (Calderon & Serven, 2010) and sub-Saharan countries (Calderon and Serven, 2008). The authors employ IV-GMM methodology in which instrumental variables including population growth and lagged growth rates were included in the first stage regression to prevent feedback loops ranging from growth rate to infrastructure quality and quantity. The authors found that both quality and quantity are positively related to economic growth and negatively related to income inequity index in 21 Latin American countries (Calderon & Serven, 2010) and in 36 sub-Saharan African countries (Calderon & Serven, 2008). These studies thus provide a strong theoretical background for the proposed second linkage from infrastructure outputs (namely quality and accessibility) to growth in the current study.

This study is organized as follows. The next section describes the theoretical background. The following section presents the data, empirical results, and discussion. The last section presents implications and the conclusion.

THEORETICAL BACKROUND

Systematic and Comprehensive Capital Investment Practices

In the public budgeting and finance literature, capital budgeting is an administrative system that links long-term capital improvement programs to the methods that will be used to pay for those improvements and provides for the implementation of these long-term financial and physical plans (Hillhouse & Howard, 1963). The normative public budgeting literature recommends systematic capital investment practices, including 1) long-term capital planning (Ammar, Duncombe, Wright, 2001; Gianakis, McCue, 1999; Moak, Killian, 1963; Government Finance Research Center, 1983); 2) program budgeting (Moak & Hillhouse, 1975; Grifel , 1993); and 3) fiscal planning (Steiss & Nwagwu, 2001). These management practices parallel fundamental concepts of results-oriented management in which organizational effectiveness and managerial activities are directed toward achieving organization-wide systematic goals (Kettl, 1997).

Capital planning involves identifying the list of major capital projects that the citizens will need within a five- or six-year period, along with potential resources to finance them, and the impacts of the projects throughout their useful lives (Vogt, 2004). Public

infrastructure stock inspection, as well as infrastructure needs-analysis relative to business investment, actual citizen usage, and future usage are the keys in this process (Ammar, Duncombe & Wright, 2001). According to the management literature, capital planning ensures investment effectiveness by being responsive to businesses and residents' needs in terms of the accessibility and service quality of the public infrastructure system (Government Finance Research Center, 1983).

Program budgeting involves balancing annual capital spending with limited public resources (Moak & Killion, 1964). Project selection based on its benefit and cost analysis is the key for this practice since it eliminates low benefit projects (Aronson & Schwartz, 2004). Fiscal planning involves projecting future resources, including increasing the tax base, incomes, and other freed-up public resources (Steiss & Nwagwu, 2001), as well as conducting a debt capacity analysis (Vogt, 2004) and maintaining debt policies in order to enhance credit rating (Johnson & Kriz, 2005). Fiscal planning and program budgeting together thus identify the optimal level of public investment that should result in an efficient public infrastructure system.

The Public Infrastructure System, National Economic Growth, and Some Research Cautions

A large number of studies have investigated the relationship between public infrastructure spending and national economic growth (Aschauer, 1989; Aschauer, 1990; Munnell, 1990; Garcia-Mila & McGuire, 1992; Moomaw, Mullen & William, 2002, Lucus, 1988, Islam, 1995). However, the findings in these studies are mixed, depending on the samples, the indicators used to measure the infrastructure systems, and the set of control variables used in testing the models. Among these studies, the work by Davarajan, Swaroop and Zou, (1996) deserves more discussion since they found that in developing country samples, public investment reduces the country's economic growth while public consumption enhances growth. The development literature in 1990s was quiet in explaining why public capital spending exhibits a negative effect on growth.

In the 2000s, the development literature started to shed some light on explaining why spending in public infrastructure is not a good indicator in empirical growth model, especially in developing countries, even though public stocks are important elements in production functions suggested by growth theory. In building the PIMI index, Dabla-Norris et al. (2011) argue that "the link between capital spending and capital stock accumulation, and hence, growth, is weakened by the evidence of low efficiency of public investment" (p. 5). According to Dabla-Norris et al. (2011), the notion that public investment spending is equivalent to public infrastructure stock and accumulation; thus, public investment spending can be used as an alternative indicator for capital stock in empirical growth model is problematic. This is because in low- to medium-income countries, high degrees of investment inefficiency and corruption often distort the outcome of public investment, especially in terms of economic growth (Dabla-Norris et al., 2011). This argument is confirmed by the two empirical studies from Calderon and Serven (2010, 2008). As mentioned in the introduction section, when public investment is alternately measured by quality and quantity of public infrastructure, Calderon and Ser-

ven (2010, 2008) found a strongly significant and positive relationship between infrastructure quantity and quality and economic growth.

The concept that efficiency and effectiveness in public infrastructure investment practice can lead to economic growth is not new. In 1994, the World Development Report for Infrastructure Development (1994) argued that efficient and effective public infrastructure provisions and services will not be possible in low-income countries unless institutional arrangement in terms of public policy and management practices that are relevant to infrastructure provision are fully reformed. According to the report, three elements will contribute to efficient and effective infrastructure system. The first is practicing business-like management in acquiring public infrastructure. The bottom line for this practice is to give autonomy to the infrastructure acquisition operators (whether public or private sectors) but hold the operators' accountability through performance contracts and measurements. The second is to set the price of public infrastructure provision and service through either tax rate or user fees and user charges in a way that reflect the true demands from the public. Such practices will guarantee both an optimal level of public investment and efficient resource allocations, in the sense that the new infrastructure will be located where needs are greatest. The last is to broaden competitive markets for public infrastructure provision and management by awarding the provider roles to not only the central government but also to private sectors and subnational governments, depending on these agents' expertise. For example, the central government may operate roads and bridges given that there is benefit spillover throughout the country, while airports may be provided and managed through a lease system due to technical expertise of the private sectors. Likewise, municipal governments should provide local water and sanitation service systems, given that they are closet operator to the citizen users.

The World Development Report (1994) also suggests that to achieve the three practices, public management institutions in poor countries must be completely reformed by 1) de-monopolizing the roles of central government in providing and managing public infrastructure and 2) de-bundling the sectors of public infrastructure services such as transportation, communication, and health so that the infrastructure in different sectors can be operated by different agents. Possible practices in de-monopolizing and de-bundling include contracting-out, leasing, building, and transferring, as well as public-private partnership. Thus, to summarize, the World Development Report (1994) viewed that efficiency in an infrastructure system cannot be achieved through small-scale reform, but that large-scale institutional changes to assure good governance can be firmly established.

The linkage between good governance and growth are not straightforward. Kaufmann and Kraay (2002) establish the Worldwide Governance Indicators constructed through the qualitative and quantitative data drawn from 32 international development institutions and think-tank organizations worldwide (the full list of these sources is provided in Table 2 of Kaufmann and Kraay's (2002) article). Kaufmann and Kraay's indicators represent good governance in six dimensions: voices and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. Kaufmann and Kraay (2002) further investigated the relationship between the level of

economic development measured through a country's log of per capita income and the level of good governance in 26 Latin American countries. They found a strong and positive relationship from the level of good governance to the wealth of the country samples, but a weak and negative relationship from the level of country's wealth to the level of good governance.

