Inter-American Development Bank
Banco Interamericano de Desarrollo (BID)
Research Department
Departamento de Investigación
Working Paper #648

Public Investment in Developing Countries: A Blessing or a Curse?

by

Eduardo Cavallo*
Christian Daude**

* Inter-American Development Bank
** Organisation for Economic Co-operation and Development

October 2008

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Cavallo, Eduardo A.

Public investment in developing countries : a blessing or a curse? / by Eduardo Cavallo, Christian Daude.

p. cm. (Research Department Working Papers ; 648)
Includes bibliographical references.

1. Public-private sector cooperation. 2. Public investment. 3. Infrastructure (Economics). I. Daude, Christian. II. Inter-American Development Bank. Research Dept. III. Title. IV. Series.

HD2961 .C234 2008
334 C234-----dc22

Inter-American Development Bank
1300 New York Avenue, N.W.
Washington, DC 20577

The Research Department (RES) produces a quarterly newsletter, IDEA (Ideas for Development in the Americas), as well as working papers and books on diverse economic issues. To obtain a complete list of RES publications, and read or download them please visit our web site at: http://www.iadb.org/res.

Abstract[*]

This paper analyzes the impact of public investment on private investment in panel of 116 developing countries between 1980 and 2006 using dynamic panel data techniques, finding a strong and robust crowding-out effect that seems to be the norm rather than the exception, both across regions and over time. It is also found that this effect is dampened (or even reversed) in countries with better institutions and that are more open to international trade and financial flows. These results are consistent with the hypothesis that, while public infrastructure may be complementary to private capital in the aggregate production function, there are distortions associated with the public investment process that might render a crowding out of private investment in the course of building public capital stocks. These distortions, in turn, are more prevalent in countries with worse institutions or that lack trade and financial openness.

Keywords: public investment; crowding out; institutions; openness

JEL-classification: E22; H54; H41; O16

[*] We thank Pelin Berkmen, Luis Catao, Eduardo Fernandez-Arias, Herman Kamil, Eduardo Lora, Andrew Powell, Gabriel Sanchez, and seminar participants at IDB's Econnet for very useful comments, as well as Francisco Arizala and Maria Fernández Vidal for providing superb research assistance. All remaining errors are exclusively our responsibility. The views expressed are those of the authors and should not be attributed to the Inter-American Development Bank.

1. Introduction

This paper tests empirically the linkages between public and private investments using a consistent dataset for a large sample of developing countries over almost three decades. We find a strong and robust crowding-out effect that seems to be the norm rather than the exception, both across regions and over time, as well as for a variety of econometric specifications and estimation methods. We go one step further by providing evidence of the country institutional factors that help to break up this negative relationship. Perhaps not surprisingly, these are related to aspects of institutional quality and access to international credit and markets, which are the main focus of the conditionality set by development banks in the credits granted to their clients in order to finance public works. Thus, the results in this paper support the rationale underlying that conditionality: public investment per se is not enough to crowd-in private investment and thus, money spent on public works could easily go to waste or have undesired adverse effects on the private sector.

The issue of the relationship between public and private investment has been a focus of attention in the literature at least since the early 1980s, and it is still the subject of considerable controversy. The main question explored by researchers is whether public and private investments have a different impact on economic growth. On theoretical grounds there is no clear reason why the institutional source of total investment levels should matter. However, if there are inefficiencies or distortions associated with the process of public investment that are not prevalent in the case of private investment, then the difference could indeed matter. For example, it is well known that governments in many developing countries often carry out inefficient public investments, or "costly prestige" public works programs (Robinson and Torvik, 2005). Along these lines, Khan and Reinhart (1990) develop an empirical growth model for a sample of developing countries that distinguishes between the private and the public components of investment. Their results support the notion that private investment has a larger direct effect on growth than public investment. Khan and Kumar (1997) discuss the extent to which public and private investment may be complementary or substitutes and develop a theoretical framework within which their respective roles in the growth process can be analyzed. They argue that complementarities may arise in the case of public investment in infrastructure, which increases the marginal product of private capital. Nevertheless, public investment in infrastructure may not automatically have a beneficial impact on private investment and growth. This might be the case,

for example, when investment projects are of dubious quality or when they are financed in ways that have an adverse effect on the availability of credit, the cost of inputs or macroeconomic stability.

If the distinction between the institutional sources of investment matters for productivity and growth, then it is very important to understand the linkages between them. If public investment crowds in private investment (for example, because the construction of roads, or ports allows firms to have broader access to markets), then the relevant question in terms of aggregate social welfare would be how to raise the productivity of public capital via, for example, reducing the distortions that may hamper its effects on growth or focalizing public investment into sectors where productivity is conceivably higher (for example, public infrastructure). But if these distortions are so great such that public investment crowds out private investment, then the problem is twofold, because every time that public investment increases, productivity takes a double hit: on the one hand, average productivity falls because public investment in less productive than private investment, and, on the other hand, total productivity falls because there is crowding-out of private investment. Therefore, the relevant question for policy purposes is what needs to happen so that the crowding-out effect disappears and developing countries can reap benefits from higher public investments.

We are not the first ones to test the linkages between public and private investment. On this issue, Blejer and Khan (1984) test whether public investment crowds out or crowds in private investment in a sample of 24 developing countries over the period 1971-1979. They provide evidence that public infrastructure investment is complementary to private investment, while other kinds of public investment led to crowding out of private investment. Aschauer (1989), using data for the United States only, finds that for a given rate of return, an increase in public capital reduces one-to-one private capital, but at the same time it also raises the marginal productivity of private capital which, in turn, crowds in private capital. Overall, this latter effect dominates in simulation exercises based on an econometric model for US data, such the net effect of public investment (particularly non military spending) is positive. More recently, Everhart and Sumlinski (2001) explore the partial correlation between public and private investment series using an unbalanced panel of 63 developing countries from 1970-2000. They find a negative correlation between the two series (consistent with crowding out), and that the correlation turns positive in countries with better institutions. Erden and Holcome (2005) find

evidence of a positive correlation between public and private investment for a sample of 19 developing countries over the period 1980 to 1997, and a negative correlation for a sample of developed economies for the period 1980 to 1996. Lora (2007) finds evidence of complementarities between public and private infrastructure investment for seven Latin American countries in the period 1987-2001.

Despite important contributions to the academic and policy debates, these papers are based on results from rather small samples and employ empirical methodologies that fall short of establishing causality. One incremental contribution of this paper is applying an empirical methodology based on dynamic panel data techniques that is well suited for identifying causality in a broader sample of developing countries using a consistent dataset.

While Khan and Reinhart (1990) and Khan and Kumar (1997) suggest that private capital formation is more productive, and hence more growth enhancing than public investment,[1] this does not necessarily imply that all forms of public investment are equally productive, nor that investment in public infrastructure is necessarily better for growth than other forms of public expenditures. In particular, Devarajan, Swaroop, and Zou (1996) develop a model from which they derive conditions under which a change in the composition of public expenditure leads to a higher steady-state growth rate of the economy. The conditions depend not just on the physical productivity of the different components of public expenditure but also on the initial shares. Using data from 43 developing countries over 20 years they show that an increase in the share of current expenditure has positive and statistically significant growth effects. By contrast, the relationship between the capital component of public expenditure and per capita growth is negative. They conclude that seemingly productive expenditures, when used in excess, could become unproductive. This, in turn, implies that if public investment is already above a certain threshold, further increases could dampen private investment even through the channel of the marginal product of private capital, which is typically considered the main conduit for crowding-in. This suggests that the potential crowding out effect can be even stronger than suspected and reinforces the idea that the actual linkages between public and private investments are an open empirical question.

[1] On this issue, see also Coutinho and Gallo (1991) and Servén and Solimano (1990).

Another set of papers has focused on the issue of the efficiency of public investment as well as on the role of good governance as a key determinant of the productivity of public investment projects. For example, Rajkumar and Swaroop (2008) study the effect of public health and education spending on outcomes (child mortality and educational failure rate). They find positive and significant effects only for countries with good governance. Keefer and Knack (2007) find that public investment is significantly higher in countries with bad institutions, which they argue is a reflection of the enhanced rent-seeking incentives of governments in environments where property rights are less secure. Mauro (1998) studies if predatory behavior by corrupt politicians distorts the composition of government expenditure. In particular, he finds that education spending is adversely affected by corruption. De la Croix and Delavallade (2006) make Mauro's empirical model more consistent with theory, developing a model where the composition of public expenditures is tilted towards physical capital and away from education and health, where the diversion of funds is more difficult. They also provide consistent empirical evidence for the model.[2] The bottom line from this strand of the literature is that the determinants and also the consequences of public investment decisions are tied to the country's institutional factors related to "good governance." Furthermore, the empirical evidence shows that high public investment ratios (as a share of total government expenditure as well as a percentage of GDP) are significantly associated with weak institutions. In this paper, we provide further evidence that good governance is a key factor mediating the relationship between public and private investment in developing countries, and we go one step further by providing evidence on other structural country characteristics related to the level of financial and trade openness that have received much less attention in the empirical literature.

The reminder of the paper is as follows. Section 2 presents a basic analytical framework to motivate our empirical exercise and main hypotheses. Section 3 describes the investment data in detail, and in Section 4 we discuss the econometric methodology. Our main results are presented in Section 5 and several robustness checks in Section 6. In Section 7 we discuss the main policy implications of our findings for public investment policies. Finally, Section 8 concludes.

[2] See also Robinson and Torvik (2005) for a theory of "white elephants," costly prestige investment, projects with negligible social returns.

2. Analytical Framework

This section discusses briefly the alternative channels through which public investment can affect private investment, in order to motivate our empirical analysis. Basically, we outline a simple framework where two countervailing forces coexist as in Aschauer (1989). On the one hand, public capital is potentially a complementary production factor which raises the marginal productivity of private capital. This fact has a crowding-in effect of public investment on private investment. On the other hand, public investment requires financing and therefore could crowd out private investment via a reduction in the amount of savings available for private investment and/or its effects on the interest rate.

