

Growth Impact of Public Investment and the Role of Infrastructure Governance

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INTRODUCTION

According to macroeconomic theory, public investment stimulates economic activity through short-term effects on aggregate demand, and it raises the productivity of existing private capital (physical and human). Public investment also encourages new private investment to take advantage of the higher productivity it creates, increasing economic growth (Barro 1990; Barro and Sala-i-Martin 1992; Futagami, Morita, and Shibata 1993; Glomm and Ravikumar 1994; Turnovsky 1997). However, the positive relationship between public investment and growth could turn negative once public capital exceeds a certain threshold, as the burden resulting from financing public capital provision adversely affects economic growth (Barro 1990) or public investment crowds out private investment (Aschauer 1989; Fosu, Getachew, and Ziesemer 2016).

Public investment affects economic growth through two main channels: (1) efficiency (how much a given amount of public investment provides in terms of physical infrastructure) and (2) productivity (how the created physical infrastructure affects the economy).¹

- *Efficiency*: Not all public investment translates into the same amount of physical infrastructure, meaning that public investment efficiency varies across countries. Many countries receive less value for money than they would have if resources were used more efficiently (see Chapter 3 for more details).
- *Productivity*: Not all new physical infrastructure has the same productive impact on the economy. Even when physical infrastructure is accumulated, its productivity can be eroded by poor project selection and if the created

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¹ See, for example, Mandl, Dierx, and Ilzkovitz (2008) for a discussion on the different channels of public investment.

infrastructure contributes little to growth. Good infrastructure governance may lead to better infrastructure quality, with greater beneficial effects (see Chapter 5 for details).

The empirical literature, however, is divided on the significance of the long-term relationship between public investment and economic growth. Aschauer (1989) found that public investment has a strong positive impact on output for the United States. Subsequent studies have shown a positive association between public investment and economic growth but with a smaller magnitude (for example, see Sturm and de Haan 1995). Recently, IMF (2014) and Abiad, Furceri, and Topalova (2016) found a short- and long-term positive and significant effect of public investment on output for advanced economies. For low-income developing countries, Furceri and Li (2017) found a positive effect of public investment on output in the short and medium terms. In contrast, Sturm, Jacobs, and Groote (1999) found a positive and significant short-term effect of public investment on output but did not find any long-term effects. Looking at large public investment boom episodes, Warner (2014, 62) found “very little” evidence supporting the idea that public capital can promote growth beyond the short-term demand effect.

Better infrastructure governance—in other words, stronger institutions to manage public investments—is likely to strengthen the connection between public investment and growth, as broadly supported by empirical findings. Gupta and others (2014) showed that an efficiency-adjusted public capital stock makes a positive and significant contribution to economic growth. IMF (2015) pointed out that countries with stronger infrastructure governance institutions tend to have lower average incremental public-capital-to-output ratios and therefore receive more growth “bang” for their investment “buck”; it also found that countries with higher public investment efficiency receive greater output dividends from public investment.

In contrast, weak infrastructure governance could lead to higher public debt without a growth dividend. Governance problems in project execution may reduce the amount of public capital generated by a unit of public investment, whereas a deficient project selection process could lead to the construction of “white elephants” with minimal contribution to economic activity.² More generally, a strong cost-benefit analysis is needed to select and prioritize projects that would meaningfully raise growth without jeopardizing fiscal sustainability.

This chapter analyzes the macroeconomic impact of public investment and explores how the relationships among public investment, economic activity, and fiscal indicators are modified by the strength of a country’s infrastructure governance. Stylized facts for public investment and the public capital stock across countries are presented first, followed by an examination of how the strength of a country’s infrastructure governance affects the macroeconomic effects of public investment. How the different stages of public investment management affect economic activity is also assessed.

² The term “white elephant” defines a project for which the cost, particularly that of maintenance, is out of proportion in comparison with its usefulness.

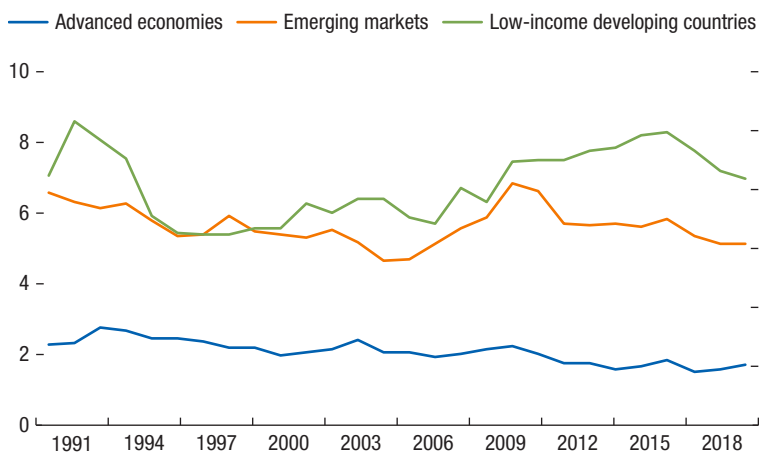
The analysis finds that the strength of a country's infrastructure governance plays a critical role in determining the macroeconomic effects of public investment. Countries with better governance enjoy positive output effects from public investment that countries with weaker governance do not. Regarding public investment management, the planning and implementation stages are important for improving the impact of public investment on economic growth.