Kaufmann and Kraay (2002) thus conclude that there are no feedback loops from the level of per capita income through a country's wealth level, given that good governance is a well-established system a country has adopted for quite a long period (40 years or more). In other words, a country's good governance is like a country's resource-endowment in which the country can yield the benefit in later years of a long-term period. If this is the case, the empirical growth study should find evidence that some developing economies do converge with the developed economies by exhibiting high-speed growth rate. Meisel and Aoudia (2008) later doubt this conclusion, given that the convergence is found in several growth studies.

Using Douglas North's (1990) concept of institutional arrangement, Meisel and Aoudia (2008) define good governance as a system in which the rules of the games in mobilizing a country's resources are well defined and formally accepted, hence lessening the uncertainty for all economic agents by ensuring that the rules of laws are followed by the other agents in the society through any transactions. According to Meisel and Aoudia (2008), good governance means 1) effectively functioning formal rules ensuring the respects of property and contracts; 2) effective and not very corrupt administrations; 3) an efficiently regulated market; and 4) respected rules of democracy. Together, these four aspects mean that the country with good governance will tend to have a relatively high degree of rule formalization.

Through a principal component analysis method, Meisel and Aoudia (2008) construct the degree of rule formalization through six indicators from the World Bank's governance indicators (i.e., voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption) and the other 77 variables from the Institutional Profile (IP) database. In a scatter plot analysis between the log of a country's per capita income and the degree of rule formalization, Meisel and Aoudia (2008) found that there is a strong and positive relationship between the "level" of economic development (measured through log of per capital income) and the degree of rule formalization (i.e., good governance indicator). However, when the log of per capita income is replaced by a country's speed of economic growth (i.e., the difference in log of per capital income—that is, annual percentage change of per capita income), Meisel and Aoudia (2008) do not find a strong and positive relationship between good governance and medium- to long-run growth path.

In the same paper, Meisel and Aoudia (2008) find that there are at least two steps in moving from developing to developed countries. The first step is to accomplish what they call "the governance focal monopoly," which refers to "an administrative system in which a country's management and policy priority are concentrated on acquiring the capacity for coordination and systematic vision, improving the quality of basic public goods and, in legal field, on element of formalization of rules that is essential for society that are mainly rural, namely agricultural property right" (Meisel & Aoudia, 2008, p.

22). Once a country accomplishes this first step of development, it can move through the developed stage by focusing more on the openness and formalization of a social regulatory system as measured by the World Bank's governance indicators. Examples of the countries in the first step include Thailand, Mexico, and Kuwait, while countries in the second step include Taiwan, Korea, Malaysia, China, and Vietnam, to name just a few (see Graph 7 in Meisal and Aouda, 2008).

Put together, the work by Meisal and Aouda (2008), the World Development Report (1994), Kauffmann and Kraay (2002), and Calderon and Serven (2010, 2008) explain why public infrastructure spending is not a suitable indicator for public stock in an empirical growth model, especially in two aspects: a) public investment in developing countries may be distorted by the lack of good governance, which is a strong foundation for economic development in the two developing stages, and b) public investment in developing countries may be inefficient due to high levels of corruption and lack of expertise, which makes quality and accessibility of public infrastructure better indicators than public spending.

In addition to the above discussions, public investment spending is not suitable for an empirical growth model for cross-country investigation given that public capital stocks in different countries depreciate at the different rates depending on the usage level and social and economic activities of each country. Bu (2004) empirically proves that in developing countries, the infrastructure depreciation rate used in calculating public and private capital stocks is not the same across countries, as economic and social forces can make national capital spending and capital formulation rates significantly different. These social and economic forces include corruption in capital goods procurement and incompatible infrastructure facilities and technical services, as well as government incentives to obtain new infrastructure through foreign aid funding rather than maintaining their existing infrastructure (Bu, 2004). The author asserts that the same capital depreciation rate calculated through capital spending levels across different countries' samples can yield invalid estimates of the effects of the infrastructure system on national productivity.

Due to the above concerns, this study measures public infrastructure service through public infrastructure's quality and population accessibility rather than public capital stocks or capital expenditure. These infrastructure indicators are discussed in the following section.

Conceptual Framework

Combining previous findings and the prescribed government capital investment practices, we form a set of hypotheses that stem from the basic theoretical argument that systematic capital budgeting and management practices will result in an effective public infrastructure system. In this study, an effective public infrastructure system is defined as the physical condition of a country's core public infrastructure, including road, electricity, and water systems, as well as citizen accessibility to the main public infrastructure systems.

A country's effective public infrastructure is thus measured through two constructed variables: 1) the average percentage of a country's paved roads to total road miles and uninterrupted electricity and water distribution output; and 2) the average percentage of people with accessibility to the country's roads, electricity, water, and communication facilities. Therefore, we measure government infrastructure investment by the annual quality and accessibility of public capital stocks rather than annual public capital expenditure. The reason is that the former measures government investment outcomes, while the latter is simply a record of government accounting, which may be subject to different depreciation rates and the lack of good governance across countries that may lead to misleading effects on growth.

At present, there are no time-series data on countries' public capital budgeting and management practices.[2] The PIMI was published in 2011, which is about the same time this paper was in progress. According to Dabla-Norris et al. (2011), the PIMI is a time-invariant factor in growth models. In this study, systematic capital budgeting and management practices are regarded as time-variant factors in the sense that such budget and capital planning practices can be changed from year to year in the same country. Given that systematic capital budgeting and management practices focus on comprehensive fiscal and capital planning, the concept is measured by three indicators: 1) the percentage of public investment to consumption, 2) the elasticity of public investment, and 3) the percentage of long-term debt interest to total revenue. The theoretical concept behind each indicator is described below.

The percentage of public investment to consumption

Effective governments should be able to balance consumption and investment rather than withdrawing investment for consumption, especially when the country's resources are limited and the economy is declining (Easterly & Schmidt-Hebbel, 1993). Fiscal planning helps the investor to identify infrastructure funding capacity relative to its revenue sources and consumption demands (Murdick & Demming, 1968). To capture this concept, we divided a country's annual total public infrastructure spending by its annual total current public operation and multiplied the ratio by 100. A larger value indicates that a government is relatively capable in terms of fiscal management of maintaining public investment spending without having to withdraw investment in that particular year.

The elasticity of public investment

We calculate the elasticity of public investment by dividing the annual percentage change of a country's total public investment by the annual percentage change of total private investment. Therefore, larger index values indicate that a government is relatively responsive to private production activity and infrastructure demands compared to the smaller index values. Note that since this variable is not simply the ratio of public investment size to private investment size but instead the elasticity of public investment with respect to private investment, it does not necessarily reflect the level of government spending on the public infrastructure system. Instead, this variable reflects the

quality of public investment decisions relative to actual private usage and future demands as determined by government physical and fiscal planning.

The percentage of long-term debt interest to total revenue

This indicator reflects a government's past investment through long-term debt finance. In developing countries, the main hurdle for public investment is capital market access (Riascos & Vegh, 2003); therefore, a larger value indicates either one of two situations: 1) a government has a poor credit rating which result in relatively high interest rate and debt services, or 2) the amount of government investment is not proportionate to its available cash flows, which results in relatively high risks for debt defaults. Thus, a larger value indicates that fiscal planning and debt management are relatively ineffective and as a result the country obtains a public infrastructure that is more expensive than that of its peers.

The following are the hypotheses for the effect of systematic capital investment practices on public infrastructure conditions and population accessibility.

H1: An increase in the percentage of total public investment to total public consumption will increase a country's percentage of core public infrastructure in good physical condition and increase a country's population accessibility rate to the core public infrastructure.

