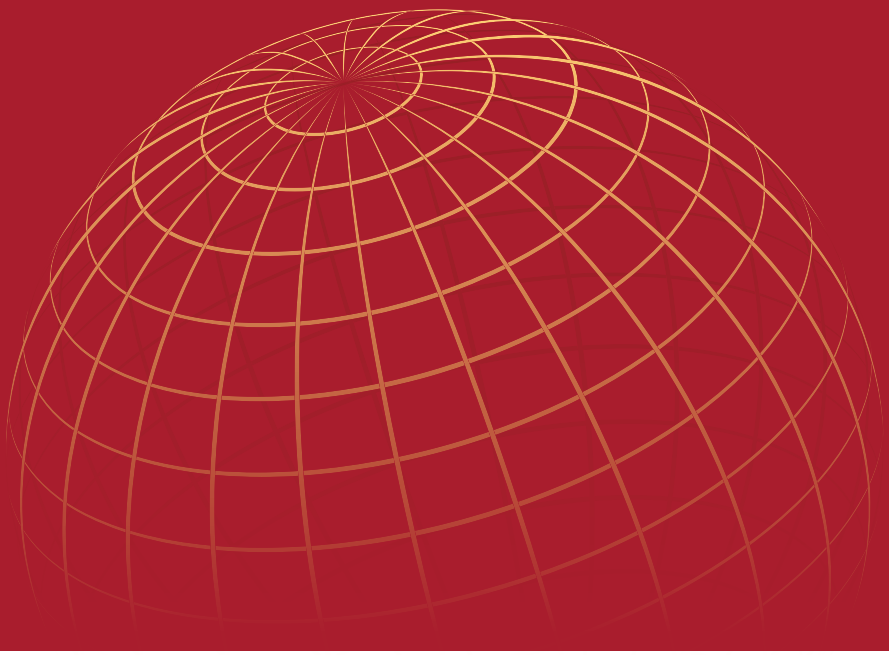


CHAPTER 3

HARNESSING THE BENEFITS OF PUBLIC INVESTMENT

A significant acceleration in investment is essential if emerging market and developing economies (EMDEs) are to achieve key development goals and tackle the challenges associated with climate change. Investment—public as well as private—tends to fuel a virtuous cycle of development, boosting growth, improving productivity, and reducing poverty. In EMDEs, however, investment growth has seen a sustained slowdown since the global financial crisis and is expected to remain weak in the coming years. Policy action is necessary to reverse this trend. Public investment averages about one-quarter of total investment in the median EMDE—a modest share. Yet it can be a powerful policy lever to help ignite growth, including by helping to catalyze private investment. This chapter offers a comprehensive assessment of public investment and its macroeconomic effects in EMDEs. It finds that public investment in these economies has experienced a historic slowdown in the past decade. In EMDEs with ample fiscal space and a record of efficient government spending, on average, scaling up of public investment by one percent of GDP can increase output by up to 1.6 percent over five years. Public investment also crowds in private investment and boosts productivity, promoting long-run economic growth in these economies. To maximize the impact of public investment, EMDEs should undertake wide-ranging policy reforms to improve public investment efficiency—by, among other things, strengthening governance and fiscal administration—and create fiscal space through revenue and expenditure measures. The global community can play an important role in facilitating these reforms—particularly in lower-income developing countries—through financial support and technical assistance.

Introduction

The scale of global investment needed to meet the Sustainable Development Goals (SDGs) and achieve commitments made under the Paris Agreement is enormous. Emerging market and developing economies (EMDEs) need to invest an estimated $2.4 trillion per year, and low-income countries (LICs) have especially hefty investment gaps (World Bank 2024; figure 3.1.A). By some estimates, to meet climate change objectives and other development goals, LICs require annual investment of 8 percent of GDP through 2030 (Rozenberg and Fay 2019; World Bank 2023a).[1] Infrastructure capital investment spending needs and maintenance costs related to SDGs vary across EMDE regions and are particularly high in Sub-Saharan Africa (figure 3.1.B). LICs have especially large infrastructure gaps related to the provision of basic public services such as electricity, transportation, clean water, basic sanitation, and health, while the quality of existing EMDE infrastructure in some sectors (transport, for example) is much lower than that in advanced economies (figures 3.1.C and 3.1.D).

Compounding the challenge, since the global financial crisis, investment has been in a broad-based and prolonged slump, as economic growth slowed and the external macroeconomic environment deteriorated. In EMDEs, average total investment growth decelerated from about 10 percent per year in the 2000s to 5 percent in the 2010s—the slowest average pace in the past three decades (figure 3.1.E).[2] Investment growth accelerations, which are associated with multiple macroeconomic benefits, also became less common in the past decade (World Bank 2024). Going forward, prospects for investment in EMDEs remain subdued (figure 3.1.F; chapter 1).

To address their substantial development needs and boost growth, EMDEs will need both public and private investment.[3] Public investment has the

Note: The chapter was prepared by Amat Adarov with contributions by Valerie Mercer-Blackman. Other contributors include Joseph Mawejje, Nikita Perevalov, and Naotaka Sugawara. Some of the analytical work draws from the background paper by Adarov, Clements, and Jalles (forthcoming).