In order to analyze these issues further, let us assume that the aggregate production function in the economy is given by $F(k,G)$, where k is the private capital stock and G is public capital (e.g. infrastructure). Furthermore, we assume that the following conditions hold:

$$F_k > 0, F_{kk} < 0, \lim_{k\to 0} F_k = \infty, \lim_{k\to\infty} F_k = 0, F_{kG} > 0 \qquad (1)$$

The first four conditions are the standard INADA conditions, while the last assumption implies that public capital increases the marginal productivity of private capital. In what follows, we might also use a specific functional form given by a Cobb-Douglas function: $F(k,G) = Ak^{\alpha}G^{\beta}$. Firms contract private capital in a perfectly competitive market, such that they take the interest rate (r) as given. For simplicity, we assume that the rate of depreciation is equal to one, such that all capital depreciates during the production period. The firm's problem is to choose k to maximize:

$$F(k,G) - (1+r)k, \qquad (2)$$

which yields the traditional first- order condition that in equilibrium the value of the marginal product of private capital has to equal its rental cost:

$$F_k(k,G) = (1+r). \qquad (3)$$

It is straightforward to show that, for a given interest rate, the optimal private capital stock is an increasing function of G. However, government investment has to be financed somehow. For simplicity, let us assume that total available savings in the economy are given by $S(\tau,r)$, where τ represents the total amount of taxes. Furthermore, we assume that savings

decrease with taxation $(S_\tau < 0)$ and increase with the real interest rate $(S_r > 0)$. The negative effect of taxation on savings clearly implies that the Ricardian equivalence does not hold, an assumption in line with the empirical evidence for developing countries (see e.g. Khamid, 1996). With respect to the positive effect of interest rates on savings, in principle there are clearly two opposed effects at work (income and substitution effects). Actually, there is some evidence by Loayza, Schmidt-Hebbel and Servén (2000) that private domestic savings decrease with the real interest rate, although interest rates are often not market determined and probably reflect other distortions in the economy that discourage savings. Furthermore, given that we also include foreign savings in *S* and that it is a well-documented fact that interest rate differentials are a key driver of capital inflows in emerging markets, the assumption is actually less restrictive.[3] These properties can also be derived in a standard neoclassical growth model, at least in the transitional dynamics as discussed, for example, in Chapter 3 of Barro and Sala-i-Martin (2004).[4]

Furthermore, assume that the government runs a balanced budget, such that $G = \tau$. Taking into account the equilibrium condition that savings has to equal investment $(S(\tau, r) = k + G)$, the effect of public investment on private investment will be given by:

$$\frac{dk}{dG} = \frac{S_\tau - 1 + F_{kG} S_r}{1 - F_{kk} S_r}. \qquad (4)$$

Given our assumptions regarding the concavity of the production function and the positive effect of the interest rate on savings, the denominator of equation (4) is positive, such that the effect of public investment on private investment will be positive if and only if the following condition holds.[5]

$$F_{kG} > \frac{1 - S_\tau}{S_r}. \qquad (5)$$

[3] See e.g. Calvo et al (2001), Daude and Fratzscher (2008) and Fernández-Arias (1996) on this issue.
[4] For a model with permanent growth effects see Rebelo (1991) and Stockey and Rebelo (1995).
[5] Observe that we follow the tradition in the literature by assuming that *G* is exogenous. A social planner would probably expand *G* if the inequality in equation (5) holds.

This equation shows that the impact of public investment on private investment will tend to be positive, the larger the impact of public investment on the marginal productivity of private investment given by F_{kG}. Considering the Cobb-Douglas case, this derivative is given by $\alpha\beta k^{\alpha-1}G^{\beta-1}$. Thus, the impact of G on private investment depends critically on the parameter β. Although this parameter could be interpreted as strictly technological, we think that the value of β is likely to vary systematically across countries. In particular, as pointed out in the literature review, governments in countries with weak institutions are more likely to invest in "white elephants" that have little positive spillovers to private sector investments. Furthermore, these countries also lack the appropriate institutional framework and technical expertise for evaluating the impact of alternative public investment projects, which on average would result in investments with lower social returns. Therefore, it could be the case that the parameter β is an increasing function of the institutional quality. Countries with good institutions would invest in projects with high social returns that have greater complementarities with private investment and positive spillovers. At the same time, given that $\beta < 1$, then F_{kG} will be lower, and thus inequality (5) less likely to hold, in countries with higher levels of public capital stocks G. Therefore, we expect more crowding out in countries where public investment levels are already high.

Another important aspect is that the effect of public investment on private investment depends critically on the sensitivity of savings to changes in the interest rate. The equation above shows that this effect will tend to be positive and stronger if savings are very sensitive to changes in the rate of return of investment (i.e., high S_r). In the case of a country having good access to international capital markets, the interest-rate elasticity of the foreign supply of savings would be very high, such that we would expect to observe a positively stronger effect in countries that are open to international capital flows and well integrated to world capital markets. Actually, crowding out would be certain if savings were completely insensitive to movements in the interest rate. The intuition for this result is simple. There would be a basically a vertical supply of funds available in the economy and any increase in public investment would reduce disposable income and therefore the private investment by the same amount.

Finally, if taxation has a detrimental effect on savings, it would be less likely to observe a positive impact of public investment. The closer a country is to the "Ricardian equivalence" case

(i.e., S_τ closer to 0), where taxation does not affect savings, the more likely it would be to observe a positive effect of public investment on private investment. Given that the conditions for Ricardian equivalence (e.g., perfect capital markets) are more likely to hold in developed economies, we expect public investment in developing countries to have a less positive impact onprivate investment.

While the framework outlined here implicitly assumes that public investment is a non-rival good, the literature has also considered the case where the government provides private goods/capital (see, for example, the discussion in Barro and Sala-i-Martin, 2004). In this case, from an aggregate viewpoint there would be more substitutability between *G* and *k*, making the case for public investment less favorable. On the other hand, as argued by Barro and Sala-i-Martin (2004) and Fisher and Turnovsky (1998) public goods are often subject to congestion effects. In Fisher and Turnovsky's model, the long-run as well as short-run effects of productive government investment on the private capital stock depend on the way government investment is financed (lump-sum versus distortionary taxes), the elasticity of substitution between public and private capital, and the degree of congestion associated with public goods. In the long run, high degrees of congestion require a greater elasticity of substitution to increase private capital, with distortionary financing reducing the expansionary effect of public investment. In addition, in the short run there is an additional wealth effect according to these authors that might induce the private sector to substitute consumption for investment, leading to a short-term fall in the private capital stock. Thus, it is reassuring that a more structural intertemporal equilibrium model would yield similar predictions as those discussed in this section.

3. Description of the Investment Data

The IMF's World Economic Outlook (WEO) is our main source for investment data. The WEO provides data on gross capital formation at current prices for developing countries disaggregated by institutional sectors (private and public). In particular, we consider the ratios of gross *private* fixed capital formation to GDP and gross *public* fixed capital formation to GDP available for 116 developing countries between 1980 and 2006. A major advantage of this dataset is the large sample size. However, the dataset does not apply a uniform set of criteria for the type of investments classified as public investments. This might be particularly important for the case of public/state enterprises. We address this problem in our analysis in two ways. First, our

econometric specification includes country fixed effects, which eliminate differences in the definition of public investment. Second, we perform robustness checks using a smaller sample of countries for which a uniform definition of public investment is available.

In order to get a first grasp of the data, we analyze trends in five regions: Latin America and the Caribbean (LAC), Asia, Africa, the Middle East, and Eastern Europe. The list of the countries in each regional group is reported in Table A.2 of the Appendix. In Figure 1, we plot the simple averages of public and private investment ratios to GDP from 1980 to 2006 for each region. Several interesting patterns emerge from the data.

In the case of LAC, while both types of investment collapsed with the debt crisis of the early 1980s, only private investment has since recovered to pre-crisis levels. However, despite this recovery, the ratio of private investment to GDP in 2006 (i.e., 16.5 percent) was not very different from the pre-1982 level (i.e., 15 percent), suggesting that private investment has been rather sluggish in the region. In Africa public investment as a share of GDP shows a downward trend, while private investment has fluctuated around the same (low) level of the early 1980s. For the case of Asian countries, private investment increased by 5 percentage points of GDP between 1980 and 2006 (i.e., 13 vs. 17 percent, respectively), while public investment as a share of GDP was roughly equal in 2006 compared to 1980. Thus, the surge in private investment observed in Asian countries appears to be delinked from the *levels* of public investment (albeit perhaps not from its composition). In Eastern Europe, private and public investments appear to be almost perfectly negatively correlated in the 1980s, delinking somewhat in the 2000s with private investment to GDP showing an upward trend and public investment remaining stable as a share of GDP. The timing of the delink is interesting because it coincides with a major process of financial and trade integration of the countries in Eastern Europe with the rest of the world. Finally, in the case of the Middle East, private and public investment appear to have moved in tandem over this period with the exception of a few years in the late 1980s and the early 1990s, when private investment increased while public investment declined, creating a wedge between the two series that would remain stable thereafter.

In Table 1, we present some moments of the correlation coefficients between the private and public investment ratios to GDP by region, in levels, first differences and for the cyclical components of both series.[6] The results show on average a negative correlation between public

[6] We de-trend the investment to GDP series using the Hodrick-Prescott filter.

and private investment, regardless of whether the correlations are computed using levels, first differences or are de-trended. In levels, for Africa and Asia the average correlations are close to zero, while Latin America and Eastern Europe show somewhat more negative correlations. However, all regions exhibit considerable internal heterogeneity. Within all regions, there are countries with a highly negative correlation and other countries with strongly positive correlations.

The main objective of this paper is to probe deeper into these correlations and, in particular, to explore the causal link between public and private investment. To do so, we employ an empirical methodology that takes into account that these variables are possibly endogenous. In the next section, we explain the empirical strategy in detail.