RECENT DEVELOPMENTS OF PUBLIC INVESTMENT

Public-investment-to-GDP ratios across countries differ by income groups.³ In advanced economies, public investment has steadily declined from an average of 2.4 percent of GDP in the 1990s to a historic low of less than 2 percent after 2010. In low-income developing countries, public investment as a percentage of GDP has been generally increasing since the mid-1990s, at 7 percent in 2018. Emerging market investment levels have historically alternated between 5 and 7 percent of GDP on average (Figure 2.1).

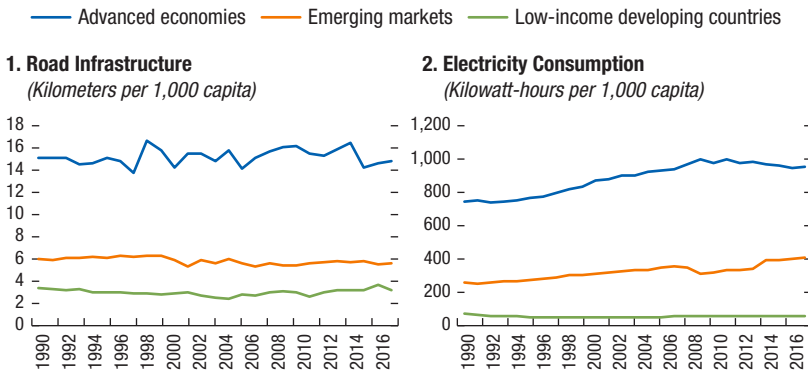
There are equally large differences in the stock of physical infrastructure across country groups (Figure 2.2). The two presented infrastructure indicators (kilometers of roads per capita and electricity consumption) show that both emerging markets and low-income developing countries significantly trail advanced economies in

Figure 2.1. Trends in Public Investment, 1991–2018
(Percent of GDP, simple average of each country group)



Sources: World Economic Outlook database; and IMF staff estimates.

³ “Public investment” refers to general government new acquisition of nonfinancial assets as a share of GDP.

Figure 2.2. Physical Infrastructure, by Income Group, 1990–2016

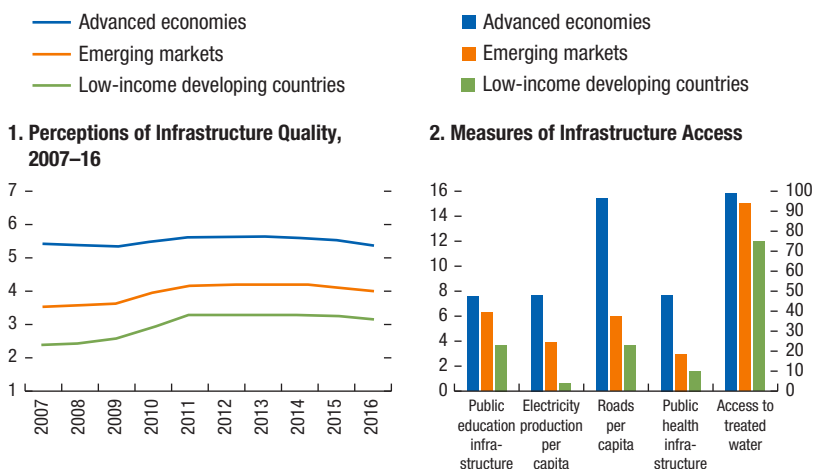
Source: World Development Indicators.

infrastructure provision, despite a consistently larger public-investment-to-GDP ratio. Kilometers of roads per capita have been almost stagnant in all three income groups since 1990, with per capita road stocks of emerging markets and low-income developing countries at a level less than one-third that of advanced economies (Figure 2.2, panel 1). Electricity consumption has equally stagnated at a very low level in low-income developing countries, whereas consumption in advanced economies reached its peak around 2008, and emerging economies continue to increase their consumption (Figure 2.2, panel 2).