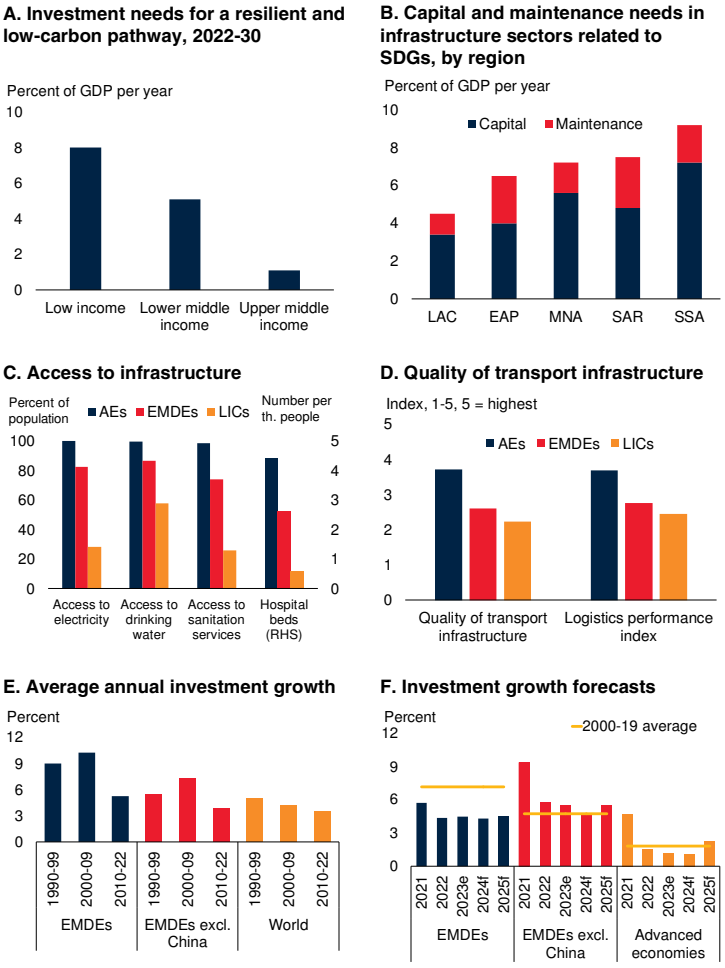
[1] For a recent assessment of investment gaps see also G20-IEG (2023), Hallegatte et al. (2018), IPCC (2022), Kose and Ohnsorge (2024), UNEP (2023), and Vorisek and Shu (2020).

[2] Investment in the context of this chapter refers to gross fixed capital formation and comprises public and private investment. The decline in investment growth is extensively discussed in Kose and Ohnsorge (2024), World Bank (2023a), and World Bank (2024a).

[3] Public investment in this chapter refers to general government gross fixed capital formation. Investment data are in constant U.S. dollar terms. More formally, public investment includes the total net value of general government acquisitions of fixed assets during a given period and changes in the valuation of non-produced non-financial assets, such as land improvements. The main source of the data for public investment is the Investment and Capital Stock Dataset (IMF 2021a). For the post-2019 period, the data are complemented by the estimates using Haver Analytics and World Bank's WDI databases.

FIGURE 3.1 Infrastructure investment needs and investment growth

The scale of global investment needed to meet the Sustainable Development Goals and achieve commitments made under the Paris Agreement is enormous. To meet climate change objectives and other development goals, LICs require annual investment of 8 percent of GDP through 2030. Investment needs are particularly high in Sub-Saharan Africa. Compounding the challenge, in EMDEs, average investment growth decelerated from about 10 percent per year in the 2000s to 5 percent in the 2010s and is likely to remain subdued.



Sources: Feenstra, Inklaar, and Timmer (2015); Haver Analytics; Rozenberg and Fay (2019); WDI (database); World Bank.

Note: e = estimate; f = forecast; AEs = advanced economies; EAP = East Asia and Pacific; EMDEs = emerging market and developing economies; LAC = Latin America and the Caribbean; LICs = low-income countries; MNA = Middle East and North Africa; SAR = South Asia; SDGs = Sustainable Development Goals; SSA = Sub-Saharan Africa.

A. Estimates of the annual investment needs to build resilience to climate change and put countries on track to reduce emissions by 70 percent by 2050. Depending on data availability, estimates include investment needs on transport, energy, water, urban adaptations, industry, and landscape.

B. Average annual spending needs on electricity, transport, water and sanitation, flood protection, and irrigation during 2015-30. Country sample includes low- and middle-income countries, as defined in the technical appendix of Rozenberg and Fay (2019).

C. 2013-23 averages of the percent of the population with access to electricity, access to minimally adequate drinking water, access to basic sanitation facilities, and 2013-23 averages of the number of hospital beds available per 1,000 people. Sample includes 34 advanced economies and up to 104 EMDEs, of which 19 are LICs.

D. 2013-23 averages. The indexes range from 1 to 5 (5 = highest). Quality of transport infrastructure reflects perceptions of the quality of trade and transport related infrastructure. Logistics performance index reflects perceptions of the overall quality of logistics. Sample includes 34 advanced economies and 100 EMDEs, of which 19 are LICs.

E. Investment growth averages are calculated using GDP weights at average 2010-19 prices and market exchange rates. Sample includes up to 103 economies, including 68 EMDEs.

F. Aggregates are calculated using investment weights at average 2010-19 prices and market exchange rates.

potential to be a strong policy lever that can help ignite growth and crowd in private investment. Public investment typically includes capital expenditures on connectivity infrastructure (roads, bridges, telecommunications networks), public hospitals and schools, energy facilities, and other infrastructure—all of which can act as building blocks to enhance firm productivity, promote the flow of capital and labor, facilitate the exchange of goods and services, and foster human capital development. In other words, beyond its short-term demand effects, public investment can have positive supply-side impacts, raising the productive capacity of the economy and private sector competitiveness, supporting economic growth in the long term.[4]

Public investment can play an important role in the economy for multiple reasons. Infrastructure investment offers a helpful lens for articulating this. First, infrastructure projects often involve substantial upfront costs and maintenance expenditures without necessarily generating a commercially viable revenue stream. Second, infrastructure sectors with especially large sunk costs and economies of scale may also exhibit natural monopoly properties: that is, there are often only a few efficient market participants given high barriers to entry. Some of these projects in advanced economies can be undertaken by the private sector with appropriate regulation. However, in EMDEs, the private sector often lacks access to finance and the technical capabilities to develop critical infrastructure effectively. Third, some capital services may also have the characteristics of public goods, meaning they are non-excludable and non-rival—they can be used by many simultaneously without the ability to exclude non-payers. This might complicate their provision by the private sector.