H2: An increase in the elasticity of public investment will increase a country's percentage of core public infrastructure in good physical condition and increase a country's population accessibility rate to the core public infrastructure.

H3: An increase in the percentage of long-term debt interest to total revenue will decrease a country's percentage of core public infrastructure in good physical condition and decrease a country's population accessibility rate to the core public infrastructure.

The concepts of infrastructure in good condition and population accessibility are different. Infrastructure in good condition represents the combination of existing infrastructure stocks and the financial and technical capacity of government to maintain them. Population accessibility represents a combination of existing public infrastructure stocks, the capacity of government to provide additional investment, and an individual decision of the country's citizens to use the new and existing infrastructure system. Thus, simply put, the infrastructure condition represents a government's fiscal and planning capacity to maintain existing stocks while the accessibility represents the stock itself and its use.

Given that the three indicators for public capital budgeting and management practices were constructed for a specific purpose in investigating the relationship between public investment practice and growth, we note that these indicators may not be absolutely free from measurement flaws. The ratio of public investment to consumption may not reflect the capacity of government in fiscal planning since public consumption may be reduced while public investment does not change. In such a case, the relatively larger ratio of public investment to public consumption has nothing to do with public investment and maintenance. Likewise, the elasticity of public to private investment is not free from measurement flaws. The percentage change in private investment may be relatively

slower in the private sectors while public investment is relatively stable, suggesting that public investment is highly sensitive to private investment. Given that both indicators are significant for infrastructure quality (see Table 2 of this study), but not significant for infrastructure accessibility (see Table 3 of this study), we note that such flaws may exist and suggest that the future studies to investigate and address such issues.

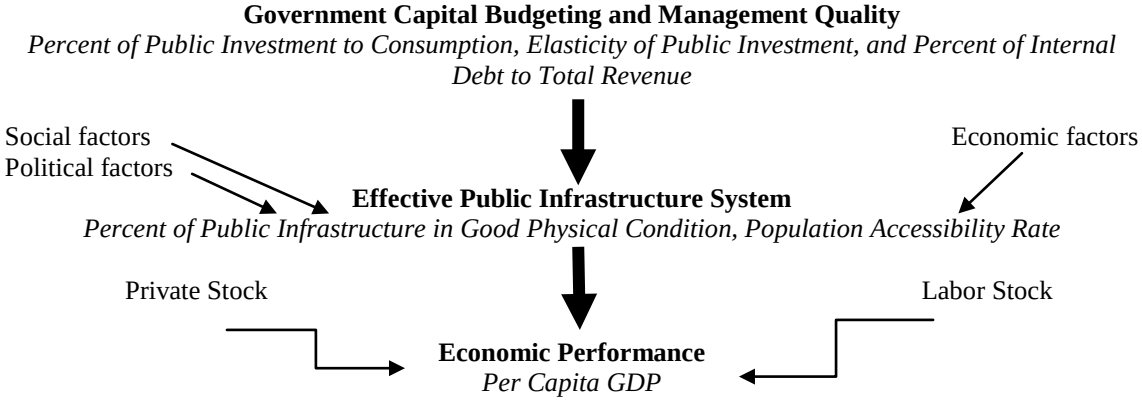
Based on the previous finding that effective public infrastructure systems positively correlate with a country's economic growth (Kumar-Jha, 2005; Calderon and Serven, 2010a and 2010b), the second set of the study's main hypotheses are the following.

H4: An increase in a country's percentage of core public infrastructure in good physical condition will increase national growth.

H5: An increase in a country's population accessibility to the core public infrastructure rate will increase national growth.

Figure 1 presents the connections among the above hypotheses and conceptual framework.

Figure 1: Conceptual Framework for the Effect of Capital Budgeting Practices on Economic Growth



MODEL AND DATA

According to the median voter model, a country's public goods and services are determined by a country's income, tax burden, population, and citizens' tastes and preferences (Kearns & Bartle, 2001; Sturm; 2001). Therefore, a country's public infrastructure quality and accessibility rate is given by equation (1):

$$G = f(Y, P, N, Z) \qquad (1)$$

where G is public goods and services, Y is median income, P is tax price, N is size of population, and Z is the vector of citizens' tastes and preferences. We operationalize tastes and preference as a function of a country's institutional setting, including government budgeting and management practices, the degree of political fragmentation, socioeconomic factors, and physical environments. Rewriting equation (1) with a linear additive demand and incorporating institutional variables in the demand function, equa-

tions (2) and (3) stated below are used to predict the physical condition and accessibility rates of a country's public infrastructure system, respectively.

$$Gq_{i,t} = a + b_1 Y_{i,t} + b_2 P_{i,t} + \boldsymbol{M}' B_m + \boldsymbol{D}' B_d + \boldsymbol{S}' B_s + \boldsymbol{E}' B_e + e_{i,t} \quad (2)$$

$$Ga_{i,t} = a + b_1 Y_{i,t} + b_2 P_{i,t} + \boldsymbol{M}' B_m + \boldsymbol{D}' B_d + \boldsymbol{S}' B_s + \boldsymbol{E}' B_e + e_{i,t} \quad (3)$$

where;

$Gq_{i,t}$ is the physical condition of the public infrastructure system measured through the percent of paved roads, uninterrupted electricity output distribution, and uninterrupted water services in country *i* at time *t*,

$Ga_{i,t}$ is the percent of population accessibility of the electricity, communication, water, and road systems publicly provided by country *i* at time *t*,

$Y_{i,t}$ is the per capita income of country *i* at time *t* in real dollar value,

$P_{i,t}$ is the total tax rate of country *i* at time *t*,

$M_{i,t}$ is the vector of government systematic capital investment practices for country *i* at time *t*, including:

M_{i,t_1}: the percentage of public investment to consumption,

M_{i,t_2}: the elasticity of public investment,

M_{i,t_3}: the percentage of long-term debt interest to total revenue,

$D_{i,t}$ is the vector of political fragmentation in country *i* at time *t*, including:

D_{i,t_1} the effective numbers of ministers in parliament,

D_{i,t_2}: the number of political parties in parliament, and

$S_{i,t}$ is the vector of social factors in country *i* at time *t*, including:

S_{i,t_1}: the ratio of the urban population to the total population,

S_{i,t_2}: total population,

S_{i,t_3}: the ratio of population aged 65 and over to total population, and

S_{i,t_4}: the ratio of budget deficits to total revenue, and

$E_{i,t}$is the vector of economic factors in country *i* at time *t*, including:

$E_{i,t,1}$: per capita foreign aid, and

$E_{i,t,2}$ per capita foreign direct investment (FDI).

The next equation is to establish a testing model for the path from public infrastructure quality and accessibility to a country's output. According to Cobb-Douglas's production function (Mankiw, Romer, & Weil, 1992), national economic output is a function of technological level, labor, and physical capital stocks. Thus, the testing model for this path is defined as follows:

$$Q_{i,t} = A + b_1 L_{i,t} + b_2 K_{i,t} + b_3 Gq_{i,t} + b_4 Ga_{i,t} + e_{i,t} \qquad (4)$$

where;

$Q_{i,t}$ is per capita Gross Domestic Product in real dollar value of country *i* at time *t*,

$L_{i,t}$ is laborer in country *i* at time *t*,

$K_{i,t}$ is the private investment as a share of GDP in country *i* and time *t*,

$Gq_{i,t}$ is the physical condition of the public infrastructure system measured through the percentage of paved roadways in a country, the percentage of a country with uninterrupted electricity output distribution, and the percentage of a country with uninterrupted water services in country *i* at time *t*,

$Ga_{i,t}$ is the percent of population accessibility of the electricity, communication, water, and road systems publicly provided by country *i* at time *t*

In order to test hypotheses 1 through 5, the path analysis method was used.