Large differences across countries also persist in the quality of infrastructure. Survey-based measures of infrastructure quality, which reflect subjective judgments about the quality of overall infrastructure, suggest that the recent ramping up of public investment in emerging economies and low-income developing countries has helped reduce the perceived disparity in infrastructure across countries.⁴ However, these measures also indicate a slight fall in infrastructure quality since the peak in the early 2010s, especially in advanced economies and emerging economies, which may have resulted from the recent fall in investment-to-GDP ratios in those country groups (Figure 2.3, panel 1). Large and persistent disparities between higher- and lower-income countries remain within the coverage of economic infrastructure, such as roads and electricity networks (Figure 2.3, panel 2).

Large differences by income groups (and more among countries) point to the importance of raising the efficiency and productivity of public investment, particularly for those with insufficient and low-quality infrastructure. With more efficient and productive public investment, countries would achieve higher growth while increasing the amount and quality of infrastructure. The next sections analyze the role that public investment management can play in achieving these goals.

⁴ The “overall quality of infrastructure” indicator from the World Economic Forum’s Global Competitiveness Index data set is used in this analysis. The indicator assesses general infrastructure such as for transport, communications, and energy.

Figure 2.3. Indicators of Infrastructure Quality and Access

Source: World Economic Forum 2017.

Note: This panel shows the perceived quality of overall infrastructure with the question, “How do you assess the general state of infrastructure (for example, transport, communications, and energy) in your country?” rated from 1 (“extremely underdeveloped—among the worst in the world”) to 7 (“extensive and efficient—among the best in the world”).

Source: World Development Indicators 2017.

Note: Units vary to fit scale. Left scale: public education infrastructure is measured as secondary teachers per 1,000 persons; electricity production per capita as thousands of kilowatt-hours per person; roads per capita as kilometers per 1,000 persons; and public health infrastructure as hospital beds per 1,000 persons. Right scale: access to treated water is measured as a percentage of the population.

PUBLIC INVESTMENT, ECONOMIC GROWTH, AND INFRASTRUCTURE GOVERNANCE

This section examines the macroeconomic effects of public investment, controlling for the strength of infrastructure governance in an estimation using the local projection method and public investment forecast errors. Similar to IMF (2014), it examines the impact of public investment shocks—defined as unexpected changes in public investment—on growth, public debt, and private investment by country income groups. It then assesses how the strength of infrastructure governance affects this impact. Our analysis extends the literature on the macroeconomic effects of public investment (IMF 2014; Furceri and Li 2017) in several dimensions, including by examining the macroeconomic effects of public investment shocks in low-income developing countries and adding the influence of countries’ infrastructure governance systems, which modifies the baseline results considerably.

Baseline Results

As a baseline, the examination looks at the macroeconomic effects of public investment shocks by country income groups, without controlling for the strength of countries’ infrastructure governance. This chapter focuses on shocks to disentangle the effect of higher public investment itself from the effect of expectations of higher

public investment, which generate their own effects. This provides a benchmark for the subsequent exploration of the role of infrastructure governance.

Advanced Economies⁵

Positive public investment shocks raise output (Figure 2.4). A positive public investment shock of 1 percentage point of GDP is associated with an increase in output of about 0.2 percent in the same year and 1.2 percent four years after the shock. This result is in line with other estimates of the public investment multiplier (in, for example, Batini, Eyraud, and Weber 2014). Moreover, public investment shocks have long-lasting effects on output, in line with the hypothesis that an increase in public investment boosts the productive capacity of the economy.

Public debt and private investment, however, are not significantly affected. Higher public investment is not associated with a significant increase in the debt-to-GDP ratio, stemming from two effects: (1) higher investment may not have a significant impact on the government's overall budget, as at least part of the increased spending may be offset by higher revenue or cuts in other spending; and (2) output expands in reaction to the investment shock, as has been noted.⁶ Private investment as a share of GDP does not respond to the public investment shock either, as the expansion of output associated with positive public investment shocks outpaces the increase in private investment. This result suggests that higher public investment neither catalyzes nor crowds out private investment. These results are in line with IMF (2014).