In addition, governments are also generally seen as more creditworthy than private companies, given their power to tax; their ownership of large-scale assets that can serve as collateral for borrowing; and greater capacity to pool the necessary

[4] Public investment may also trigger sustained investment accelerations associated with multiple positive macroeconomic effects (World Bank 2024).

resources to execute large-scale infrastructure investment projects.[5]

A combination of these factors means that the private sector in EMDEs may not always be best-placed to deliver some types of public infrastructure effectively and ensure equitable or universal access by the population without some form of government intervention. This is especially so in the case of public health care, water provision, electricity transmission, public transportation, and recreation spaces (parks, for example). Provision of such infrastructure can also help lower poverty and inequality, build resilience against climate change and natural disasters, and promote inclusive economic development (Schwartz et al. 2020). This may strengthen the case for public investment, extending it far beyond pure economic growth effects, though the benefits can be difficult to quantify precisely, and alternative approaches (such as regulation), as well as different forms of public-private sector interaction related to investment, may help address specific market failures in certain circumstances.

That said, investment, whether public or private, can also lead to undesired outcomes if mismanaged. Specifically for public investment, there can be negative fiscal implications: the construction and upkeep of public infrastructure can involve massive costs, which could lead to large fiscal deficits and debt-related risks. Public sector inefficiencies can also undermine investment projects, especially in countries with weak governance and limited capacity for fiscal administration. In the worst case, public investment could yield infrastructure that is both unproductive and costly to maintain, resulting in negative net macroeconomic effects over an extended period. Furthermore, public investment could crowd out private investment in some circumstances, especially when public sector is inefficient and/or when scaling up is sizable and fast-paced. These challenges are particularly relevant for EMDEs, many of which have weak institutions, public sector inefficiencies, and limited fiscal resources.[6]

Against this background, this chapter presents a detailed study of the macroeconomic implications of public investment focusing on EMDEs. It addresses the following questions:

- How has public investment evolved in EMDEs?
- What is the impact of public investment on output and private investment?
- What policies can EMDEs adopt to bolster public investment and harness the benefits from it?

Contributions. The chapter contributes to the literature in several ways:

- *Reviewing public investment trends with a focus on EMDEs.* The chapter provides a thorough assessment of public investment trends in EMDEs and reviews the evolution of public investment growth during major adverse events, including recessions and financial crises. It considers a large set of countries and examines heterogeneity as well as commonalities across EMDE country groups and regions.
- *Assessing macroeconomic implications of public investment in EMDEs.* The chapter offers a comprehensive account of the macroeconomic effects of public investment. To this end, it provides a broad synthesis of the existing literature and estimates the effect of public investment on output—known as the public investment multiplier—using a new approach to identify public investment shocks. This approach can be applied to a broad sample of countries. The chapter analyses the macroeconomic conditions and structural characteristics that help bolster the effects of public invest-

[5] For the role of public investment in the provision of infrastructure see Aschauer (1989a,b), Ramey (2021), Schwartz et al. (2020); for constraints faced by private investment see IMF (2021b), Kose and Ohnsorge (2024), World Bank (2023a); for the borrowing capacity of governments see Martinez et al. (2023).

[6] For the fiscal impact of public investment, see Afonso and Alves (2023), Berg et al. (2012); for public sector inefficiencies in the context of investment, see Chakraborty and Dabla-Norris (2011), Dabla-Norris et al. (2012); for unproductive public infrastructure, see Pritchett (2000); and for the role of public investment in crowding out private investment, see Aschauer (1989a) and Cavallo and Daude (2011).

ment, and examines the impact of public investment on private investment, productivity, and potential output.

- *Outlining key policy interventions to increase public investment and enhance its benefits in EMDEs.* In light of the insights from the empirical analysis, the chapter presents a high-level summary of policies in EMDEs to boost public investment and to maximize its positive macroeconomic effects. It considers the current capacity of EMDEs to engage in government investment without undermining fiscal sustainability as well as structural challenges critical for ensuring investment efficiency and opportunities for greater international support.

Main findings. The chapter offers the following key findings:

Public investment growth in EMDEs slowed sharply over the past decade. Public investment growth in EMDEs halved from an average of 10 percent per year over 2000-09 to about 5 percent over 2010-22. More generally, public investment growth tended to slow following adverse events such as recessions and financial crises. Recessions also have scarring effects: public investment in the average EMDE contracted by about 4 percent during recessions (a drop of 9 percentage points from the pre-recession trend) and remained subdued for an extended period. Given the significant infrastructure needs of EMDEs, the broad-based decline in public investment growth is worrisome—particularly because it has been accompanied by a slowdown in private investment and in light of greater reliance of EMDEs on government investment. In particular, over the past decade, public investment comprised about 7 percent of GDP in EMDEs (compared with an average of 4 percent in advanced economies).

Public investment has the strongest impact on output when it occurs in countries with ample fiscal space and high government efficiency. Effective public investment can stimulate economic growth in EMDEs—for an average EMDE, scaling up of public investment equivalent to one percent of GDP leads to an increase in output of 1.1 percent after five years. However, its effectiveness hinges on government efficiency and fiscal space.[7] In countries with higher public investment efficiency or low fiscal sustainability concerns, an increase in public investment equivalent to one percent of GDP can increase output by up to 1.6 percent in the medium term—over the horizon of five years.[8] In countries with low public investment efficiency and high public debt, the output effects of public investment are positive but not statistically significant.