Table 1 presents the summary statistics for the study data. The data were derived from 25 developing countries[3] as classified by The World Bank during the period from 1990 to 2000, resulting in 275 observations (25 countries*11 years = 275). All fiscal variables are in constant dollars (base year 2000) and were gathered from the Government Finance Statistics CD-ROM, published by the International Monetary Fund (2006). Social and economic data were obtained from World Development Indicators complied by The World Bank (2006). Political variables were calculated from the Database of Political Institutions (DPI) from The World Bank (2006). The data for percentage of private investment to GDP were derived from the paper "Trends in Private Investment Developing Countries" by Everhart and Sumlinski (2000). The data are available from 1970 to 2000. Given that the data is standardized by GDP (and multiplied by 100), the dollar value was not converted in to constant value. The values of this variable are shown in Appendix III.

Table1: Descriptive Statistics

	Variable Name	Mean	Std. Deviation	Minimum	Maximum
Q	Per Capita Gross Domestic Product (Real Dollar Value)	$2,454	$1,736	$312	$8,213
L	Labor (Million)	25.00	69.60	0.46	389.00
K	Percent of Private Stock to GDP	14.049	5.657	0.346	34.413
Y	Per Capita Income (Real Dollar Value)	$2,213	$1,534	$227	$8,142
P	Tax Rate	17.1%	15.7%	3.9%	105.9%
M1	Percent of Public Investment to Consumption	12.8%	12.5%	-8.6%	61.8%
M2	Elasticity of Public Investment (unit free)	0.975	1.309	-10.673	12.104
M3	Percent of Long-term Debt Interest to Total Revenue	17.2%	13.3%	0.0%	92.7%
KGQ	Percent of Public Infrastructure System in Good Physical Condition	64.20%	15.50%	40.90%	98%
KGA	Percent of Population Accessibility to Public Infrastructure System	18.9%	6.7%	0.5%	29.8%
D1	Effective Numbers of Ministers in Parliament	3.172	1.835	1.000	11.467
D2	Effective Numbers of Political Parties in Parliament	0.593	0.211	0.000	0.921
S1	Ratio of Urban Population to Total Population	55.70%	18.70%	13%	91.70%
S2	Total Population	64,730,288	178,666,691	1,057,000	999,016,000
S3	Ratio of Population Aged 65 and Over to Total Population	14.05%	5.70%	0.34%	34.40%
S4	Ratio of Budget Deficits to Total Revenue	25.3%	89.5%	0.0%	640.0%
E1	Per Capita Foreign Aid	16.77	34.08	0.00	372.64
E2	Per Capita Foreign Direct Investment	51.05	77.38	3.78	663.94

Total Observations = 275

Since there is no public data availability for key variables including public infrastructure quality and accessibility at the time this paper was in progress, the data for these variables were constructed by the authors through World Development Indicators (http://data.worldbank.org/products/data-books/WDI-2006) complied by The World Bank (2011). As discussed in the Conceptual Framework section of this paper, an effec-

tive public infrastructure system is defined as "the physical conditions of a country's core public infrastructure, including road, electricity, and water systems as well as citizen accessibility to the main public infrastructure systems." The concept of a country's effective public infrastructure thus can be operationalized by two indicators: 1) the average percentage of a country's paved roads to total roads, uninterrupted electricity, and water distribution output; and 2) the average percentage of people with accessibility to the country's roads, electricity, water, and communication facilities. Table 2 below presents the World Development Indicators comprised for quality and quantity indexes.

Table 2: The indicators for quality and accessibility indexes

QUALITY	ACCESSIBILITY
1. Roads, paved (% of total roads)	1. Improved Water Source, Rural (Percent of Rural Population With Access)
2. Road Sector Energy Consumption (% of total energy consumption)	2. Improved Water Source, Urban (Percent of Urban Population With Access)
3. Percent of Domestic Annual Freshwater Withdrawal to a country's total withdrawal	3. Telephone mainlines (per 1,000 people)
4. Electric power transmission and distribution losses (% of output) which is (100percent interrupted data) = percent of uninterrupted power.	4. Road per 1000
	5. Electricity Production per 1000
	6.Fixed line and mobile phone subscribers (per 1,000 people)

For the quality index, we simply added up the percentages of all four subscales (the left column of Table 2) and divided the sum value by four and then multiplied the ratio with 100, yielding the average percentage of core infrastructure in good quality. For accessibility index, as shown in Table 2, scale numbers 3 through 6 are in per thousand; thus, we converted these scales by dividing each of these per thousand values by 1,000 and then multiplying such ratios by 100 to obtain percentage value. Finally we simply added up the values from the six scales, and then divided the summed values by 6 and multiplied the ratio with 100, yielding the average percentage of a country's core infrastructure accessibility. As shown in Table 1: the mean for quality of core public infrastructure is 64.2% while the mean for accessibility is 18.9%. See Appendixes I and II for the quality and accessibility data, respectively.

The strengths of these indexes are as follows. First, the indexes embrace important infrastructure sectors for development including electricity, transportation, water and communication. Second, the indexes are easily interpreted given that they are simply the average values of the selected World Development Indicators. Third, the indexes are time-variant data which is suitable in understanding annual impact of government practices on core infrastructure output and outcome through panel data analysis method with fixed effect estimator.

The weaknesses of such indexes include 1) given that there is no weighting system in constructing these index, it may be difficult in terms of pinpointing which sector is more important in applying the empirical results to practices and 2) the indexes may not pure-

ly represent a country's government investment outputs given that some of the infrastructure quality and accessibility scales may include infrastructure outputs provided by private sectors and foreign donors. If the latter is true, the indexes thus partially reflect government management capacity rather than completely reflecting government management capacity.

RESULTS

We used the path analysis method to analyze the entire process of capital investment practices and growth presented in Figure 1 with two steps.

1. Understanding the causal relationship between public capital management practices and public infrastructure quality and accessibility rates.
2. Understanding the causal relationship between public infrastructure quality and accessibility rates and a country's growth.

The path analysis method is one among several causal modeling techniques available used in examining whether a pattern of inter-correlations among variables fit the researchers' underlying theory of which variables causing other variables (Mertler & Vannatta, 2005, p.199). The analytical approach for the path analysis is similar to those of standard Two-stage Least Square (2SLS) method in that both approaches estimate the causal relationship of the variables of interest in the first stage. We estimated another causal relationship of the variables in the second stage using the predicted values of the variables obtained from the first stage as the model's independent variables.