Emerging Markets and Low-Income Developing Countries

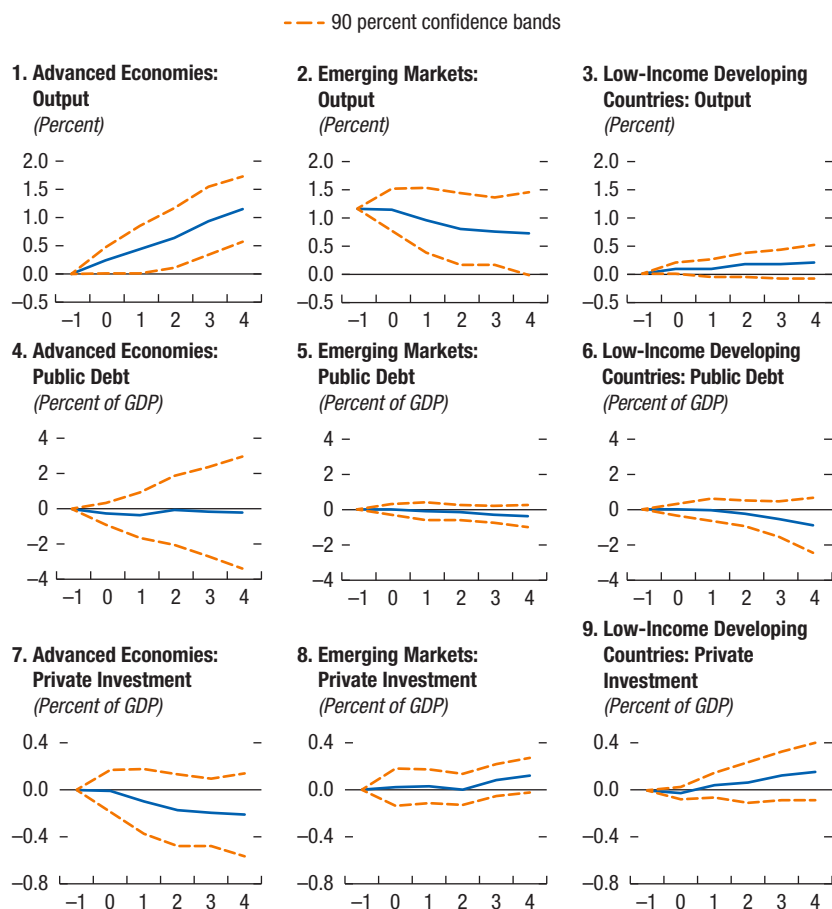
The impact of public investment shocks on output differs between emerging markets and low-income developing countries (Figure 2.4). In emerging markets, positive public investment shocks increase output in both the short and medium terms. An unanticipated positive public investment shock of 1 percentage point of GDP increases output by about 0.2 percent in the same year and 0.5 percent four years after the shock. This finding is consistent with results in the literature (for example, Furceri and Li 2017). In contrast, the effect of the public investment shock on output is short-lived and weak in low-income developing countries. On impact, output increases by 0.1 percent.⁷

As in advanced economies, there is no statistically significant effect on public debt and private investment, and higher public investment is not associated

⁵ When the full sample (advanced economies, emerging markets, and low-income developing countries) is used, the impacts of public investment shocks on the economy are not clear. This is likely due to heterogeneity in macroeconomic impacts of public investment shocks across country income groups.

⁶ Although not presented here, the response of the fiscal balance to the positive public investment shock is not statistically significant.

⁷ The analysis in Chapter 6 finds that changes in the composition of spending toward greater public investment generally produce strong growth dividends, while the lower the investment efficiency, the lower the expected fiscal multiplier of public investment.

Figure 2.4. Responses to Unanticipated Public Investment Shocks

Source: IMF staff calculations.

Note: The x-axis indicates years after the shock at $t=0$. Shock represents an increase of 1 percentage point of GDP in public investment spending. The sample consists of 107 countries (17 advanced economies, 39 emerging markets, and 51 low-income developing countries).

with an increase in the debt-to-GDP ratio. The results for emerging markets could be understood in the same way as for advanced economies. Because of the higher output associated with the positive public investment shock and the effort to offset part of the investment increase on the deficit, the debt-to-GDP ratio does not increase significantly. For low-income developing countries, the large heterogeneity between countries produces large standard errors that may mask the impact of a public investment shock on public debt. As in advanced economies, private investment does not seem to respond to a public investment shock in both emerging markets and low-income developing countries.