Public investment can have broader benefits: mobilizing private investment, enhancing productivity, and generating potential output gains. Public investment can have significant crowding-in effects on private investment. In EMDEs, a scaling up of public investment by one percent of GDP leads to an increase in private investment by up to 2.2 percent over the horizon of five years, on average. In the EMDE sample with available data, an equivalent increase in public investment can increase labor productivity by 1.9 percent and total factor productivity by 0.8 percent over the medium term. Potential output in response to these positive public investment shocks increases by up to 1.1 percent over the same period. These results offer empirical support for the arguments in favor of long-run supply-side transmission channels of public investment.

Pursuing a "Three Es" package of policy priorities can help harness the benefits of public investment in EMDEs. Specific policy interventions to increase public investment and secure the benefits from it depend on individual country circumstances, but three broadly applicable

[7] Fiscal space can be affected by government debt sustainability, balance sheet composition, external and private sector debt, and market perceptions of sovereign risk (see Kose et al. 2022). The chapter's empirical analysis uses the public-debt-to-GDP ratio as a proxy for fiscal space, though the amount of fiscal space for a given debt-to-GDP ratio may vary depending on country circumstances.

[8] In more technical terms, public investment efficiency is defined as the fraction of public investment that translates into effective public capital stock (Pritchett 2000). This entails the strength of institutions, quality of the design and implementation of public investment projects, effectiveness of procurement systems, among other factors (see also Kim, Fallov, and Groom 2020). The chapter uses several measures of public investment efficiency (see a detailed discussion in the sections on methodology and policy implications).

policy interventions—the "Three Es"—emerge as priorities for EMDEs:

- *Expansion of fiscal space.* Limited fiscal space not only impedes the ability of a government to scale up public investment, but also undermines its effectiveness. This is because additional public spending in countries with weak fiscal positions may lead to a heavier tax burden, greater sovereign risk, and higher borrowing costs weakening private sector activity. Estimates suggest that the effect of public investment on output in countries with large fiscal space is up to one percentage point higher than in countries with small fiscal space, on average.[9] Policy measures that help expand fiscal space are a priority for EMDEs as many of them suffer from elevated fiscal deficits and debt levels. EMDEs often have constrained revenue mobilization capacity and limited scope to (re)allocate budgetary resources to public investment. They should therefore undertake reforms to improve tax collection efficiency, enhance fiscal frameworks, and curtail unproductive spending.

- *Efficiency of public investment.* Public investment efficiency is paramount for reaping the full benefits of public investment. A wide range of policy interventions can be employed by EMDEs to improve the efficiency of public investment. Tackling corruption, poor governance, and limited capacity of fiscal administration are all important, as is improving public investment project management frameworks. These policies can be complemented by initiatives to prioritize public investment projects with the greatest potential to mobilize private investment and spark productivity gains, such as health, education, digital networks, and renewable energy infrastructure projects. In some cases, effective public-private partnerships can also help achieve the twin objectives of efficiency gains and mobilization of private capital. Estimates suggest that in EMDEs with high public investment efficiency, an increase in public investment by one percent of GDP may lead to an increase in output of up to 1.6 percent in the medium term (about one-half percentage point higher than the average effect in EMDEs). By contrast, in countries with the lowest efficiency, the output effects of public investment are lower and not statistically significant.[10]

- *Enhanced global support.* Developing countries with limited fiscal space and deep structural challenges, especially LICs, need external support to undertake comprehensive reforms critical for ensuring the effectiveness of public investment and to embark on large-scale public investment projects addressing vast infrastructure gaps. Coordinated financial support and effective technical assistance are both imperative for accelerating structural reforms and improving investment prospects. Given challenging macroeconomic conditions and the growing urgency of tackling climate change, delivering the green transition, and making progress toward other sustainable development goals, enhanced support from the international community will be vital for these countries.

Evolution of public investment

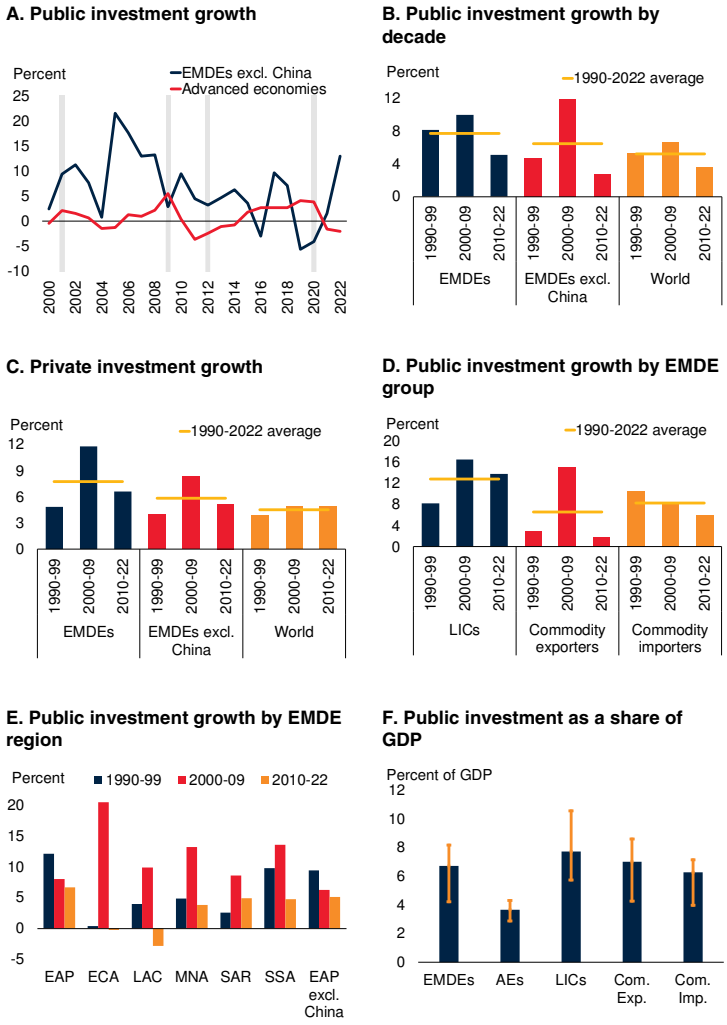
Public investment growth in EMDEs. Public investment growth has evolved notably over the past three decades. In the 1990s, public investment in EMDEs was growing at a much higher pace relative to advanced economies to a large extent on account of robust growth in China. This was followed by exceptionally high public investment growth in the 2000s which witnessed a period of macroeconomic stability, rapid economic integration, and reduction of poverty, amid elevated commodity prices (figures 3.2.A