4. Empirical Methodology

In order to evaluate the impact of public investment on private investment, we use system GMM estimators developed by Arellano and Bover (1995) and Blundell and Bond (1998). This estimation method is especially convenient in our framework because it allows for addressing two important econometric problems. First, it enables us to control for unobserved heterogeneity at the country level in a dynamic setup such as is commonly used for estimating investment equations, given the natural inertia in investment. Under these conditions, while unobserved time-effects can be isolated by introducing year-dummies, the traditional fixed-effects methods would yield inconsistent estimates. Second, many of the variables included in the equation are likely to be endogenous and determined jointly with private investment. Clearly, this can be the case of our variable of interest—public investment—which could react to movements in private investment or shocks that affect both investment ratios. Thus, given that our interest is to capture the causal link from public investment and country characteristics on private investment, it is important to deal with this problem. The system GMM estimator enables us to address both of these problems jointly.

In particular, our baseline equation is given by:

$$\left(\frac{I^P}{Y}\right)_{i,t} = \rho\left(\frac{I^P}{Y}\right)_{i,t-1} + \alpha\left(\frac{I^G}{Y}\right)_{i,t} + \beta' X_{i,t} + \mu_t + \gamma_i + \varepsilon_{i,t}, \qquad (6)$$

where I^P represents private investment in fixed capital, I^G is public investment in fixed capital, Y is GDP, X includes additional controls, μ_t represents an unobserved common time-effect, γ_i is an unobserved country-effect, and $\varepsilon_{i,t}$ is the error term. In order to eliminate the country-effects, we take first differences in equation (6), which yields:[7]

$$\Delta\left(\frac{I^P}{Y}\right)_{i,t} = \rho\Delta\left(\frac{I^P}{Y}\right)_{i,t-1} + \alpha\Delta\left(\frac{I^G}{Y}\right)_{i,t} + \beta'\Delta X_{i,t} + \Delta\mu_t + \Delta\varepsilon_{i,t}. \qquad (7)$$

Observe that in addition to the potential endogeneity problem of public investment and controls, the error term in equation (7) $\Delta\varepsilon_{it}$ is correlated with the lagged dependent variable by construction. In order to address this problem as well as the potential endogeneity of controls, the system GMM estimator uses a series of instrumental variables based on lagged values of the explanatory variable and the dependent variable, exploiting the panel nature of our dataset.

The estimation procedure relies on the idea that internal lagged instruments can be found, given that they are weakly exogenous if they are not correlated with future error terms. While the lagged dependent variable is "predetermined" because it is correlated with past error terms, but uncorrelated with the current and future error terms, the other variables are potentially endogenous given that they are correlated with the current and past error terms, but are assumed to be uncorrelated with future errors. This means that predetermined and endogenous variables are uncorrelated to unanticipated shocks (future error terms), even though expected future dynamics may affect them. Under these assumptions, a possible set of instruments is the lagged levels of the dependent variables like $\left(I^P/Y\right)_{i,t-2}$ as instrument for $\Delta\left(I^P/Y\right)_{i,t-1}$, $X_{i,t-2}$ for $\Delta X_{i,t}$, and $\left(I^G/Y\right)_{i,t-2}$ for $\Delta\left(I^G/Y\right)_{i,t}$.[8]

However, as pointed out by Blundell and Bond (1998), the GMM estimators based on estimating equation (7) using these lagged level instruments (called the difference estimator in the literature) might be unreliable and biased in small samples. In particular, this problem arises when there is high persistence in the levels of the explanatory variables, because the lagged

[7] We follow the standard notation by representing the difference $y_t - y_{t-1}$ by Δy_t.

[8] Of course, more lags for $t \geq 3$ could be used as additional instruments, but we limit the number of lags to avoid over-fitting.

levels would be weak instruments of the first differences in this case. The system GMM estimator overcomes this problem by including a further moment restriction which assumes that although $\left(I^G / Y\right)_{i,t}$ and $X_{i,t}$ might be correlated with the unobservable component γ_i, the first differences are uncorrelated with $\gamma_i + \varepsilon_{i,t}$.This is basically a stationarity assumption, saying that deviations from long-term trends are not correlated to country fixed effects. Under these conditions, lagged first differences can be used as instruments for the levels in equation (6). Thus, we can estimate a system GMM using the level and difference equations (6) and (7) and the corresponding instruments under the moment restrictions discussed above.

In terms of testing the validity of our identifying restrictions, we perform two tests. First, we test whether the error term is second-order serially correlated, i.e., whether $\Delta\varepsilon_t$ is uncorrelated with $\Delta\varepsilon_{t-2}$, which happens only if ε_t is serially uncorrelated.[9] The second test we carry out is a Hansen J-test which is equivalent to the traditional Sargan test but allows for heteroskedasticity in the error term.

Finally, a potential problem with the proposed estimation procedure is that too many instruments can over-fit the endogenous variables and fail to isolate their exogenous component. At the same time, it also weakens the power of the Hansen test to detect over-identification (Roodman, 2007). To deal with these problems we follow Roodman's suggestion of limiting the number of lags that are used as instruments, and also "collapsing" them into a single vector.[10] This procedure yields a smaller set of instruments without a loss of information.[11]

[9] Observe that first-order correlation should be expected in equation (7), even if the error term in (6) is white noise. Thus, while we report also the first-order autocorrelation in our tables, a rejection of the null hypothesis of no correlation does not translate into a rejection of the validity of our instruments.

[10] All econometric estimations in this paper were carried out using STATA 10. In particular, we use the "collapse" option with xtabond2.

[11] We also perform the small-sample correction to the covariance matrix estimate. Standard errors are robust to heteroskedasticity and arbitrary patterns of autocorrelation by country.

5. Results

In Table 2 we present the results of estimating the system of equations (6) – (7) with different combinations of our baseline specification that—in addition to the public investment ratio—also include the three basic controls based on Servén (2003): the relative price of investment, domestic credit to the private sector as a fraction of GDP, and real exchange rate uncertainty.[12]

The first column of Table 2 shows a negative and significant impact of public investment on the private investment rate. In the short run, a one-percentage-point increase in the ratio of public investment to GDP decreases private investment to GDP by 0.17 percentage points. The implied long-run effect shows crowding-out with a 60 percent reduction of private investment in response to an increase in public investment.[13]

In column 2, we introduce the relative price of investment from the Penn World Tables 6.2, measured by the ratio of the capital goods price index to the GDP deflator. According to theory, investment should be a negative function of the relative price of capital goods. In fact, the point estimate is consistent with this prediction, although it is not statistically significant. Importantly, the coefficient for public investment remains significant and close to the estimate presented in column 1.

Next, we include a measure of financial development (domestic credit to the private sector as a fraction of GDP) which is associated with lower funding costs and a higher efficiency of investment. As expected, financial development has a positive and economically significant impact on private investment. The estimated coefficient implies that a 10 percent increase in domestic credit to GDP increases private investment by 2.3 percent. The effect of public investment remains significant and similar in size to the previous specifications. Alternatively, we have also used the real interest rate from the World Development Indicators as an alternative proxy for the cost of financing. While this variable turns out not to be significant, the main result of the paper—ie., the sign, size and significance of the estimated coefficient for the public investment ratio—is robust.[14]

[12] See the Appendix for a detailed description of the data and sources.
[13] The long-run effect is approximated by the ratio $\alpha/(1-\rho)$.

[14] The problem with using interest rates is, as discussed in Servén (2003), that for developing countries in general, the role of interest rate controls and non-price-rationing mechanisms in financial markets is very pervasive, and thus, interest rates are uninformative of the true marginal cost of funds.

In column 4, we include the volatility of the real exchange rate as a measure of uncertainty, which in theory could have a negative impact on investment if investment is to some extent irreversible (see Pindyck, 1991, and Dixit and Pindyck, 1994). We measure uncertainty by the conditional variance of the residuals resulting from estimating a simple GARCH (1,1) for the variance and an AR(1) in the conditional mean equation of the real exchange rate (in logs) by country, as in Servén (2003). Column 4 shows that the results concerning the effect of public investment continue to hold. In addition, the point estimate for the volatility of the real exchange rate is negative, as expected, although not significant at conventional levels.

Finally, public investment continues to have a significantly negative impact on private investment when including all three controls jointly in the regression (column 5). In line with economic theory and consistent with the results of Servén (2003), this specification also shows significant impact of financial development, while the other two variables show the "correct" signs but are not significant at conventional levels. Furthermore, it is important to point out that both diagnostic statistics tests—for serial correlation and the validity of the instruments (i.e., the AR2 test and the Hansen-J test)—provide support for the chosen specification. In particular, they show that there are no traces of second-order autocorrelation and that the over-identifying restrictions are not rejected at conventional levels of confidence.

In Table 3, we explore potential differences across regions and time periods. In column (1), we estimate the model for Asia only.[15] The results are very similar to the ones in the baseline case. In particular, public investment has a significantly negative impact on private investment while financial development has a positive impact. In column 2, we estimate the model only for Latin America and the Caribbean. The results are again very similar to the ones in the baseline, with the only difference that now the relative price of capital goods has a significantly negative effect on private investment, while financial development is not statistically significant. The results for other countries, shown in column 3, are also similar to the baseline. Again, we find a significantly negative effect of public investment on private investment.

Next, in column 4, we estimate the model excluding the highly indebted poor countries (HIPC) to check if our results are driven by the inclusion of these countries in the sample. The results show that crowding-out result is not due to the HIPC countries in our sample.

[15] See Table A.2 for details on the countries included in each sub-sample.

Alternatively, it could be argued that the estimates reported so far conceal important differences in the effects of public investment over time. For example, many emerging markets carried out structural reforms and privatizations during the 1990s. In this latter case, a negative correlation between public and private investment might be driven by the simple substitution of public investment by private investment after the privatizations took place. While we explore the direct impact of privatizations in the robustness section, here we test if the results change over time by splitting the sample into three periods: the 1980s, the 1990s and the 2000s. The results are reported in columns 5-7. They suggest that the crowding-out effect of public investment is significant in all three sub-periods.

Finally, we split the sample among countries with low, medium and high average public investment ratios.[16] As pointed out in Section 2, more crowding out should be expected in countries with already high levels of public investment. The results in columns (8)-(10) are consistent with this prior: the crowding-out effect appears only in the sub-samples of countries with intermediate and high public investment ratios.