The Role of Infrastructure Governance

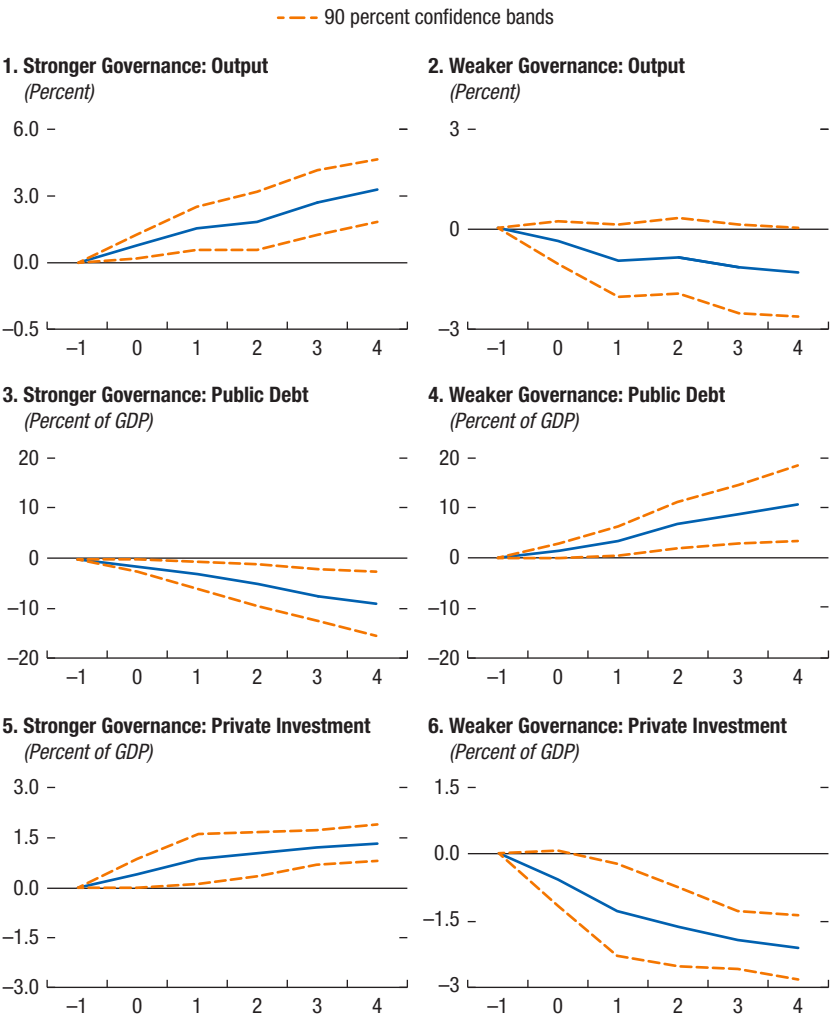
Governance of the public investment process affects the macroeconomic effects of public investment in different ways. As noted, recent studies have indicated that the strength of a country's infrastructure governance plays an important role in determining the connection between public investment and growth (Gupta and others 2014; IMF 2015). A clear picture of how the public investment management process modifies the macroeconomic effects of public investment is warranted to assess the benefits and costs of public investment. The IMF's Public Investment Management Assessment (PIMA) is used for this, measuring the strength of countries' infrastructure governance in emerging markets and low-income developing countries.⁸ The PIMA was developed by the IMF to help countries evaluate the strength of their public investment management practices. Because PIMAs have so far been conducted mainly in emerging markets and low-income developing countries, insufficient observations are available for advanced economies in the analyses here. Thus, the World Bank's government effectiveness indicator is used for advanced economies, because of its high correlation with the PIMA for countries where both are available (for details, see Annex 2.1).

Stronger governance in advanced economies results in positive public investment shocks generating better macroeconomic outcomes (Figure 2.5). The analysis shows that in countries with stronger governance, a positive investment shock of 1 percentage point of GDP increases output by about 0.8 percent in the same year, and by 3.2 percent in the medium term.⁹ In contrast, in countries with weaker governance, the response of output is, if anything, negative and marginally statistically insignificant. As for public debt, although public investment shocks reduce the debt-to-GDP ratio in countries with stronger infrastructure governance, they increase public debt in countries with weaker governance. The difference in public debt responses between countries with stronger and weaker governance likely reflects differences in responses of the fiscal balance and output. In countries with stronger governance, higher public investment may be accommodated within available resources without significantly affecting the fiscal balance. Furthermore, the higher output associated with a shock reinforces the decline in the debt-to-GDP ratio. Last, in response to an investment shock, private investment tends to increase in countries with stronger governance (possibly through crowding in private investment by improving the productive capacity of the economy), and it declines in countries where governance is weaker. These results are stronger and more significant than the baseline that was shown in Figure 2.4, underscoring the importance of quality

⁸ See Chapter 5 for more details.

⁹ Stronger (weaker) governance is defined based on the value of z in the transition function between governance regimes. If z has a large positive (negative) value, the country is considered to have stronger (weaker) governance (see Annex 2.1).