[9] The high-debt and low-debt states are defined using the smooth transition function in the estimations (see annex 3.2). For a median EMDE, a low-debt state over the sample period corresponds to about 30 percent of GDP and a high-debt state corresponds to about 80 percent of GDP.

[10] Here, the high and low levels of public investment efficiency correspond to the top and bottom quartiles of the public infrastructure efficiency index used in the estimation of public investment multipliers—see annex 3.2 and estimation results.

FIGURE 3.2 Public investment patterns in EMDEs

Average annual public investment growth in EMDEs halved, dropping from 10 percent in the 2000s to 5 percent in the 2010s—the slowest average pace over the past three decades. Private investment growth in EMDEs also decelerated significantly, from 11 percent per year in the 2000s to 7 percent in the following decade The slowdown was broad-based across EMDE regions and country groups. In EMDEs, public investment tends to play a greater role than in advanced economies: it accounted for about 7 percent of GDP on average in EMDEs in the past decade, versus about 4 percent of GDP in advanced economies.



Sources: Haver Analytics; Investment and Capital Stock Dataset (IMF 2021a); WDI (database); World Bank.

Note: AEs = advanced economies; EMDEs = emerging market and developing economies; Com. Exp. = commodity-exporting EMDEs; Com. Imp. = commodity-importing EMDEs; EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; LICs = low-income countries; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa. Public investment growth is calculated with countries' public investment in constant international dollars as weights.

A. Shaded areas indicate global recessions (in 2009 and 2020) and slowdowns (in 2001 and 2012), as defined in Kose, Sugawara, and Terrones (2020). Sample includes 27 EMDEs and 12 advanced economies.

B.D.E. Average annual public investment growth. Sample includes up to 162 economies, of which 126 are EMDEs, 23 are LICs, 76 are commodity-exporting EMDEs, 50 are commodity-importing EMDEs. Sample includes 12 EAP, 19 ECA, 28 LAC, 15 MNA, 8 SAR, and 44 SSA countries.

C. Average annual private investment growth, calculated with countries' private investment in constant international dollars as weights. Sample includes up to 162 economies, of which 126 are EMDEs.

F. Bars show means and whiskers show interquartile ranges for 2010-22 by group. Sample includes up to 36 advanced economies and 126 EMDEs.

and 3.2.B). The latter also resulted in accelerated public investment growth in commodity-exporting EMDEs.

However, public investment growth plunged after the global financial crisis, contracting in advanced economies and decelerating significantly in EMDEs. Average annual public investment growth in EMDEs halved, dropping from 10 percent in the 2000s to 5 percent in the 2010s—the slowest average pace over the past three decades (figure 3.2.B). This slowdown was associated with multiple factors: weaker economic growth in EMDEs in the aftermath of the global financial crisis; the worsening of global macroeconomic environment resulting in the slowdown of trade and capital flows; heightened economic uncertainty; geopolitical tensions; tight financial conditions; increased debt levels eroding fiscal space and requiring consolidation; and highly volatile commodity prices. The pandemic global recession further worsened the macroeconomic backdrop. Government expenditures to contain the pandemic, provide support to vulnerable population groups and the private sector were prioritized, resulting in cutbacks and delays in public investment spending. The decline in public investment growth was also accompanied by a broad-based slowdown in private investment growth in EMDEs, decelerating from 11 percent per year in the 2000s to 7 percent in the 2010-22 period (figure 3.2.C).

Trends across EMDE groups and regions. Public investment growth in commodity-exporting EMDEs—which was much higher than that in other EMDEs through the 2000s—has slumped as global commodity prices declined, adversely affecting these countries' public finances (figure 3.2.D). Over this period, public investment in LICs, on average, grew much faster than in other EMDEs.

The weakening of public investment in the past decade was broad-based across EMDE regions. The decline was especially notable in Europe and Central Asia, Latin America and the Caribbean, and the Middle East and North Africa, where fiscal challenges were compounded by the

sustained decline in commodity prices leading to falls in revenues and adjustments in government spending in commodity-exporting countries (figure 3.2.E).

Public investment dynamics around adverse events. An event study analysis suggests that recessions and financial crises in EMDEs often cause prolonged dips in public investment (box 3.1). In recessions, public investment contracts by about 4 percent (a decline of about 9 percentage points relative to periods of economic stability) and remains subdued for an additional two years after the initial shock. Currency crises are also associated with a decline of about 6 percent in public investment during the crisis year, while debt and banking crises tend to have the largest impact in the year that follows the crisis—with public investment contracting by 3.5 and 3 percent, respectively.