Overall, the results in Table 3 shows that the negative impact of public investment on private investment seems to be the norm rather than the exception, both across regions and over time. The only exception is the sub-sample of countries where the public investment ratios are very low. For this sub-set of countries, there is no evidence of either crowding-out or crowding-in.

What factors lie behind the negative relationship between public and private investment? In Table 4, we present a series of estimations that explore whether the impact of public investment on private investment depends on three structural country characteristics that derive from our discussion in Section 2. We perform this analysis by including interaction terms in the panel regressions of Table 2. Including these terms allows us to probe deeper into the aforementioned hypotheses. For example, suppose that one reason why public investment crowds out private investment is that in some countries public investment is wasteful and associated with corruption rather than productive investment (i.e., low F_{kG} due to a low β), as the empirical evidence reported in several of the papers discussed in the introduction shows. If that is the case, then the crowding-out effect should disappear in countries with better institutions. In

[16] We compute the average public investment to GDP ratio for every country in the sample, and divide the sample into three groups: low, medium and high, where every group is one-third of the distribution.

order to explore this possibility we include an index of institutional quality from the International Country Risk Guide (ICRG). This index is a perception-based rating of experts regarding several institutional aspects of the country which are constructed to ensure comparability across countries. In particular, we consider the index on Political Risk which is reported on a scale from 0 to 100, with higher ratings representing less risk. This index includes several dimensions such as government stability, corruption, bureaucratic quality, law and order, and political conflict, which have been shown to affect investment decisions.[17]

We test the impact of political risk on private investment in columns (1) and (2). In column 1, the measure of institutional quality is statistically significant with the expected sign in the regression. From an economic point of view, the estimated coefficient implies that a one-standard-deviation improvement in institutional quality (e.g., improving Bolivia's institutions to the level of Uruguay) would increase the ratio of private investment to GDP by 1.2 percentage points. In column (2) we also include the interaction term between this index and the ratio of public investment to GDP (Public). The coefficient of the interaction term is positive and statistically significant, such that the crowding out of public investment is dampened in countries with better institutions.

The inclusion of the interaction term in the regression means that the net effect of an increase in public investment on the private investment ratio depends on the estimated coefficients, and on the level of the index of institutional quality. In particular the net effect of a change in the public investment ratio is given by the following equation:

$$\Delta\left(\frac{I^p}{Y}\right)_{i,t} = \left(\alpha + \beta X_{i,t}\right)\Delta\left(\frac{I^G}{Y}\right)_{i,t} \qquad (8)$$

where Δ represents the change in the respective variable. Equation (8) says that any change in the public investment ratio affects private investment directly via α, and indirectly through the interaction effect with the control variable $X_{i,t}$.

In Figure 2, we plot the estimated net effect of a one standard deviation increase in the public investment ratio for different percentiles of the distribution of the index of institutional

[17] See, for example, Daude and Stein (2007) for an analysis of the impact of different institutional aspects on foreign direct investment. See also http://www.prsgroup.com/ICRG_Methodology.aspx for details on the methodology of the political risk index.

quality, using the estimated coefficients in column (2). The results indicate that for countries at the higher end of the distribution of institutional quality (in our sample, countries like Botswana, Chile, Slovakia and the United Arab Emirates) the net effect of an increase in the public investment ratio is *crowding-in* of private investment.

In columns (3) and (4), we perform the same exercise for de jure financial openness (FO) to test if the crowding out effect that we identify is related to a competition between public and private investment for limited financing sources. In principle, the availability of foreign savings serves as a way to relax the domestic financing constraint. This would be equivalent to increasing S_r (via increasing the availability of foreign savings) or S_τ (via expanding the availability of portfolio choices to domestic savers in ways that might render the Ricardian equivalence more plausible) in the context of the framework in Section 2. Thus, we check if the crowding-out effect of private investment is dampened in countries that are more integrated to foreign capital flows. In particular, we use the "KAOPEN" indicator constructed by Chin and Ito (2006; 2007). This indicator is the first principal component of four variables based on a detailed analysis of the IMF's *Annual Report on Exchange Rate Arrangements and Exchange Rate Restrictions*: the existence of multiple exchange rates, restrictions on current account transactions, restrictions on capital account transactions, and the existence of requirements regarding export proceeds. The indicator is computed annually and available from 1970 to 2006.

We find evidence that is consistent with this hypothesis. In column (3) we show that when financial openness per se is incorporated into in the regression, it is positive and statistically significant. In column (4) we also incorporate the interaction of FO with the public investment ratio, and we find that the interaction coefficient is positive and significant, meaning that, as expected, there is a dampening effect.

In Figure 3, we plot the estimated net effect of a one standard deviation increase in the public investment ratio for different quintiles of the distribution of financial openness, using the estimated coefficients in column (4). The results are that for countries at the higher end of the distribution of financial openness (in our sample, countries like Peru, Qatar, and Mauritius) the net effect of an increase in the public investment ratio is positive, meaning that there is *crowding in* of private investment.

In columns (5) and (6) we show that we obtain similar results when interacting the public investment ratio with de facto trade openness (Trade), measured as the ratio of real export plus real imports to real GDP. These results suggest that in countries that are more open to trade, the crowding-out effect of public investment is dampened.

In Figure 4, we plot the estimated net effect of a one standard deviation increase in the public investment ratio for different quintiles of the distribution of trade openness, using the estimated coefficients in column (6). The results are that for countries at the higher end of the distribution of trade openness (in our sample, countries like Malaysia or Panama) the net effect of an increase in the public investment ratio is *crowding in* of private investment.

Although the three variables used in the previous regressions--institutional quality, de jure financial openness, and de facto trade openness—might represent independent mechanisms through which public investment impacts private investment, we need to be careful with the interpretation as they are all highly correlated. In our sample, the pair-wise correlation between any two of these variables fluctuates between 0.36 and 0.42. More in general, it has been documented elsewhere that trade openness is associated with both financial openness[18] and institutional quality.[19]

6. Robustness Checks

In order to check the robustness of our results, we perform a series of additional tests. First, we consider alternative estimation methods. We re-run the regressions using standard panel fixed-effects; random effect; difference OLS; Pooled OLS with panel corrected standard errors and first-order country specific autocorrelation correction (Prais-Winsten); and difference GMM estimator. While these regressions are potentially mis-specified due to the omission of the lagged dependent variable as an independent regressor,[20] they are useful for checking if the results of our benchmark regressions are driven by the choice of the estimator. The results are reported in Table 5. Reassuringly, the significance of the crowding-out effect remains unchanged throughout all the alternative specifications.

[18] See Aizenman (2008) and Aizenman and Noy (2004)
[19] See, for example, Rodrik, Subramanian and Trebbi (2004)
[20] In these regressions, we omit the lagged dependent variable as an independent regressor, as these estimators are not suited for dealing with the "dynamic panel bias". This arises because $y_{i,\,t-1}$ is endogenous to the fixed effects in the error term.

Finally, we consider an alternative source for our dependent variable as well as public investment. As discussed above, our data on investment come from WEO, which in turn aggregates data from standard national accounts statistics. In particular, the definition of public investment is not always precise or necessarily homogenous across countries. For example, most standard measures classify capital expenditures of state-owned enterprises as private investment. In contrast, Everhart and Sumlinski (2001) build a new dataset on public and private investment for 63 developing countries that counts all investment undertaken by the public sector—including through state enterprises—as public sector investment. It is based on complementary data compiled by the IMF and the World Bank. Thus, in the regression reported in column (6), we replace the ratios of public and private investment to GDP from the WEO for the data from Everhart and Sumlinsky (2001). The main results remain unchanged. In particular, the coefficient that captures the effect of the public investment ratio on private investment is still negative and significant.

In Table 6, we include additional control variables to check if the results may be biased by omitted variables not accounted for by either the country fixed-effects or the time dummies. One such variable is the "output gap" which would be included in a financial-accelerator type of investment equation. We compute the output gap for each country/year as the difference between the actual real GDP and trend GDP, computed using the Hodrick-Prescott filter. Results are reported in column (1) of Table 6. While this variable per se is positive but statistically not significant, its inclusion does not change the estimated effect of the public investment ratio on private investment.

Next, in column (2) we check the effect of including the general government expenditure as a share of GDP from the World Development Indicators. The inclusion of this variable serves two purposes. On the one hand, if limited financing is part of the story behind the negative relationship between public and private investment, then public investment should not be different in terms of the crowding-out effect than other forms of public spending. At the same time, including this additional variable allows us to disentangle whether the crowding-out effect is driven by public capital expenditure or other types of expenditures. The result reported in column (2) is that the general government current expenditure ratio enters the regression with a negative sign and is statistically significant. However, the public investment coefficient remains negative and significant. It is interesting to point out that the government's consumption

expenditure has a significantly larger effect than public investment (i.e., it has a point estimate of -0.234 vs. -0.131 for public investment), suggesting that there is *less* crowding out associated with public investment than with current expenditures. Assume that all types of public expenditure have the same crowding-out effect via the limited financing story. Then what might explain the different coefficients? The answer is that while all forms of public expenditures might render the same crowding-out effect via the limited financing story, public investment has some positive effects on private investment that dampen the effect. This is consistent with the analytical framework in Section 2. Recall from that section that public investment has potentially two different impacts on private investment: a positive impact via increasing the marginal product of private capital and a negative impact via the reduction in the amount of savings available for private investment. The fact that we find crowding-out for public investment suggests that the latter channel is stronger than the former. And the fact that the estimated crowding-out effect is smaller for public investment suggests that other forms of public expenditures do not have the dampening effect.[21]

In column (3) we include the central government balance as a share of GDP from the World Development Indicators. This could be an important variable, given that lower government balances imply higher future taxes—which could reduce the private return to investment—and/or a higher financing cost for private firms due to the competition for funds with the public sector.[22] We find that, as expected, higher government balance as a ratio of GDP is associated to higher private investment, but the effect is not statistically significant. Nevertheless, reassuringly, the effect of the public investment ratio is still negative and significant.