Figure 2.5. Effects of Public Investment Shocks in Advanced Economies: The Role of Infrastructure Governance



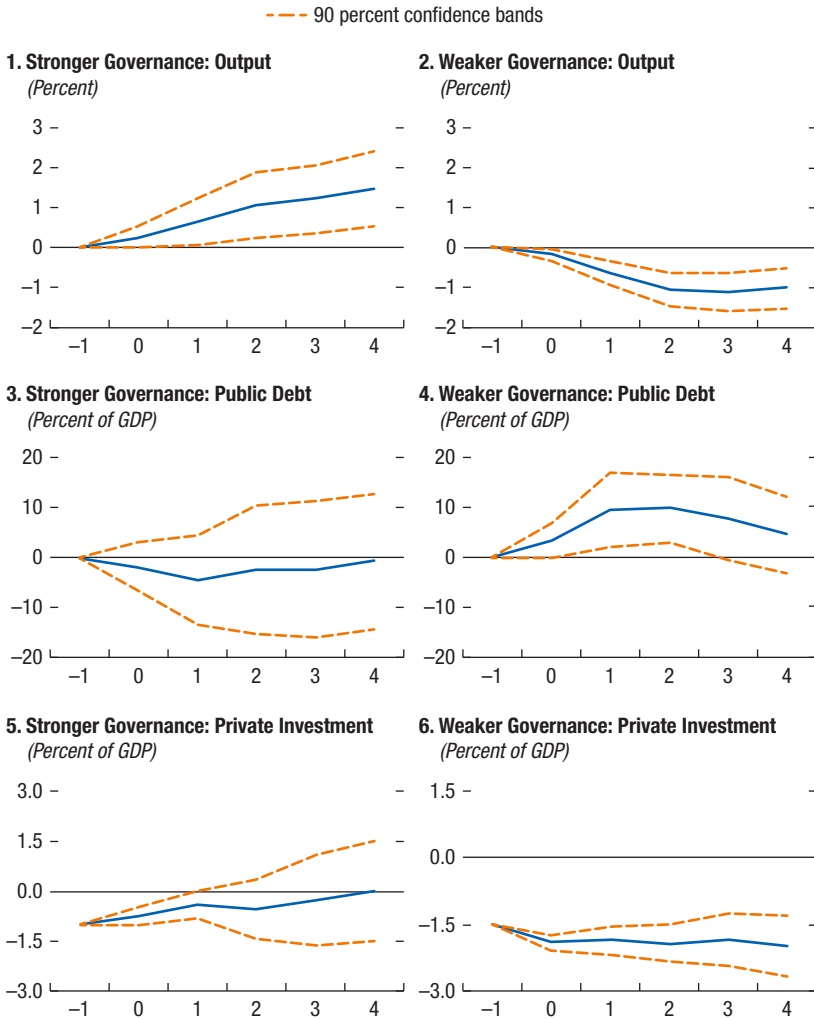
Source: IMF staff calculations.

Note: The x-axis indicates years after the shock, and $t = 0$ represents the year of the shock. Shock represents an increase of 1 percentage point of GDP in public investment spending. The sample size is 507, and the number of countries is 17. Stronger (weaker) governance is defined based on the value of z in the transition function between governance regimes (see Annex 2.1).

infrastructure governance systems for public investment to deliver positive economic outcomes.

The strength of infrastructure governance also matters for the impact of public investment on output in emerging economies and low-income developing countries (Figure 2.6). The results using PIMA show that in countries with stronger

Figure 2.6. Effects of Public Investment Shocks in Emerging Markets and Low-Income Developing Countries: The Role of Infrastructure Governance