Public-investment-to-output ratios. In EMDEs, public investment tends to play a greater role than in advanced economies: it accounted for about 7 percent of GDP on average in EMDEs in the past decade, versus about 4 percent of GDP in advanced economies (figure 3.2.F). Although public investment shares are similar across EMDE regions and country groups, LICs and commodity-exporting EMDEs have public investment ratios slightly higher than other EMDEs.

Public investment tends to play a larger role in EMDEs because the private sector is generally weaker in EMDEs than it is in advanced economies. It often lacks the capacity or willingness to invest in large infrastructure projects, partly because of greater uncertainty and perceived risks. EMDEs thus tend to rely on the public sector to deliver necessary infrastructure to a larger extent than advanced economies. Moreover, domestic and international creditors often see EMDE governments as more creditworthy than local private investors, given their power to tax, their ownership of significant assets that can serve as collateral, and their capacity to pool the resources needed to execute large-scale projects (Martinez et al. 2023).

Public investment-growth nexus: Channels of transmission

Public investment can be a potent policy tool to promote economic growth. The literature documents that public investment has a positive impact on growth in the medium term, but the range of the estimated public investment multipliers varies widely (see box 3.2 for a detailed discussion). Because of data constraints and methodological challenges, estimates of public investment multipliers for EMDEs are especially limited. Studies show that the economic effects of public investment may be influenced by various factors, such as public investment efficiency, fiscal space, trade openness, currency regime, informality, financial development, the phase of the business cycle, and macroeconomic uncertainty.

The heterogeneity of the output impacts of public investment reflects the effectiveness of the transmission channels through which public investment operates:

- *Short-term aggregate demand effects.* Public investment has the potential to support economic activity by boosting aggregate demand in the short term. This positive impact, however, is at least partly offset by the associated fiscal effects on the real economy, because public investment in principle is funded via taxation, debt issuance, or reallocation of government expenditure. In addition, the multiplier effect is weakened by purchases of investment goods abroad and depends on the import intensity of investment ("leakage effect"). Rapid scaling up of public investment, depending on its funding source and efficiency, may fuel fiscal imbalances and thereby undermine growth prospects (Bom and Ligthart 2014a; Romp and de Haan 2005).

- *Long-run aggregate supply effects.* Public investment has the potential to directly increase the productive capacity of an economy by fostering enhanced productivity

of private fixed capital and labor through the provision of public infrastructure. For instance, new roads and bridges can increase the overall competitiveness of an economy by enabling connectivity or reducing its cost (Aschauer 1989b; Romp and de Haan 2005; Straub 2011).

- *Crowding-in or crowding-out of private investment.* Public investment can *crowd in* private investment directly by requiring the use of private capital in the implementation of an investment project, for instance, via public-private partnerships. Public investment can also enable infrastructure that raises returns on private capital—for instance, roads and communications infrastructure—thereby encouraging private sector investment (Aschauer 1989a; Eden and Kraay 2014). Public investment helps to reduce uncertainty and risks associated with large private investment projects, especially infrastructure projects requiring massive upfront costs but longer payback periods (IMF 2021b). However, public investment may also *crowd out* private investment, especially when fiscal space is limited and additional fiscal stimulus raises sovereign risk and borrowing costs for the private sector (Abiad, Furceri, and Topalova 2016; Erenburg and Wohar 1995; Huidrom et al. 2020). The net effect on the private sector depends on the balance between these opposing factors, which, in turn, is influenced by fiscal space and the quality of public investment.

- *Efficiency and quality of public investment.* Scaling up of public investment may not necessarily result in an equivalent increase in the value of productive public capital (Pritchett 2000). Some of the resources are lost during the investment process because of weak governance, corruption, coordination issues, and poor design and implementation of investment projects. There may also be diminishing returns on additional public investment, though this depends on a country's circumstances and the merits of specific projects. In the worst case, poor investment may yield infrastructure that is unproductive and yet requires a continuous stream of fiscal resources to maintain, thereby hurting long-term growth prospects (Chakraborty and Dabla-Norris 2011; Dabla-Norris et al. 2012). In part, this also relates to the composition of public investment: not all projects contribute equally to growth.[11]

- *Public capital maintenance costs.* More generally, depreciating public capital stocks require additional short- and long-run maintenance. The associated costs may lead to additional fiscal strains that undermine long-term positive growth effects. Meanwhile, inadequate or untimely maintenance of public capital could lead to even larger social and economic costs associated with infrastructure failures (Schwartz et al. 2020).[12] The strength of this channel is intertwined with the efficiency channel, as low-quality public investment is more likely to yield infrastructure that is prone to larger or more frequent upkeep costs.

- *Sustainability of growth.* Public investment—though not always the only solution—can also play an important role in delivering public goods or services that may not be privately profitable, such as public health care and education, water and energy transmission, and national security. This type of public investment can be instrumental for facilitating sustainable and inclusive growth through its positive effects on human capital development, social inclusion, environmental impacts (Foster et al. 2023; Mazzucato and Semieniuk 2017; Turnovsky 2015; Zachmann et al. 2012).

[11] As a related matter, there are challenges associated with the measurement and valuation of public investment at a disaggregated level—identifying infrastructure-related spending and composition of public investment by capital asset types (see also ADB 2017 and Fay et al. 2019b). This hinders the assessment of the macroeconomic effects by individual categories of public investment and types of infrastructure—likely to be heterogeneous (see a meta-analysis in Foster et al. 2023).

[12] Governments may also have stronger incentives to spend on new investment projects rather than on maintenance as the former is more visible and attractive from an electoral perspective (De Haan and Klomp 2013).