In column (4) we control for the ratio of net foreign direct investment inflows as a share of GDP, from the World Development Indicators. We find that while the effect of FDI inflows on private investment is positive and significant, the effect of public investment remains unchanged. In column (5) we control for a privatization dummy that takes the value of one if

[21] Or if they do have an effect, it is smaller.

[22] If the deficit is financed with external rather than domestic borrowing, the effect is still the same, as more external borrowing by the government raises country risk and, thus, the cost of financing for domestic firms. Cavallo and Valenzuela (2007) provide evidence that sovereign risk is an important determinant of the cost of financing of private firms in emerging market economies.

there were any significant privatizations during that year in the country,[23] but it turns out to be not significant and its inclusion does not change the results regarding the effect of public investment.

In columns (6) and (7) we include some available measures of public infrastructure (or public capital *stock*): paved roads, and kilometers of roads per capita from the World Development Indicators database. We test whether the estimated crowding out effect of private investment might be due to the fact that (low) public investment is a proxy for inadequate public infrastructure. The results suggest that it is not. While these measures of public infrastructure have a positive effect, the estimated effect of the public investment ratio remains negative and significant. These results are consistent with the hypothesis that, while public infrastructure may be complementary to private capital in the aggregate production function, there are distortions associated with the public investment process in developing countries (some of which we have discussed above) that might render a crowding out of private investment in the process of building public capital stocks. This is akin to the results reported in Blejer and Khan (1984), who argue, using a smaller sample of 24 developing countries, that while public *infrastructure* investment is complementary to private investment, other kinds of public investment lead to crowding out of private investment (more on this below).

Finally, in column (8) we include all these additional controls together, and show that the crowding out effect of private investment remains unchanged. All in all, these results, together with the fact that the estimation technique also accounts for unobserved fixed-effects, give us reassurance that the results are not driven by omitted variable bias.

7. Discussion and Policy Implications

It is important to emphasize what this paper is saying and what it is not saying. First, we are *not* arguing that public and private capital are, or may be, substitutes in the aggregate production function. On the contrary, we acknowledge in the analytical framework and in the empirical estimations that there are potentially important complementarities between, for example, an adequate public infrastructure and private capital. Aschauer (1989) presents evidence suggesting

[23] The information on privatizations comes from the World Bank's database on privatizations in developing countries.

a strong positive role for non-military public capital stock in determining the rate of return to private capital, consistent with the hypothesis that public and private capital stocks are complementary inputs to private production technology. Similarly, a number of more recent studies have shown that improving infrastructure has a positive impact on output, particularly for developing countries. As might be expected, the greatest returns are in the early stages of development, when the existing infrastructure is poor.[24] Furthermore, we provide consistent evidence that public infrastructure (in this case, proxied by the availability of paved roads) has a positive effect on private investment.

Second, we are not saying that all forms of public investment render the same crowding-out effect. We do not have data on the composition of public investment to conduct a detailed analysis on the possible differential effects of various forms of public investment. On this issue, Blejer and Khan (1984), in their cross-country study of private investment for a sample of 24 developing countries, suggest that public investment in infrastructure is likely to increase private investment while other types of public investment tend to produce a crowding out effect.[25] Similarly, Lora (2007) finds evidence of complementarities between public and private investment in infrastructure for a sample of seven Latin American countries.

Third, we are not saying that public investment is per se a bad thing. What we recognize in this paper is that building public capital requires investment, and that there might be distortions associated to the public investment process that crowd out private investment. We have made conjectures on the origin of some of these possible distortions and provided supportive evidence for these hypotheses. Public investment may crowd out private investment in certain contexts: for example, in countries with poor institutions, binding financing constraints, insufficient integration into world capital markets, and insufficient openness to international trade. Furthermore, in terms of its effects on GDP growth, as long as there is no complete crowding out, which we have not found in this paper, public investment would still

[24] Notable papers on this line include Canning (1999), which uses panel data for a large number of countries, and Demetriades and Mamuneas (2000), which uses data for OECD countries. Röller and Waverman (2001), find that telecommunications infrastructure has large output effects. Similar results for roads are reported by Fernald (1999) using data on U.S. industry. Calderón and Servén (2003) present a similar empirical analysis focused on Latin America. They find positive and significant output contributions from three types of infrastructure: telecommunications, transport and energy.

[25] They approximate infrastructure investment with the trend of real public investment, and take the deviations from the trend as a proxy for non-infrastructure investment.

have a positive effect on growth, although it might not be the optimal use of resources from a social welfare viewpoint.

There is also a more subtle point to be made: some of the investment required to build public capital stocks need not be entirely *public* in nature. The economic justification for certain level of public investment is well-known: some public services enjoy a substantial public good component, meaning that their production and provision has externalities, and thus the private sector would provide suboptimal amounts. But the role of the public sector as the sole provider and financier of public investment is more dubious. Isham and Kaufmann (1999) make this point very eloquently: *"…as the public sector extends itself into lower priority areas (where the public good component is nonexistent or the private sector can provide these services more effectively)… the complementarities between public and private investments are circumscribed…public investments in certain priority areas are complementary to the efficiency of individual investments; in other areas, they may supplant private investments."* Thus, it is not the *quantity* of public investment that matters, but rather the *quality*. In other words, not only must more money be spent on building public capital, but it must be spent more wisely, avoiding costly prestige or "white elephant" projects.

8. Conclusions

Is public investment in developing countries a blessing or a curse? The evidence presented in this paper suggests that the answer to this question is that it is "mixed blessing": on average public investment does crowd out private investment in our sample of developing countries, and the result is very robust both across regions and over time. However, the "good" news of the paper is that the size and sign of the impact depends on a series of factors that are amenable to policy action: institutional quality and polices that relate to market access both in terms of trade and also in finance.

The aforementioned structural factors, in particular in regard to institutional quality, are indeed the basis of the conditionality that multilateral development agencies often set when giving loans to national governments to finance public works projects. This conditionality is oftentimes criticized on the basis that it is an interference with national domestic affairs that should be outside of the scope of these institutions. The results reported in this paper suggest that this line of criticism has to be qualified as there are no guarantees that the loans provided by

these institutions will end up having the intended outcomes independently of the institutional context.

Public investments should ideally be focused on increasing productivity and competitiveness, searching for the areas where social returns are the highest and externalities and spillover effects are significant. The most important concern when it comes to infrastructure investment, for example, is project selection. Selecting projects with the greatest impact is critical; thus, it is crucial that countries set up institutions capable of doing adequate planning, cost-benefit analysis and ongoing monitoring and evaluation. If, instead, the focus in on quantity, then it is more likely that higher levels of public investment have undesirable collateral effects such as crowding out private investment with little productivity gains for the economy. This is, indeed, what our results seem to suggest: on average, for the sample of developing countries covered in this study, increases in public investment tend to crowd out private investment. This would not be the case if public investment were either productivity enhancing or if there were no distortions associated with the public investment process.

References

Aizenman, J. 2008. "On the Hidden Links Between Financial and Trade Opening." *Journal of International Money and Finance* 27(3): 372-386.

Aizenman, J., and I. Noy. 2004. "On the Two-Way Feedback between Financial and Trade Openness." NBER Working Paper 10496. Cambridge, United States: National Bureau of Economic Research.

Arellano, M., and O. Bover. 1995. "Another Look at the Instrumental Variable Estimation of Error-Components Models." *Journal of Econometrics* 68: 29-51.

Aschauer, D.A. 1989. "Does Public Capital Crowd Out Private Capital?" *Journal of Monetary Economics* 24: 171-188.

Barro, R.J., and X. Sala-i-Martin. 2004. *Economic Growth*. Second edition. Cambridge, United States: MIT Press.

Blejer, M.I., and M.S. Khan. 1984. "Government Policy and Private Investment in Developing Countries." *International Monetary Fund Staff Papers* 31(2): 379-403.

Blundell, R., and S. Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87: 115-43.

Calderón, C., and L. Servén. 2003. "The Output Cost of Latin America's Infrastructure Gap." In: W. Easterly and L. Servén, editors. *The Limits of Stabilization: Infrastructure, Public Deficit and Growth in Latin America*. Palo Alto and Washington, DC, United States: Stanford University Press/World Bank.

Calvo, G. et al. 2001. "The Growth-Interest Rate Cycle in the United States and its Consequences for Emerging Markets." Research Department Working Paper 458. Washington, DC, United States: Inter-American Development Bank.

Canning, D. 1999. "The Contribution of Infrastructure to Aggregate Output." Policy ResearchWorking Paper 2246. Washington, DC, United States: World Bank.

Cavallo, E.A., and P. Valenzuela. 2007. "The Determinants of Corporate Risk in Emerging Markets: An Option-Adjusted Spread Analysis." Research Department Working Paper 602. Washington, DC, United States: Inter-American Development Bank.

Chin, M., and H. Ito, 2006. "What Matters for Financial Development? Capital Controls, Institutions, and Interactions." *Journal of Development Economics* 61(1): 163-192.

----. 2007. "A New Measure of Financial Openness." Madison, Wisconsin, United States: University of Wisconsin. Mimeographed document.

Coutinho, R., and G. Gallo. 1991. "Do Public and Private Investment Stand in Each Other's Way." World Development Report background paper. Washington, DC, United States: World Bank. Mimeographed document.

Daude, C., and M. Fratzscher. 2008. "The Pecking Order of Cross-border Investment." *Journal of International Economics* 74: 94-119.

Daude, C., and E. Stein, 2007. "The Quality of Institutions and Foreign Direct Investment." *Economics and Politics* 19(3): 317-344.

Demetriades, P., and T. Mamuneas. 2007. "Intertemporal Output and Employment Effects of Public Infrastructure Capital: Evidence from 12 OECD Economies." *Economic Journal* 110: 687-712.

De la Croix, D., and C. Delavallade. 2006. "Growth, Public Investment and Corruption with Failing Institutions." CORE Discussion Paper 2006/101. Available at SSRN: http://ssrn.com/abstract=970305

Devarajan S., V. Swaroop and H.F. Zou. 1996. "The Composition of Public Expenditure and Economic Growth." *Journal of Monetary Economics* (37): 313-344.