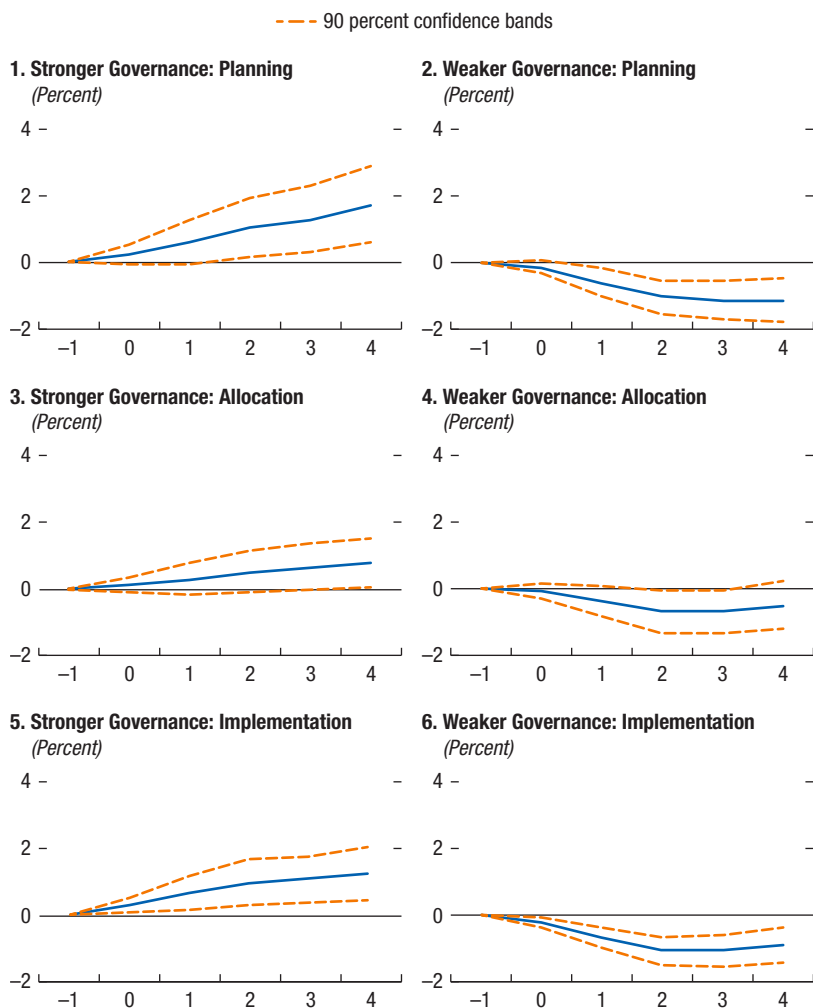


Source: IMF staff calculations.

Note: The x-axis indicates years after the shock, and $t=0$ represents the year of the shock. Shock represents an increase of 1 percentage point of GDP in public investment spending. The sample size is 792, and the number of countries is 44. Stronger (weaker) governance is defined based on the value of z in the transition function between governance regimes (see Annex 2.1).

governance, positive public investment shocks generate better macroeconomic outcomes. The positive impacts on growth and private investment are larger and debt-to-GDP ratios are not increased. In contrast, output and private investment tend to decline, and public debt tends to rise, in response to an increase in public investment in countries with weaker governance, possibly suggesting problems with project selection and costing, and with the crowding out of private investment.

Figure 2.7. Effects of Public Investment Shocks on Output



Source: IMF staff calculations.

Note: The x-axis indicates years after the shock, and $t=0$ represents the year of the shock. Shock represents an increase of 1 percentage point of GDP in public investment spending. The sample size is 792, and the number of countries is 44. Stronger (weaker) governance is defined based on the value of z in the transition function between governance regime (see Annex 2.1).

Stages of the Public Investment Management Process

The analysis has indicated the important role of infrastructure governance. Next, the investigation turns to how each stage of the public investment management process affects the growth impact of public investment. Using the three PIMA subindicators for each of the three stages of the public investment cycle (planning, allocation, and implementation), further inquiry looks at how the strength of public investment management at each stage of the process affects the growth impact of public investment shocks.

The findings suggest that all three stages are important for the growth impact of public investment (Figure 2.7). At each stage, countries with stronger governance enjoy a positive output effect from public investment; in countries with weaker governance, the output responses are either not statistically significant or negative. This result is important and reasonable, as the three stages are an integral part of the public investment cycle and so interact with each other. A chain is only as strong as its weakest link. Take, for example, where deficiencies in planning affect the allocation and implementation stages of projects. Amid efficient planning, deficiencies in allocation and implementation would also limit the delivery and impact of infrastructure.

CONCLUSIONS

The strength of infrastructure governance plays a critical role in determining the macroeconomic effects of public investment. Countries with stronger governance achieve a stronger output impact of public investment than do countries with weaker governance. Stronger infrastructure governance helps public investment yield a higher growth dividend by improving investment efficiency and productivity, and it stimulates private sector investment. In contrast, in countries with weak infrastructure governance, crowding out of private investment, higher debt-to-GDP ratios, and significant waste of public money can lead to a negative impact on output even after public investment has been increased.

Public investment supports growth without raising public debt in countries with stronger infrastructure governance. In those countries, increased public investment leads to higher output, in turn raising revenue performance and offsetting some of the deficit increase. In countries with weaker governance, however, the public investment shock is more likely to increase the debt-to-GDP ratio—reflecting a weak growth impact of public investment. The analysis in this chapter also finds that private investment tends to increase in countries with stronger governance and decline in countries with weaker governance.

To ensure a positive growth impact of public investment, strengthening each process of public investment management is essential. Separating public investment processes into the three stages (planning, allocation, and implementation), the findings show that all three stages affect the output effects of public investment shocks.

The study draws out two main policy implications. First, countries could significantly improve the growth impact of public investment by strengthening their infrastructure governance. Good infrastructure governance allows public investment to raise output without jeopardizing fiscal sustainability. Second, unless countries with weaker infrastructure governance and investment management improve their institutions and processes before increasing public investment, they risk wasting much of the growth benefit.