Macroeconomic implications of public investment

Database and methodology

Database. The database used in the estimation of the macroeconomic effects of public investment draws from several sources. Public investment, private investment, and capital stock data are from the International Monetary Fund's Investment and Capital Stock Dataset (IMF 2021a). Public debt data are retrieved from the World Bank's Fiscal Space Database (Kose et al. 2022). Public investment efficiency data are obtained from several sources: IMF (2021b) Fiscal Monitor database, Devadas and Pennings (2018), and Dabla-Norris et al. (2012). Potential output data are sourced from Kilic Celik et al. (2023). GDP and inflation series are from the IMF's World Economic Outlook database. Labor productivity and total factor productivity data are from Penn World Table 10.01. The resulting dataset comprises up to 129 EMDEs, spanning the period 1980-2019 (see table A3.2.1 for the sample composition).[13]

Methodology. The major challenge in the estimation of the macroeconomic effects of public investment is associated with the bidirectional causality between public spending and economic growth (Canning and Pedroni 2008). Several approaches have been developed in the literature to address this problem. However, the methods devised to date have certain caveats that limit their application to the large sample of EMDEs (see annex 3.1 for an overview). This section summarizes the new approach used in the analysis to identify the changes in public investment that are not affected by macroeconomic conditions (public investment shocks), and the methodology deployed to estimate the effect of these shocks on output (in other words, public investment multipliers) and other macroeconomic variables.

- *Identification of public investment shocks.* The chapter identifies public investment shocks as episodes of large changes in cyclically adjusted public investment (technical details are provided in annex 3.1 and Adarov, Clements, and Jalles, forthcoming). This framework removes the component of public investment associated with transitory macroeconomic dynamics (the business cycle) and focuses only on episodes of large discretionary public investment. This approach is easy to replicate and can be applied to a broad sample of countries. This enables an analysis of heterogeneity across countries and the effects of public investment conditional on country characteristics and macroeconomic conditions.

- *Estimation of public investment multipliers.* The responses of output to identified public investment shocks are estimated using the local projections method (Jordà 2005). The results are reported in the form of impulse response functions showing the effects on real GDP (cumulative change in percent relative to the year preceding the public investment shock) of public investment shocks equivalent to one percent of GDP. These effects are examined over a five-year horizon following a shock. A similar approach is used to estimate the impact of public investment on potential output, productivity, and other macroeconomic variables. Annex 3.2 provides further details on the estimation methodology, data, and robustness checks.

Results

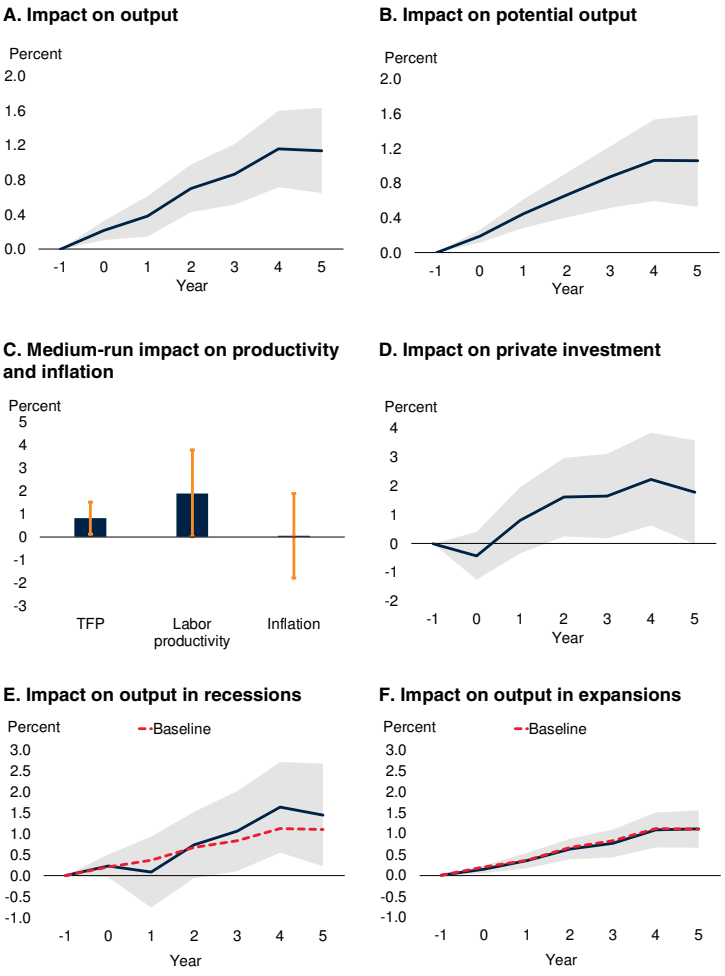
Growth effects of public investment in EMDEs. Public investment shocks lead to positive output responses that remain highly statistically significant at the horizon of five years (figure 3.3.A). An increase in public investment equivalent to one percent of GDP is associated with a gradual increase in output from 0.4 percent after one year, reaching 1.1 after five years.[14] The output effects of public investment tend to be smaller in the

[13] The sample composition and time coverage are determined entirely by the data availability. In particular, the current version of the Investment and Capital Stock Dataset (IMF 2021a), providing consistent disaggregated series for public and private investment, covers the period 1960-2019.

[14] The responses are the cumulative changes relative to the year before the public investment shock, in percent. The results are confirmed using robustness checks (see annex 3.2 for details).

FIGURE 3.3 Macroeconomic impacts of public investment in EMDEs

An increase in public investment equivalent to one percent of GDP in EMDEs is associated with a gradual increase in output from 0.4 percent after one year, reaching 1.1 percent after five years. Potential output in response to public investment shocks increases by 1.1 percent after five years. This effect is associated with a boost in productivity—by up to 0.8 percent for total factor productivity and 1.9 percent for labor productivity over the medium term. A scaling up of public investment by one percent of GDP leads to an increase in private investment by up to 2.2 percent over the horizon of five years, on average. Public investment multipliers tend to be larger in recessions.