The path analysis and 2SLS are different in three points. First, unlike the 2SLS equations, for the path analysis, the estimating equations in stage one (i.e., equations 2 and 3 of this paper) and stage two (i.e., equation 4 of this paper) are not necessarily the same in the sense that all auxiliary variables (i.e., control variables) must be presented in both equations. Path analysis begins with the researchers developing structural diagrams with arrows connecting variables and depicting casual flow for a direction of cause-and-effect (Mertler & Vannatta, 2008, p.199). The structural diagram is influenced by several sources on information including literature research, formal and informal theories, personal observations and experiences with the phenomenon of interest, expert opinions, and last but not least, common sense and logic (Mertler & Vannatta, 2008, p.200). The specification of the equations (i.e., equations 2 and 3 for the first stage and equation 4 for the second stage) is the researchers' formal declaration of the literature and theories drawn from several sources regarding the logical causal linkage among the model's variables.

Second, because of the approaches described in the first point above, 2SLS and path analysis are also different in that while the former methodology reveals only the direct effect of capital management practices on growth, path analysis reveals both direct and indirect effects of capital management practices on growth. Table 5 of this paper presents the empirical results for the indirect effects of capital management practices on growth as mediated by a country's core infrastructure quality and accessibility.[4] Based on our theoretical model shown in Figure 1, we meant to estimate the indirect effect of

capital management practice on growth, rather than the direct effect of capital management on growth.

Third, while the standard 2SLS uses Ordinary Least Square (OLS) method in estimating coefficients, path analysis is relatively more flexible in allowing unobserved heterogeneity panel data analysis depending on data types. Given that we have panel data, we employ models that capture unobserved heterogeneity, rather than OLS to find the relationship slopes.

Autocorrelation is another inherent problem for panel data. Autocorrelation occurs when the data in the current year explains the data in the following years in the same country, and such correlation is persistent for long periods (Kennedy, 2008). In order to purge such autocorrelation, researchers have two choices.

1. Taking simple first differences in which the previous year data is subtracted from the current year data.
2. Directly transforming the data (see endnote 5).

We first attempted the simple differencing method, but found that autocorrelation was not completely removed. We then directly transformed the data by multiplying the lagged value of the data by the first-order autocorrelation coefficient and then subtracting that value from the current value of the data. This transformation method is described in footnote 5 of this paper. Thus, the dependent variable, growth, of stage two in path analysis is the first difference of the current year per capita GDP and its own lagged, being weighted by its own autocorrelation coefficient (see Wooldridge 2008, p.426 and endnote 5).

We also conducted a Hausman test to determine whether fixed or random effect estimators are appropriate for our panel data. The results indicates that at the .01 significance level the fixed effect estimator is more appropriate than random effect given that the countries' dummy variables are highly associated with the model's independent variables and error terms. We thus used fixed effects estimators for our panel data throughout the two steps of our path analysis. The empirical results shown in Tables 3,4, and 5 are the within effects of capital management practices on growth.

In order to test our hypotheses, the first step was to estimate the effects of systematic capital investment practices on the quality of the public infrastructure system using equation (2), controlling for political, social, and economic factors. Table 3 presents the results from this step. Regression diagnostics further indicated that the error terms were constant within each country, but correlated across countries. Thus, panel-corrected standard errors were computed according to the method of Beck & Katz (1995).

Table 3: Empirical Results for the Effects of Government Institutions on Public Infrastructure

Quality (Estimated by Equation (2))

	Coeffi-cient	**Panel-Correc-ted Stan-dard Errors**	**t-Statis-tics**	**Proba-bility**
Dependent Variable: Percent of Public Infrastructure System in Good Physical Condition (KGQ)				
Basic Variable				
Per Capita Income (Y)	.007***	0.002	2.85	0.004
Tax Rate (P)	-.371	.342	-1.08	0.279
Government Capital Management Practices				
Ratio of Public Investment to Consumption (M1)	3.159***	1.048	3.02	0.003
Elasticity of Public Investment (M2)	2.317***	0.791	2.93	0.003
Ratio of Long-term Debt Interest to Total Revenue (M3)	-3.455	11.780	-0.29	0.769
Political Institution				
Effective Numbers of Ministers in Parliament (D1)	0.233	0.732	0.32	0.750
Effective Numbers of Political Parties in Parliament (D2)	-1.344**	.683	-1.97	0.049
Socio-Economic Institution				
Ratio of Urban Population to Total Population (S1)	0.354	0.223	1.59	0.112
Total Population (S2)	2.458	1.597	1.54	0.124
Ratio of Population Aged 65 and Over to Total Popula-tion (S3)	-0.740	0.284	-2.60	0.009
Ratio of Budget Deficits to Total Revenue (S4)	1.292	3.085	0.42	0.675
External Institutions				
Per Capita Foreign Aid (E1)	-24.735	34.505	-0.72	0.473
Per Capita Foreign Direct Investment (E2)	1.054	0.585	1.80	0.072
Constant	1.094	0.894	1.22	0.221
Adjusted R-Squared	0.1595			
Wald chi2	43.160			
Prob > chi2	0.002			
Number of Observation	275			

Note: ** indicates statistical significance at the 05 level. *** indicates statistical significance at the .01 level. Country-fixed effects and time-fixed effects were removed by entity and time demeaning prior to

regression estimation. Autocorrelation correction was conducted through the method of Prais-Winsten (see footnote). Panel-corrected standard errors were computed according to Beck & Katz (1995).

The results in Table 3 suggest that overall the model explains a significant part of the variation in the physical condition of a country's core public infrastructure. The adjusted R-squared indicates that 16% of the variation in the physical condition of public infrastructure was explained by the model independent variables. As shown in the table, systematic investment practices measured through two variables, the ratio of public investment to public consumption (M1) and the elasticity of public investment (M2), were strongly significant for the quality of a country's public infrastructure system. A percentage increase in public investment to consumption results in a 3.2 percent increase in the better physical condition of public infrastructure. A one-unit increase in the degree of government responsiveness to private investment results in a 2.3 percent increase in the physical condition of public infrastructure throughout a country, everything else equal. These results suggest that a country's government institutional practice in conducting fiscal and physical planning that is responsive to private demands enhances the quality of the public infrastructure system.

For the other control variables, the results in Table 3 suggest that the number of political parties in parliament significantly affects the country's public infrastructure quality. A one-party increase in the parliament reduces the quality of public infrastructure by about 1.3 percent. The control variable results were generally in the direction and magnitude expected. Of note, a dollar increase in per capita income results in a 0.7 percent increase in the core public infrastructure being in good physical condition. The predicted value of the physical condition of public infrastructure was saved for estimation of the economic growth model.

The next task was to estimate the effects of government management, and political, social, and economic factors, on the accessibility of public infrastructure systems using equation (3). Table 4 presents the results. The statistical procedures were the same as those in the first step, except that an autocorrelation correction procedure was not conducted since the initial regression results indicated that there was no serial correction for the infrastructure accessibility data.