Dixit, A., and R.S. Pindyck. 1994. *Investment under Uncertainty*. Princeton, United States: Princeton University Press.

Erden, L., and R.G. Holcombe. 2005. "The Effects of Public Investment on Private Investment in Developing Economies." *Public Finance Review* 33(5): 575-602.

Everhart, S.S., and M.A. Sumlinski. 2001. "Trends in Private Investment in Developing Countries and the Impact on Private Investment of Corruption and the Quality of Public Investment." International Finance Corporate Discussion Paper 44. Washington, DC, United States: World Bank.

Fernald, J.G. 1999. "Roads to Prosperity? Assessing the Link between Public Capital and Productivity." *American Economic Review* 89: 619-38.

Fernández-Arias, E. 1996. "The New Wave of Private Capital Inflows: Push or Pull?" *Journal of Development Economics* 48: 389-418.

Fisher, W.H., and S.J. Turnovsky. 1998. "Public Investment, Congestion, and Private Capital Accumulation." *Economic Journal* 108(477): 399-413.

Isham, J., and D. Kaufmann. 1999. "The Forgotten Rationale for Policy Reform: The Productivity of Investment Projects." *Quarterly Journal of Economics* 114(1): 149-184.

Keefer, P., and S. Knack. 2007. "Boondoggles, Rent-Seeking and Political Checks and Balances: Public Investment under Unaccountable Governments." *Review of Economics and Statistics* 89(3): 566-572.

Khamid, A.M. 1996. "Ricardian Equivalence: Empirical Evidence from Developing Countries." *Journal of Developing Economies* 51: 413-432.

Khan, M.S., and M.S. Kumar. 1997. "Public and Private Investment and the Growth Process in Developing Countries." *Oxford Bulletin of Economics and Statistics* 59(1): 69-88.

Khan, M.S., and C.M. Reinhart. 1990. Private Investment and Economic Growth in Developing Countries. *World Development* 18(1): 19-27.

Loayza, N., K. Schmidt-Hebbel and L. Servén. 2000. "What Drives Private Saving across the World?" *Review of Economics and Statistics* 82(2): 165-181.

Lora, E. 2007. "Public Investment in Infrastructure in Latin America: Is Debt the Culprit?" Research Department Working Paper 595. Washington, DC, United States: Inter-American Development Bank.

Mauro, P. 1998. "Corruption and the Composition of Government Expenditure." *Journal of Public Economics* 69(2): 263-279.

Panizza, U. 2006. "Public Debt around the World: A New Dataset of Central Government Debt." Available at http://www.iadb.org/res/pub_desc.cfm?pub_id=DBA-005.

Pindyck, R.S. 1991. "Irreversibility, Uncertainty and Investment." *Journal of Economic Literature* 29(3): 1110-48.

Pritchett, L. 1996. "Mind your P's and Q's: The Cost of Public Investment is Not the Value of Public Capital." Policy Research Working Paper 1660. Washington, DC, United States: World Bank.

Rancière, R., A. Tornell and F. Westermann. 2005. "Systemic Crises and Growth." NBER Working Paper 11076. Cambridge, United States: National Bureau of Economic Research.

Rajkumar, A.S., and V. Swaroop. 2008. "Public Spending and Outcomes: Does Governance Matter?" *Journal of Development Economics* 86: 96-111.

Rebelo, S. 1991. "Long-Run Policy Analysis and Long-Run Growth." *Journal of Political Economy* 99(3): 500-521.

Robinson, J., and R. Torvik. 2005. "White Elephants." *Journal of Public Economics* 89: 197-210.

Rodrik, D. A. Subramanian and F. Trebbi. 2004. "Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development." *Journal of Economic Growth* 9(2): 131-165.

Röller, L., and L. Waverman. 2001. "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach." *American Economic Review* 91: 909-923.

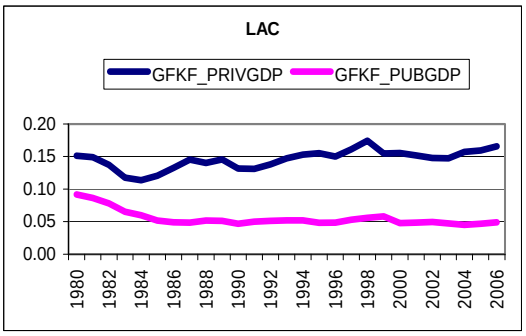
Roodman, D. 2007. "How to Do xtabond2: An Introduction to 'Difference' and 'System' GMM in Stata." Working Paper 103. Washington, DC, United States: Center for Global Development. http://www.cgdev.org/content/publications/detail/11619.

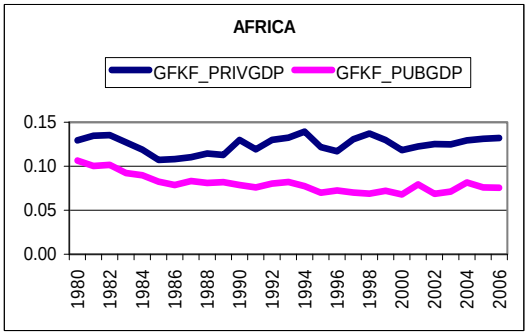
Servén, L., 2003. "Real-Exchange-Rate Uncertainty and Private Investment in LDCs." *Review of Economics and Statistics* 85(1): 212-218.

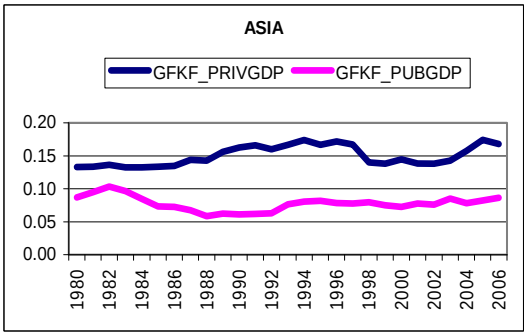
Servén, L., and A. Solimano. 1990. "Private Investment and Macroeconomic Adjustment: Theory, Country Experience and Policy Implications." Washingotn, DC, United States: World Bank. Unpublished paper.

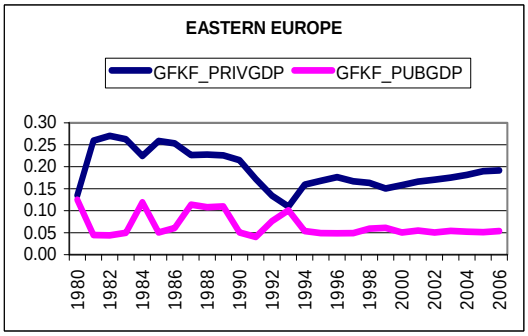
Stockey, N.L., and S. Rebelo. 1995. "Growth Effects of Flat-Rate Taxes." *Journal of Political Economy* 103(3): 519-550.

Figure 1. Investment Trends of World Regions









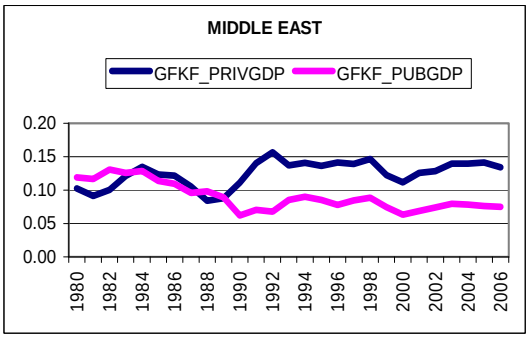


Figure 2.

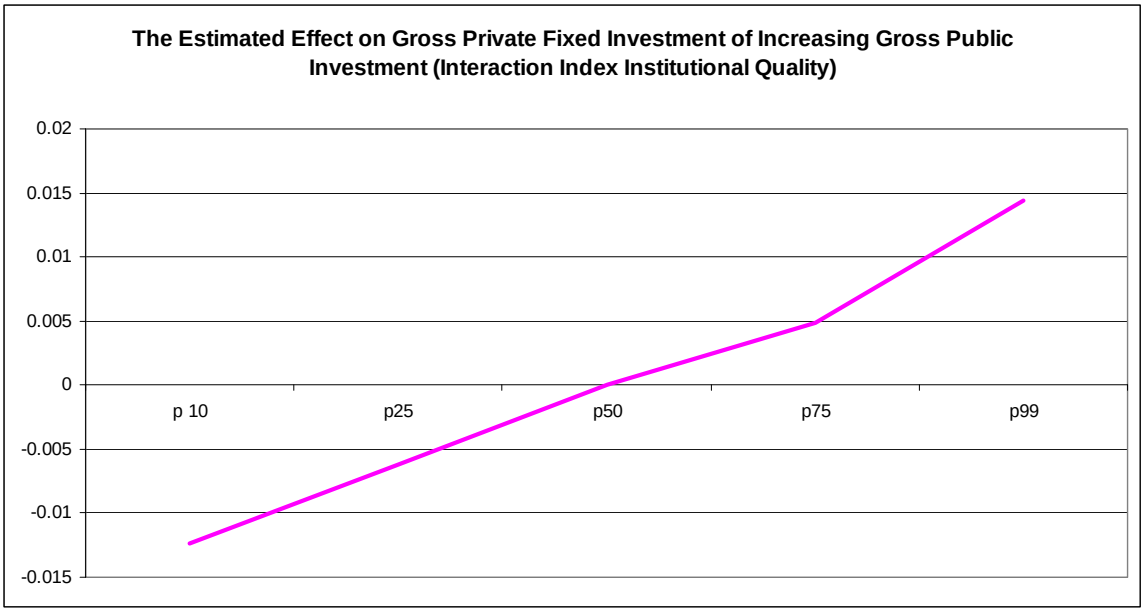


Figure 3.