ANNEX 2.1. EMPIRICAL APPROACH

Public investment shocks are identified by using the approach of Auerbach and Gorodnichenko (2012, 2013). In this approach, public investment shocks are identified as forecast errors of public investment. Thus,

$$Shock_{i,t} = PI_{i,t} - PI_{i,t}^E,$$

where $PI_{i,t}$ is the actual public investment spending as a share of GDP of country i in year t , and $PI_{i,t}^E$ is the forecast of the public investment spending.¹⁰ Forecasts are taken from the fall issue of the Organisation for Economic Co-operation and Development *Economic Outlook* and October publications of the IMF's *World Economic Outlook* (WEO) for the same year over the period 1985–2017. Because of data limitations, forecasts for advanced economies are taken from the OECD's database, whereas WEO forecasts are used for emerging economies and low-income developing countries.¹¹ Other macroeconomic variables (real GDP, the debt-to-GDP ratio, and real private investment as a share of GDP) come from various issues of the WEO.

The identified public investment shocks are used to examine the macroeconomic effects of public investment with the local projection method of Jordà (2005):

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \gamma_t^h + \beta^h shock_{i,t} + \theta^h X_{i,t} + \varepsilon_{i,t}^h \quad (2.1.1)$$

where y is log of the macroeconomic variable of interest (real GDP, the debt-to-GDP ratio, and private investment as a share of GDP), α is the country fixed effect, γ is the time fixed effect, $shock$ is the identified public investment

¹⁰ This methodology overcomes two typical empirical challenges. First, using forecast errors eliminates the “fiscal foresight” problem (for example, see Leeper, Richter, and Walker 2012; and Leeper, Walker, and Yang 2013) because it aligns the information sets of the economic agents with those of the econometricians (see IMF 2014 for details). Second, the forecast error mitigates the endogeneity problem that unanticipated economic conditions may affect the public investment shock. Given that October's forecast has already included information on public investment and economic performance in most of the current year, for endogeneity to be present, public investment should be changed within the same quarter when news on economic conditions is received. However, as Blanchard and Perotti (2002) argued, this is unlikely to occur.

¹¹ In issues of the *World Economic Outlook*, there are no forecasts of public investment for advanced economies during 2004–08 because of changes in the data aggregation method. As a robustness check, we use different forecasts (spring in the same year and fall in the previous year) and find that the results remain unchanged.

shock, and X is a set of control variables.¹² We estimate equation (2.1.1) for each $h=0, \dots, 4$, where $h=0$ is the year of the public investment shock. We compute the impulse response functions of variables of interest with the estimated β^h . The confidence intervals associated with the impulse response functions are obtained by the estimated (clustered robust) standard errors of the coefficient β^h .

We further extend the analyses by allowing the response of the variable of interest to vary with public investment management quality within a regime-switching panel of the form:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \gamma_t^h + \beta_1^h G(z_{i,t}) shock_{i,t} + \beta_2^h (1 - G(z_{i,t})) shock_{i,t} + \theta^h X_{i,t} + \varepsilon_{i,t}^h \quad (2.1.2)$$

with

$$G(z_{i,t}) = \frac{\exp(-\delta z_{i,t})}{1 + \exp(-\delta z_{i,t})}, \quad \delta > 0$$

where $G(\cdot)$ is the transition function and z is an indicator of public investment management, normalized to have zero mean and unit variance. As in IMF (2014), $\delta = 1$.¹³ For the indicator z , either the PIMA score or the World Bank's government effectiveness indicator are used as measures of infrastructure governance quality. The PIMA score evaluates the strength of public investment management practices at three key stages of the public investment management cycle: planning, allocation, and implementation. To construct the overall PIMA score, 15 subindicators are averaged. However, the countries covered by PIMA are mainly emerging markets and low-income developing countries (with only a few advanced economies). The World Bank's government effectiveness indicator, which accounts for investment and public financial management, is used for advanced economies. This seems reasonable as PIMA and the World Bank's government effectiveness indicator are positively and statistically significantly correlated (correlation = 0.85 for countries where data are available for both indicators).¹⁴

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¹² Although the local projection method is robust to omitted variables and misspecification (Jorda 2005), we assess the robustness of our results by estimating equation (2.1.1) with control variables including lags of the investment shock and lags of the growth rate of the dependent variable. The results remained qualitatively the same.

¹³ The results remain qualitatively unchanged if we use an alternative value of 1.5, as in Furceri and Li (2017).

¹⁴ Similar results are obtained when we use alternative proxies based on "government efficiency" from the World Economic Forum's *Global Competitiveness Report* 2005 through 2017.

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