Table 4: Empirical Results for the Effects of Government Institutions on Public Infrastructure

Accessibility (Equation (3))

	Coefficient	**Panel-Corrected Standard Errors**	**t-Statistics**	**Probability**
Dependent Variable: Percent of Population Accessibility to Public Infrastructure System (KGA)				
Basic Variable				
Per Capita Income (Y)	.015**	0.006	2.38	0.018

Tax Rate (P)	.317	.889	0.36	0.721
Government Capital Management Practices				
Percent of Public Investment to Consumption (M1)	-42.722	27.699	-1.54	0.123
Elasticity of Public Investment (M2)	0.612	1.525	0.40	0.688
Percent of Long-term Debt Interest to Total Revenue (M3)	-.929**	.393	-2.36	0.018
Political Institution				
Effective Numbers of Ministers in Parliament (D1)	-0.574	1.321	-0.43	0.664
Effective Numbers of Political Parties in Parliament (D2)	6.081	11.274	0.54	0.590
Socio-Economic Institution				
Ratio of Urban Population to Total Population (S1)	-0.543	0.392	-1.38	0.166
Total Population (S2)	0.501	0.574	0.87	0.383
Ratio of Population Aged 65 and Over to Total Population (S3)	5.150	4.041	1.27	0.202
Ratio of Budget Deficits to Total Revenue (S4)	-1.244	9.536	-0.13	0.896
External Institutions				
Per Capita Foreign Aid (E1)	11.290	33.802	0.33	0.738
Per Capita Foreign Direct Investment (E2)	-1.472**	0.741	-1.99	0.047
Intercept	-1.968	1.598	-1.23	0.218
Adjusted R-Squared	0.1312			
Wald chi2	109.380			
Prob > chi2	0.000			
Number of Observation	275			

Note: ** indicates statistical significance at the 05 level. *** indicates statistical significance at the .01 level. Country-fixed effects and time-fixed effects were removed by entity and time demeaning prior to regression estimation. Panel-corrected standard errors were computed according to Beck & Katz (1995).

For two control variables, a dollar increase in per capita income resulted in an estimated 1.5 percent increase in the accessibility rate. Per capita foreign direct investment significantly and negatively affected population accessibility to core public infrastructure. This may be due to the "focusing" effect of foreign direct investment (FDI), where capital investment in low income countries is targeted to areas with large inflows of FDI and therefore it competes with local residents in other areas for limited public infrastructure. The predicted value of the population accessibility rate for core public infrastructure was also saved for the next step of the method in estimating the effect of this variable on growth.

The final step was to enter the predicted values for infrastructure physical condition and accessibility, along with other institutional variables, into a regression predicting economic growth. According to equation (4), the dependent variable, national productivity, was measured through Real Per Capita Gross Domestic Product. The control variables included per capita private capital stocks and labor supply, two variables which usually are employed in empirical economic growth models. All statistical procedures were used as in the previous steps.

Table 5: Empirical Results for Indirect Effect of Systematic Capital Investment Practices on Productivity Growth Mediated Through Public Infrastructure Condition and Accessibility Rates (Equation 4)

	Coefficient	**Panel-Corrected Standard Errors**	**t-Statistics**	**Probability**
Dependent Variable: Changed in Per Capita Gross Domestic Product (Real Dollar Value)				
Number of Laborers (Million) (L)	-11.872***	2.620	-4.53	0.000
Percent of Private Investment to GDP (K)	13.915***	2.950	4.72	0.000
Predicted Percent of Public Infrastructure System in Good Physical Condition ($\widehat{GQ}$)	4.693***	0.874	5.37	0.000
Predicted Percent of Population Accessibility to Public Infrastructure System ($\widehat{GA}$)	11.027***	1.731	6.37	0.000
Per Capita Income (Y)	0.360***	0.017	20.96	0.000
Tax Rate (P)	.812***	.305	2.66	0.008
Effective Numbers of Ministers in Parliament (D1)	8.787	7.296	1.2	0.203
Effective Numbers of Political Parties in Parliament (D2)	-8.781	6..245	-1.39	0.166
Ratio of Urban Population to Total Population (S1)	5.390***	2.063	2.61	0.01
Total Population (S2)	-19.132	11.834	-1.62	0.107
Ratio of Population Aged 65 and Over to Total Population (S3)	-17.706	32.062	-0.55	0.581
Ratio of Budget Deficits to Total Revenue (S4)	0	0	1.25	0.214
Per Capita Foreign Aid (E1)	40.241**	19.168	2.1	0.037
Per Capita Foreign Direct Investment (E2)	30.119	31.163	0.97	0.335
Constant	0.095	7.086	0.01	0.989
Adjusted R-Square	0.742			
Wald chi2	649.9			
Prob > chi2	0.000			
Number of Observation	275			

Note: *** indicates statistical significance at the 05 level. *** indicates statistical significance at the .01 level. Country-fixed effects and time-fixed effects were removed by entity and time demeaning prior to regression estimation. Autocorrelation correction was conducted through the method of Prais-Winsten (see footnote). Panel-corrected standard errors were computed according to Beck & Katz (1995).*

Table 5 presents the results estimated by equation (4). The predicted public capital condition ($\widehat{GQ}$) and accessibility ($\widehat{GA}$) were strongly significant with the expected directions: increases in the physical condition and accessibility rate of a country's core public infrastructure system enhance growth. These results suggest that the model stated in equations 2 and 3 are completed in terms of containing important explanatory variables. The main findings were that the ratio of public investment to consumption (M1), elasticity of public to private investment (M2), and ratio of past investment to total revenue (M3) *indirectly* enhanced national growth through better the physical condition and accessibility rates of the public infrastructure system.

One curious result for the control variables is noted. In our model, changes in labor supply were estimated to have a negative effect on productivity. In most developed country studies, the sign of the labor supply coefficient is positive. However, in low income countries, it is quite possible that labor and capital are strong substitutes. Countries that rely heavily on labor-intensive industries may not have large investment in capital. Increases in labor supplies would therefore represent competition for resources, not increased resource bases. Using the same model as those models estimated in Table 5 and directly incorporating the three capital management variables (M1, M2, and M3), the results indicated that all else equal, these management variables have no direct effect on growth.

Implications

Based on the descriptive statistics shown in Table 1, sample mean countries annually invest in their core public infrastructure at about 13% of the total current operation budget and have long-term debt interest payment at about 17% of the total revenue. The sample mean countries tended not to be highly responsive to private investment demand given that the elasticity of their public to private investment was less than 1.0 (mean elasticity was 0.97). Using these sample mean data and the indirect effects on systematic management practice reported in Tables 3, 4, and 5, the calculated indirect effects of systematic capital investment practices on growth for the study samples are as follows.

First, if the sample mean countries increased their investment as a percent of consumption from 13% to 14%, their per capita GDP would increase by about $15 per person ((4.693/100) * (3.159*100) = $14.8) through better public infrastructure conditions. Second, if these countries reduced their debt cost to total revenue from 17% to 16%, they would see an increase in per capita GDP at about $11 per person ((11.027/100) * (.929*100) = $10.9) through a better rate of population accessibility to the public infrastructure system. Finally, if these countries were more responsive to private investment demand by 1 more unit point, they would see a per capita GDP increase at about $10 per person ((4.693/100) * (2.317*100) = $10.2) through better public infrastructure conditions.

CONCLUSIONS

This paper investigates the path effects of government capital management on national growth. The determinants of economic growth have been a relatively unexplored area in the literature. The paper looks solely at developing countries, a set of countries that the literature has thus far ignored. This focus, however, presents some problems, mainly with obtaining consistent data over a sufficient time frame for analysis. The results from the path analysis indicate that government management and political institutions indirectly affected national productivity through the physical condition and accessibility of core public infrastructure in the 25 developing countries. This is in accordance with previous research on developing countries, which concluded that good governance makes public spending more effective in terms of accomplishing targeted outcomes (Rajkumar & Swaroop, 2008). The results in this study specifically suggest that if a government adopts systematic capital investment practices, its per capita GDP will increase for about $10-$15 in the real dollar value through the country's better public infrastructure service system. This dollar value increase may not make a country move from low income group to middle income group over a year, but the annual increase can help alleviate poverty level along with other development practices.