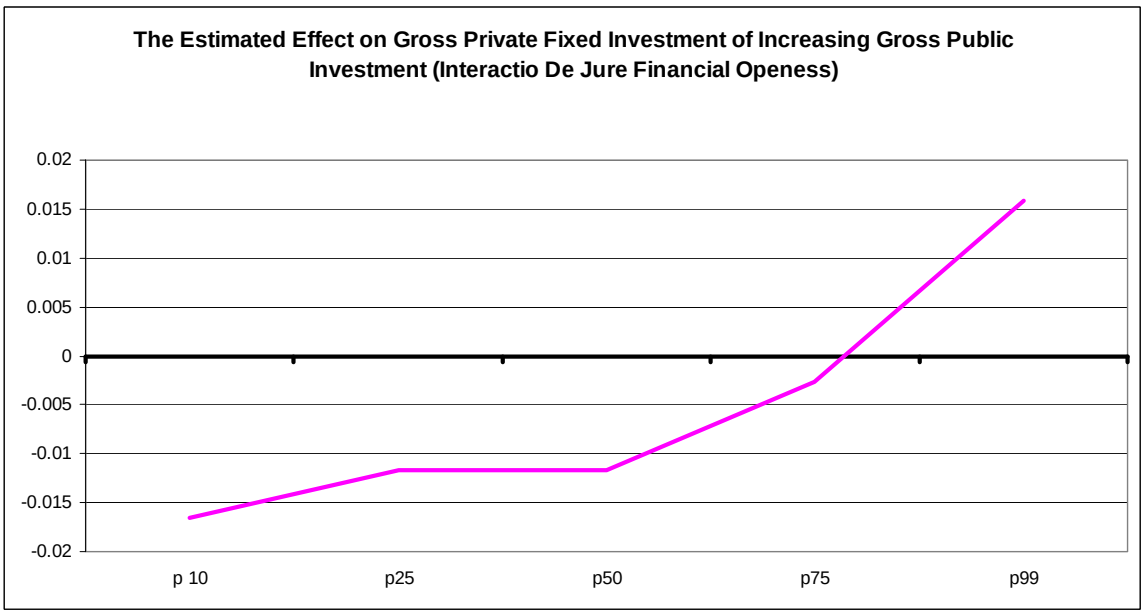


Figure 4.

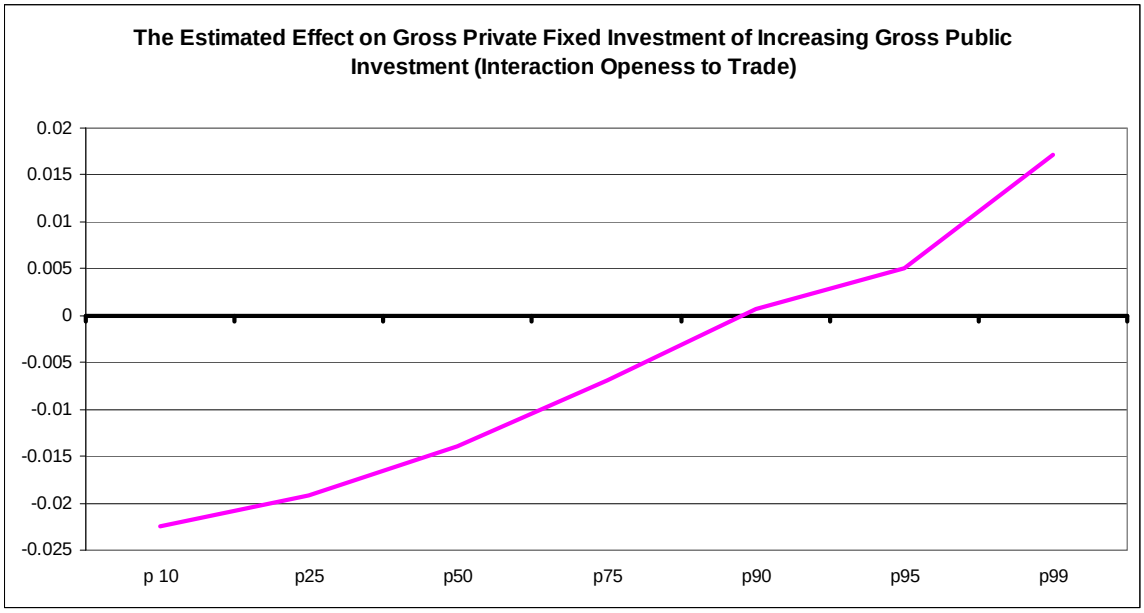

The Estimated Effect on Gross Private Fixed Investment of Increasing Gross Public Investment (Interaction Openess to Trade)
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
p 10
p25
p50
p75
p90
p95
p99

Table 1. Correlations between Public and Private Investment Ratios

Region	Correlations in Levels				
	Mean	Median	Std	Min	Max
Africa	-0.05	0.03	0.45	-0.86	0.92
Asia	-0.06	-0.05	0.47	-0.92	0.72
Latin American and the Caribbean	-0.26	-0.24	0.32	-0.92	0.43
Middle East	-0.13	-0.14	0.41	-0.73	0.44
Eastern Europe	-0.28	0.55	0.55	-0.94	0.72
	Correlations in Differences				
	Mean	Median	Std	Min	Max
Africa	-0.10	-0.18	0.34	-0.66	0.75
Asia	-0.27	-0.19	0.32	-0.92	0.31
Latin American and the Caribbean	-0.19	-0.11	0.29	-0.80	0.31
Middle East	-0.18	-0.25	0.28	-0.58	0.36
Eastern Europe	-0.40	-0.34	0.37	-0.98	0.08
	Correlations in Cycle				
	Mean	Median	Std	Min	Max
Africa	-0.11	-0.16	0.34	-0.67	0.70
Asia	-0.31	-0.35	0.33	-0.92	0.29
Latin American and the Caribbean	-0.16	-0.09	0.30	-0.80	0.41
Middle East	-0.19	-0.25	0.30	-0.58	0.46
Eastern Europe	-0.38	-0.38	0.41	-0.99	0.18

Table 2. Baseline Model (system GMM estimates)

	Dependent Variable: Gross Fixed Private Capital Formation / GDP				
	(1)	(2)	(3)	(4)	(5)
(Gross Private Fixed Capital Formation / GDP) $_{t-1}$	0.704***	0.688***	0.734***	0.698***	0.680***
	[0.061]	[0.054]	[0.067]	[0.054]	[0.045]
(Gross Public Fixed Capital Formation / GDP)	-0.172*	-0.192***	-0.182*	-0.175*	-0.188**
	[0.089]	[0.069]	[0.108]	[0.095]	[0.078]
Log (Relative Price of Investment)		-0.01			-0.009
		[0.012]			[0.011]
Log (Domestic Credit to Private Sector / GDP)			0.023***		0.022***
			[0.006]		[0.006]
Log(Real Exchange Rate Volatility)				-0.000005	-0.0002
				[0.0004]	[0.001]
Constant	0.061***	0.071***	-0.017	0.061***	-0.002
	[0.013]	[0.015]	[0.026]	[0.012]	[0.023]
Observations	1928	1928	1928	1928	1928
Number of id	106	106	106	106	106
AR(1) (P-value)	0.000	0.000	0.000	0.000	0.000
AR(2) (P-value)	0.194	0.208	0.235	0.216	0.288
Hansen Test (P-value)	0.265	0.491	0.0525	0.325	0.175

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

Year dummies are included in the regressions but the coefficients are not reported in the table.

Table 3. System GMM Estimates by Sub-Samples

Dependent Variable: Gross Fixed Private Capital Formation / GDP										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Asia	LAC	Other than Asia or LAC	Non-HIPC	1980	1990	2000	Low Pub. Inv.	Medium Pub. Inv.	High Pub. Inv.
(Gross Private Fixed Capital Formation / GDP) $_{t-1}$	0.905***	0.857***	0.658***	0.756***	0.763***	0.432***	0.380***	0.828***	0.682***	0.522***
	[0.073]	[0.053]	[0.058]	[0.057]	[0.028]	[0.008]	[0.006]	[0.020]	[0.035]	[0.054]
(Gross Public Fixed Capital Formation / GDP) : Public	-0.272*	-0.223***	-0.208*	-0.198**	-0.093***	-0.390***	-0.163***	-0.035	-0.163***	-0.361***
	[0.144]	[0.065]	[0.115]	[0.085]	[0.030]	[0.015]	[0.008]	[0.092]	[0.026]	[0.070]
Log (Relative Price of Investment)	0.007	-0.031**	0.005	-0.067***	0.007	-0.028***	0.005***	0.027***	0.015***	-0.072***
	[0.025]	[0.013]	[0.014]	[0.024]	[0.006]	[0.001]	[0.000]	[0.006]	[0.004]	[0.017]
Log (Domestic Credit to Private Sector / GDP)	0.010**	0.015	0.020**	0.027***	0.020***	0.016***	-0.010***	0.021***	0.01	0.017**
	[0.004]	[0.009]	[0.009]	[0.007]	[0.006]	[0.001]	[0.001]	[0.002]	[0.007]	[0.007]
Log(Real Exchange Rate Volatility)	0.001	0.000005	-0.0004	-0.00005	-0.00004	-0.001***	0.002***	0.0001	0.001	-0.001
	[0.000]	[0.001]	[0.001]	[0.0004]	[0.001]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]
Constant	0.006	-0.008	-0.003	-0.001	-0.031	0.070***	0.134***	-0.056***	0.018	0.088***
	[0.028]	[0.031]	[0.037]	[0.037]	[0.019]	[0.003]	[0.003]	[0.012]	[0.020]	[0.029]
Observations	279	511	1138	1379	595	896	437	566	656	706
Number of id	16	23	67	76	73	102	105	33	34	39
AR(1) (P-value)	0.050	0.000	0.001	0.000	0.001	0.008	0.020	0.007	0.001	0.0175
AR(2) (P-value)	0.679	0.45	0.313	0.593	0.321	0.859	0.45	0.0332	0.41	0.417
Hansen Test (P-value)	0.56	0.216	0.283	0.0542	0.368	0.428	0.917	0.514	0.397	0.249

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

Table 4. Interaction Effects with Institutional Quality, Financial Openness and Trade Openness