There are some limitations which must be discussed with respect to the results. First the variables representing public infrastructure condition and access were only constructed variables. There is likely to be some errors in the measurement of the constructs of condition and access. Future studies should attempt to model these constructs more fully. Second, the panel data were relatively short, including only 10 years. Though the econometrics was defensible for short panels, the use of data spanning longer time periods should be undertaken to generate results with which to compare the results in this study. Finally, in using only developing countries, we chose not include industrialized countries and thus the results are generalizable only to developing countries. There may be different sets of dynamics occurring in developed countries. Other recent work has taken up this examination in the United States (Srithongrung, 2008), but an extension to other developed countries would be better for the development of the literature. Within the bounds of these limitations, however, the paper contributes to the empirical literature around the determinants of economic growth and the role that government management plays in public infrastructure systems and national productivity.

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NOTES

[1] According to Dabla-Norris et al (2011), the sources include World Bank Public Investment Management (PIM) case studies, the Budget Institutions database, World Bank Public Expenditure Reviews (PERs), World Bank Country Procurement Assessment Reviews, and World Bank Country Financial Accountability Assessments and each specific country website.

[2] International Budgeting Practices and Procedures Databases (2011) provide survey data across 97 countries regarding their operational and capital budgeting practices in years 2003, 2005, and 2007. However, the questionnaire items for capital budgeting practices are not available in 2003 edition and are not consistent for 2005 and 2007 editions. Due to this problem, we did not adopt capital budgeting practices data from this organization because the data are sporadic and may not be conceptually valid. See the survey questionnaires at http://www.oecd.org/document/61/0,3746,en_2649_34119_2494461_1_1_1_1,00.html

[3] The 25 countries in our sample included Argentina, Bulgaria, Colombia, Costa Rica, the Dominican Republic, Egypt, El Salvador, Guatemala, India, I.R. of Iran, Mauritius, Mexico, Nicaragua, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Romania, South Africa, Thailand, Tunisia, Turkey, Uruguay, and Venezuela.

[4] Path analysis allow us to also estimate the direct effect of capital management practice on growth, but conceptually, we focus on indirect path rather than direct path of government practices given that economic growth can be resulted from other factors outside government performances. We believe the direct effect of government capital management practices is relatively weak and thus it may not be very much useful in understanding the direct effect of government programs on growth.

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APENDIX I: Public Infrastructure Quality Data

Quality of Public Infrastruc-ture	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Argentina	55.1	54.8	54.1	54.2	55.2	55.7	55.8	56.6	57.2	57.3	56.7
Bulgaria	90.5	89.0	89.0	89.5	89.6	89.3	89.3	88.9	89.3	90.5	91.0
Colombia	45.3	45.5	46.3	45.2	44.9	43.6	45.0	44.8	45.6	45.3	44.6
Costa Rica	53.5	54.1	54.1	54.3	54.2	54.6	54.5	54.8	56.6	57.2	57.6
Dominican Republic	60.1	60.2	59.4	59.8	60.2	60.5	63.1	66.5	75.7	61.0	60.4
Egypt	81.0	80.9	81.2	80.6	82.3	83.4	81.3	84.3	84.0	83.7	82.6
El Salva-dor	49.1	50.2	49.9	51.8	52.1	53.6	53.2	53.3	53.3	53.3	53.3
Guatema-la	55.4	56.1	56.8	56.9	57.2	55.9	54.9	54.0	55.2	59.6	56.6
India	61.3	63.9	66.6	68.0	68.4	68.2	67.0	67.8	67.3	65.6	65.2
Iran, I.R. of	52.1	54.7	56.3	60.7	66.4	67.8	69.9	71.3	70.8	72.6	73.1
Mauritius	96.5	96.5	96.5	96.5	96.5	96.5	97.5	97.5	98.0	98.0	98.5
Mexico	61.4	61.9	61.2	61.2	58.6	58.5	58.6	57.8	59.9	59.2	58.4
Nicaragua	46.5	44.4	44.3	43.8	41.9	41.2	41.0	41.5	40.9	41.9	40.6
Pakistan	66.6	66.6	65.4	65.6	65.6	61.1	60.3	59.7	61.3	64.2	65.9
Panama	53.0	53.4	54.1	55.0	55.9	56.1	56.2	52.9	53.3	57.5	59.5
Papua New Guinea	51.6	51.6	51.6	51.6	51.6	51.7	51.8	51.8	51.8	51.8	51.8
Paraguay	54.1	54.3	54.3	53.7	53.9	53.9	54.7	56.4	58.1	74.0	75.7
Peru	48.1	49.5	46.4	46.1	45.2	46.4	47.5	47.9	50.0	50.5	50.9
Romania	70.1	70.3	70.4	70.4	70.9	69.8	70.3	70.6	70.5	70.2	68.4
South Africa	61.9	62.6	63.2	64.9	65.8	67.7	56.0	55.9	55.7	55.9	56.0
Thailand	72.4	88.8	89.7	92.3	92.5	94.6	94.4	94.4	94.4	94.6	95.3
Tunisia	82.9	82.6	82.3	82.8	83.6	84.5	84.4	84.3	76.6	76.7	78.9
Turkey	51.4	52.3	52.7	52.9	53.0	53.5	54.1	53.5	54.6	57.7	58.1
Uruguay	80.0	80.8	82.2	84.5	85.1	84.2	85.1	85.6	87.4	85.6	84.7
Venezuela, Rep. Bol.	58.8	58.6	59.5	59.8	57.9	57.3	57.3	56.3	55.8	55.1	55.2

APENDIX II: Public Infrastructure Accessibility Data

Accessibility Rate	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Argentina	8.7	9.0	9.7	10.7	12.0	13.3	14.3	15.9	17.2	18.8	19.1
Bulgaria	24.7	24.2	24.2	25.3	26.0	27.5	28.4	29.3	29.8	31.2	32.6
Colombia	6.1	6.4	6.3	6.9	7.5	8.1	9.2	10.5	11.8	12.0	12.7
Costa Rica	7.7	8.2	8.6	9.2	10.2	10.8	11.3	13.9	14.5	15.6	17.4
Dominican Republic	3.8	4.3	5.2	5.4	5.7	5.8	6.4	6.8	7.9	8.8	9.1
Egypt	3.4	3.6	3.7	3.9	4.1	4.4	4.7	5.1	5.6	6.3	6.5
El Salvador	2.4	2.4	2.7	2.9	3.6	4.1	4.4	4.8	5.4	7.7	8.2
Guatemala	1.8	1.8	1.9	2.0	2.1	2.4	2.7	3.2	3.8	4.8	5.2
India	1.2	1.3	1.4	1.5	1.6	1.8	2.0	2.2	2.5	2.8	3.1
Iran, I.R. of	4.8	5.2	5.8	6.6	7.3	8.0	8.6	9.5	10.4	11.3	11.7
Mauritius	2.7	3.1	3.8	5.0	6.0	6.9	8.6	10.7	11.9	13.2	15.7
Mexico	7.0	7.4	7.8	8.4	9.1	9.3	9.5	10.1	10.9	12.7	13.1
Nicaragua	1.6	1.6	1.7	1.9	2.0	2.2	2.4	2.5	2.8	3.0	3.4
Pakistan	1.3	1.5	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.4	2.4
Panama	7.3	7.6	7.8	8.3	8.8	9.1	9.6	10.5	11.9	14.1	15.4
Papua New Guinea	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.9
Paraguay	17.6	18.4	16.8	18.9	21.1	23.8	24.7	25.3	26.2	29.0	29.6
Peru	3.0	2.9	2.9	3.2	3.5	4.2	5.0	5.7	5.8	6.2	6.5
Romania	12.2	11.6	11.8	12.0	12.4	13.3	14.0	14.3	14.9	15.7	17.5
South Africa	16.6	16.4	16.4	16.5	16.8	17.6	18.5	19.5	20.1	21.1	22.3
Thailand	3.3	3.7	4.3	4.9	5.8	7.0	8.0	8.9	8.8	9.0	9.7
Tunisia	3.7	3.9	4.2	4.4	4.8	5.1	5.5	5.9	6.6	7.3	8.1
Turkey	8.8	9.9	11.1	12.5	13.5	14.5	15.6	17.1	18.8	21.2	24.4
Uruguay	12.8	12.9	15.0	14.8	15.2	14.9	16.1	17.9	21.0	21.4	21.7
Venezuela, Rep. Bol.	11.4	11.9	12.8	13.5	14.1	14.5	15.1	15.9	16.4	17.8	17.9