	Dependent Variable: Gross Fixed Private Capital Formation / GDP					
	(1)	(2)	(3)	(4)	(5)	(6)
(Gross Private Fixed Capital Formation / GDP) $_{t-1}$	0.757***	0.726***	0.725***	0.699***	0.675***	0.659***
	[0.047]	[0.044]	[0.046]	[0.041]	[0.033]	[0.033]
(Gross Public Fixed Capital Formation / GDP) : Public	-0.116	-0.780**	-0.165*	-0.071	-0.224***	-0.534***
	[0.076]	[0.321]	[0.096]	[0.078]	[0.063]	[0.087]
Log (Relative Price of Investment)	0.011*	0.013*	-0.011	-0.004	-0.007	-0.005
	[0.007]	[0.007]	[0.011]	[0.010]	[0.007]	[0.007]
Log (Domestic Credit to Private Sector / GDP)	0.009	0.010*	0.015***	0.007	0.008*	0.006
	[0.005]	[0.005]	[0.005]	[0.005]	[0.004]	[0.004]
Log(Real Exchange Rate Volatility)	0.0003	0.001	-0.0002	-0.0004	-0.001	-0.0004
	[0.0003]	[0.0003]	[0.001]	[0.001]	[0.0003]	[0.0003]
Index of Institutional Quality	0.001***	0.0001				
	[0.0001]	[0.0004]				
Index of Political Stability - Public		0.013**				
		[0.006]				
De jure Financial Openess			0.005**	-0.006		
			[0.002]	[0.003]		
(De jure Financial Openess * Public)				0.140***	0.0002***	
				[0.047]	[0.00006]	
(Trade Openess / GDP) : Trade						-0.00001
						[0.00006]
(Trade * Public)						0.004***
						[0.001]
Constant	-0.044*	-0.002	0.009	0.025	0.014	0.045***
	[0.023]	[0.027]	[0.021]	[0.020]	[0.016]	[0.016]
Observations	1336	1336	1764	1764	1907	1907
Number of id	80	80	96	96	106	106
AR(1) (P-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) (P-value)	0.665	0.474	0.248	0.239	0.5	0.638
Hansen Test (P-value)	0.107	0.155	0.118	0.0941	0.156	0.167

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

Table 5. Robustness of Alternative Estimation Methods

	Dependent Variable: Gross Fixed Private Capital Formation / GDP					
	(1)	(2)	(3)	(4)	(5)	(6)
	Fixed Effects	Random Effects	Difference OLS	Prais-Winsten	Difference GMM	WB Data
(Gross Private Fixed Capital Formation / GDP) $_{t-1}$					0.531***	0.716***
					[0.025]	[0.037]
(Gross Public Fixed Capital Formation / GDP)	-0.370***	-0.360***	-0.374***	-0.374***	-0.309***	-0.149***
	[0.087]	[0.042]	[0.073]	[0.073]	[0.043]	[0.039]
Log (Relative Price of Investment)	0.007	0.005	-0.0004	-0.0003	-0.025***	-0.009
	[0.010]	[0.006]	[0.009]	[0.009]	[0.007]	[0.006]
Log (Domestic Credit to Private Sector / GDP)	0.010*	0.012***	0.015***	0.014***	0.026***	0.019***
	[0.005]	[0.003]	[0.004]	[0.004]	[0.005]	[0.005]
Log(Real Exchange Rate Volatility)	-0.0003	-0.0004	-0.0003	-0.0005	-0.002***	0.0004
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.0003]
Constant	0.120***	0.117***	0.002	0.002		-0.005
	[0.021]	[0.013]	[0.003]	[0.003]		[0.018]
Observations	2027	2027	1895	1895	1800	833
Number of id	106	106			104	53
AR(1) (P-value)					0.00009	0.001
AR(2) (P-value)					0.423	0.022
Hansen Test (P-value)					0.507	0.117

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

Table 6. Robustness Checks with Additional Controls

	Dependent Variable: Gross Fixed Private Capital Formation / GDP							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(Gross Private Fixed Capital Formation / GDP) $_{t-1}$	0.668***	0.709***	0.645***	0.707***	0.655***	0.585***	0.608***	0.580***
	[0.041]	[0.049]	[0.043]	[0.040]	[0.040]	[0.049]	[0.048]	[0.027]
(Gross Public Fixed Capital Formation / GDP) : Public	-0.189**	-0.131*	-0.249***	-0.193**	-0.203***	-0.314***	-0.238**	-0.139*
	[0.075]	[0.078]	[0.071]	[0.075]	[0.076]	[0.107]	[0.103]	[0.081]
Log (Relative Price of Investment)	-0.006	0.018**	-0.013	0.021***	-0.01	0.012	0.008	0.027***
	[0.010]	[0.007]	[0.010]	[0.007]	[0.011]	[0.013]	[0.013]	[0.007]
Log (Domestic Credit to Private Sector / GDP)	0.021***	0.020***	0.017***	0.020***	0.021***	0.025***	0.017***	0.023***
	[0.006]	[0.006]	[0.005]	[0.006]	[0.006]	[0.006]	[0.005]	[0.005]
Log(Real Exchange Rate Volatility)	-0.0002	-0.0001	-0.001	-0.001*	-0.0002	-0.001	-0.0004	-0.001**
	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]	[0.000]	[0.0001]
Output Gap	0.054							0.255***
	[0.043]							[0.052]
General Government Final Expenditure / GDP		-0.234***						0.137**
		[0.079]						[0.060]
Central Government Balance / GDP			0.03					0.112**
			[0.022]					[0.046]
Foreign Direct Investment Net Inflows / GDP				0.002***				0.002***
				[0.001]				[0.0001]
Privatization					0.001			-0.005*
					[0.002]			[0.002]
Paved Roads						0.033		0.058***
						[0.024]		[0.014]
Roads (km) per capita							2.551**	-0.228
							[1.170]	[0.393]
Constant	0.002	0.013	0.022	-0.033	0.002	-0.017	-0.006	-0.075***
	[0.022]	[0.021]	[0.021]	[0.024]	[0.023]	[0.027]	[0.023]	[0.015]
Observations	1928	1664	1857	1625	1928	893	930	647
Number of id	106	87	102	84	106	100	103	74
AR(1) (P-value)	0.000	0.000	0.000	0.000	0.000	0.018	0.023	0.084
AR(2) (P-value)	0.272	0.37	0.303	0.172	0.3	0.643	0.588	0.625
Hansen Test (P-value)	0.238	0.102	0.114	0.255	0.249	0.599	0.463	0.474

Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1

Table A.1. Summary Statistics

Variable	Source	Obs	Mean	Std. Dev.	Min	Max
Gross Private Fixed Capital Formation / GDP	WEO, IMF	2723	0.14	0.07	-0.01	0.51
Gross Public Fixed Capital Formation / GDP	WEO, IMF	2723	0.07	0.05	-0.03	0.49
Relative Price of Investment	Penn World Tables 6.2	2320	2.11	1.04	0.36	11.28
Domestic Credit to Private Sector / GDP	WDI, World Bank	2505	28.79	25.06	0.00	210.42
Real Exchange Rate Volatility	Own estimates, data IMF	2492	0.01	0.07	0.00	1.54
Output Gap	Own estimates, data WB	2723	0.00	0.03	-0.46	0.27
General Government Final Expenditure / GDP	WDI, World Bank	2255	0.15	0.06	0.03	0.55
Central Government Balance / GDP	WEO, IMF	2837	-0.04	0.08	-1.51	0.59
Foreign Direct Investment Net Inflows / GDP	WDI, World Bank	2133	2.17	3.49	-28.62	46.62
Privatization	WDI, World Bank	2723	0.24	0.42	0.00	1.00
Paved Roads (Fraction of total roads)	WDI, World Bank	1065	0.40	0.31	0.01	1.00
Roads (km) per capita	WDI, World Bank	1126	0.01	0.01	0.00	0.05
Index of Politacl Stability (ICPR)	International country Risk Guide	1700	58.88	11.75	17.00	86.50
Trade Openess / GDP	WDI, World Bank	2298	75.66	45.41	7.97	623.46
De jure Financial Openess	Chin and Ito (2006)	2114	-0.30	1.36	-1.72	2.66

Table A.2. Country List by Region

LAC	Africa	Middle East	Asia	Eastern Europe
Argentina	Algeria	Bahrain, Kingdom of	Bangladesh	Albania
Bahamas, The	Angola	Iran, I.R. of	Cambodia	Armenia
Barbados	Benin	Kuwait	China,P.R.: Mainland	Bosnia & Herzegovina
Belize	Botswana	Lebanon	India	Bulgaria
Bolivia	Burkina Faso	Oman	Indonesia	Croatia
Brazil	Burundi	Qatar	Lao People's Dem.Rep	Czech Republic
Chile	Cameroon	Saudi Arabia	Malaysia	Estonia
Colombia	Cape Verde	Syrian Arab Republic	Maldives	Kazakhstan
Costa Rica	Central African Rep.	United Arab Emirates	Myanmar	Lithuania
Dominican Republic	Chad	Yemen, Republic of	Nepal	Macedonia, FYR
Ecuador	Comoros		Pakistan	Moldova
El Salvador	Congo, Dem. Rep. of		Papua New Guinea	Mongolia
Guatemala	Congo, Republic of		Philippines	Romania
Honduras	Côte d'Ivoire		Solomon Islands	Russia
Mexico	Djibouti		Sri Lanka	Serbia and Montenegro
Panama	Egypt		Thailand	Slovak Republic
Paraguay	Equatorial Guinea		Vietnam	Turkey
Peru	Eritrea			Ukraine
St. Vincent & Grens.	Ethiopia			
Suriname	Gabon			
Trinidad and Tobago	Gambia, The			
Uruguay	Ghana			
Venezuela, Rep. Bol.	Guinea			
	Guinea-Bissau			
	Kenya			
	Lesotho			
	Libya			
	Madagascar			
	Malawi			
	Mali			
	Mauritania			
	Mauritius			
	Morocco			
	Namibia			
	Nigeria			
	Rwanda			
	São Tomé & Príncipe			
	Senegal			
	Seychelles			
	Sierra Leone			
	South Africa			
	Swaziland			
	Tanzania			
	Togo			
	Tunisia			
	Uganda			
	Zambia			
	Zimbabwe			