APENDIX III: PERCENT OF PRIVATE INVESTMENT TO GDP DATA

% Private Investment to GDP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Argentina	9.4	12.7	14.9	18.1	19.1	15.8	16.1	17.3	17.9	16.1	17.1
Bulgaria	0.8	0.5	0.3	2.9	5.4	6.8	5.3	5.5	7	8	5.9
Columbia	10.2	8.4	8.3	10.8	16.7	14.5	13	11	9.9	5.5	11.3

Costa Rica	17.7	15.5	16.6	18.3	14.6	13.8	12.2	14.0	18.2	19.1	15.7
Dominican Republic	18.2	15.3	15.4	16.4	12.6	11	10.2	12.7	16.6	18.9	14.0
Egypt	16.7	13.1	10.5	9.2	10.5	10.7	10.5	12.1	12.3	13	11.7
El Salvador	11.2	12.3	13.2	13.7	14.7	15	12.1	12.7	13.2	13	13.1
Guatemala	10.4	9.8	13.2	13.4	11.7	12	10.8	12.1	13.7	14.8	12.5
India	13.9	12.9	14.2	13.4	13.2	16.7	15.9	15.4	15	14.9	15.2
Iran	8.5	13.6	13.4	11.4	12.8	12.6	14.2	14.2	13.4	13	13.5
Mauritius	19.2	20.4	18.3	20.6	21.7	16.3	16.7	20.8	18.3	21.8	18.8
Mexico	13.6	14.6	15.8	14.8	14.3	12.4	14.9	16.4	18.3	18.9	16.4
Nicaragua	11.2	10.7	9.7	8.9	9.6	10.6	11.6	18.2	19.8	22	16.1
Pakistani	8.9	8.9	9.8	10	9.6	8.7	9.1	10.3	9.5	8.3	9.6
Panama	7.4	12	15.1	19.2	20.8	21.8	21.2	22.3	23.2	26.3	21.8
Papua New Guinea	20.0	23.3	18.6	12.5	11.6	15.7	24.2	21.6	23.3		21.3
Paraguay	19.2	20.4	18.2	18.8	19	17.7	18.2	15.2	14.4	14.2	16.0
Peru	12.9	13.1	12.4	13.7	16.4	19.5	18.3	19.6	19.4	16.8	18.7
Romania		1.4	2.3	3.7	5.9	7.1	7.6	6.2	6.6	6.9	6.3
South Africa	12.9	11	10.4	10.3	11	11.6	11.7	11.8	11.1	10.3	11.4
Thailand	34.2	34.4	31.1	31.6	31.2	32	30.8	22.2	19.4	19.4	24.4
Tunisia	19.7	19.9	20.3	12.8	13.3	11.9	11.9	12.7	13.2	13.1	13.1
Turkey	15.8	16.1	15.6	18.3	19.4	20	20.2	20.6	18.8	16.1	19.4
Uruguay	8.3	9.3	9.9	10.3	10.1	9.9	10.5	10.6	10.9	10.6	10.5
Venezuela	4.9	7.6	8.9	9	8.2	7.1	7	9.4	10.7	8.8	9.2

Source: Everhart, S. E. & Sumlinski, M.A. (2001). Trends in Private Investment in Developing Countries, Statistics for 1970-2000. International Finance Corporation

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From the Editor

All papers submitted to IPMR are subject to two double blind peer reviews, including suggestions for improvements. As an example of how the process works, the paper: "From Public Infrastructure to National Economic Growth: Do Strategic Investment Practices Matter" was reviewed by two researchers with considerable experience in the area. The first reviewer found that the paper was well organized, well written, well researched, well and appropriately cited, and methodologically sound. The reviewer found that the conclusions followed clearly from both the stated objective of the paper up front and from the analysis.

The second reviewer had quite a different view, suggesting areas of improvement including the inclusion of key citations in the literature review, clarification on concepts relate to infrastructure stock versus infrastructure use, and explanations of the data used in the analysis.

The second reviewer found that the focus on infrastructure and growth did not appear to add anything new to the rather large literature already established on the subject. A more fruitful approach would be to focus only on the impact of government investment practices on infrastructure quality. Yet, the author cannot pursue this in a credible fashion if he/she wishes to retain flawed independent variables. For example, the hypothesis that the ratio of public investment to public consumption will be positively correlated with the percent of infrastructure in good shape is undermined by the possibility that the share could increase because public consumption is reduced with no potential impact at all on infrastructure maintenance or investment. Alternatively, some shock could cause both investment and consumption to shift by the same percent so that the ratio is unchanged – and yet the real financing flowing to infrastructure maintenance or investment will have changed and should affect outcomes. In another example, the hypothesis that the elasticity of public investment to private investment is positively correlated with the percent of infrastructure in good shape is also subject to attack. It might be the case that private investment falls in response to some shock (weakened business outlook) which would make the ratio higher and yet leave real public financing for infrastructure maintenance or investment unaffected.

The dependent variables look worrisome as well. The author's explanation of how these data were generated left the reviewer in doubt. The index of infrastructure quality includes "road sector energy consumption" which is more a function of vehicle efficiency and density than road quality. The index also includes electrical transmission line losses which is a good idea except that the author claims that this sub-component is added into the index, as if losses are a good thing. Another part of the index refers to the domestic share of total freshwater withdrawals. It doesn't make sense to include this in an index of infrastructure quality: this is a measure of a country's pressure on its water resources and therefore on the sustainability of its water use. Water losses per km of pipe might be a better measure. Another dependent variable, the index of accessibility, incorrectly includes energy production when access is more a function of distribution. It also includes redundant information with one sub-indicator focused on telephone mainlines and another focused on mainlines plus mobile subscriptions. Bottom line: rather than

inventing new indices, why not make use of the data already available from Serven and Calderon (2010) World Bank Policy Research Working Paper 5317 for infrastructure quality ... a paper which the author now cites in other parts of the manuscript?

Finally, the author's explanation of how path analysis is or is not the same as 2SLS regression, and why it is better, was not at all clear and was generally unconvincing.

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