Source: World Bank.

Note: CPI = consumer price index; EMDEs = emerging market and developing economies; TFP = total factor productivity. Sample includes up to 129 EMDEs. Responses of variables (cumulative change in year *t* relative to year *t* = -1, in percent) to a public investment shock equivalent to one percent of GDP; *t* = 0 is the year of the shock. Shaded areas denote 90 percent confidence bands, based on standard errors clustered at the country level.

A. Response of real GDP to a public investment shock.

B. Response of real potential GDP to a public investment shock.

C. Responses of TFP, labor productivity, and CPI to a public investment shock after five years based on local projections. Bars indicate the point estimates, whiskers indicate 90 percent confidence intervals.

D. Response of real private investment to a public investment shock.

E.F. Response of real GDP to a public investment shock in recessions and expansions, defined as periods of negative and positive real GDP growth. Dashed lines indicate the baseline unconditional responses.

short run, but increase over the long term as supply-side effects on productivity and productive capacity fully manifest themselves, consistent with the literature (Leduc and Wilson 2012; Ramey 2021). In the short run, offsetting fiscal effects, impact of leakage through imports, possible transitory crowding out of private investment, private sector capacity constraints, and the time needed to adjust consumption and production may dampen the effects of public investment.[15] The estimated effects are broadly in line with public investment multipliers reported in existing empirical studies on EMDEs (box 3.2).[16]

The analysis suggests that *potential* output also increases steadily in response to public investment. In a sample of EMDEs with the available data, a one percent of GDP rise in public investment leads to an increase in potential output peaking at about 1.1 percent over five years (figure 3.3.B).[17] This effect is associated with a concurrent boost in productivity—by up to 0.8 percent for total factor productivity and 1.9 percent for labor productivity over the medium term (figure 3.3.C). The impact of public investment surges on output does not lead to a corresponding increase in inflation. These findings support the hypothesis that public investment can increase output through both short-term aggregate demand and longer-run aggregate supply channels, thereby boosting potential output (Ramey 2021).

Impact on private investment. An important impact of public investment occurs via the crowding-in effect on private investment. An increase in public investment equivalent to one percent of GDP induces an increase in private

[15] Similar results are reported in recent empirical studies (for instance, Abiad, Furceri, and Topalova 2016; Furceri and Li 2017; Ilzetzki, Mendoza, and Végh 2013).

[16] Public investment multiplier estimates reported in the literature vary widely for EMDEs and tend to be larger in advanced economies. Gechert and Rannenberg (2018) and Vagliasindi and Gorgulu (2021) in a meta-analysis show the average value of public investment multiplier across studies of about 1.5—slightly larger than the value estimated in the chapter for EMDEs. Public investment multipliers are larger than public consumption multipliers; the latter are not statistically significant from zero (see table B3.2.1 for studies reporting similar findings).

[17] The sample size for the exercises with potential output and productivity is smaller because of data availability, and is not directly comparable to the baseline results, which use the full EMDE sample.

investment by up to 2.2 percent at the horizon of five years (figure 3.3.D). The estimates also suggest a possible crowding-out effect on impact; however, the effect is small, not statistically significant from zero, and is reversed within a year.

The crowding-in effect on private investment is in line with the estimates reported in the literature (see, for instance, Eden and Kraay 2014; Furceri and Li 2017). In this regard, the results provide empirical support for policies to mitigate private investment slowdown through a scaling up of public investment. This effect could operate through several transmission channels. An increase in public capital can raise the return on private capital by facilitating connectivity (for instance, roads and bridges), thereby facilitating private sector investment (Aschauer 1989a, Eden and Kraay 2014). Public investment reduces uncertainty and risks associated with private investment in large infrastructure projects and may also directly crowd in private investment via public-private partnerships (IMF 2021b).

The role of the business cycle. Public investment multipliers, on average, are greater in magnitude during recessions than during expansions. A one percent of GDP increase in public investment yields an increase in output by 1.1 percent in times of expansion after five years. An equivalent public investment shock in recessions leads to an increase in output by up to 1.6 percent over the same period. However, the estimates during recessions are characterized by notable heterogeneity across countries, resulting in wider confidence bands (figures 3.3.E and 3.3.F). These results are consistent with the empirical literature reporting larger government spending multipliers in recessions.[18]

The position of an economy in the business cycle may affect the size of the multiplier for several reasons. In expansions, public spending stimulus may be less effective because, if the economy is operating close to full capacity, an additional increase in public spending is less likely to crowd in private sector resources.[19] In contrast, economic slack during recessions enables public investment to mobilize unused private sector capacity (Batini et al. 2014). Public spending during recessions may also help mitigate unemployment and improve market confidence, and is less likely to be accompanied by increasing inflation and interest rates (Auerbach and Gorodnichenko 2012; Ghassibe and Zanetti 2022).

In practice, however, EMDEs often have limited fiscal resources for public investment projects during recessions and crises. In fact, public investment tends to contract during economic distress (see box 3.1). "Shovel-ready" investment projects may help revive economic activity and crowd in private investment during economic downturns as long as they are well-planned and executed, and do not undermine fiscal sustainability; such projects and conditions, however, may not always be present.

Implications of fiscal space. EMDEs with lower fiscal sustainability concerns, as measured by public-debt-to-GDP ratios (indicating larger fiscal space), experience much stronger positive impacts of public investment: output increases by up to 1.6 percent five years after a public investment shock equivalent to one percent of GDP. Conversely, public investment in countries with high and rising debt (implying limited fiscal space) appears to be ineffective: the estimated public investment multipliers are lower and not statistically significant (figures 3.4.A and 3.4.B).[20] While changes in public-debt-to-GDP ratios only partly reflect fiscal space dynamics, these results nevertheless imply that the effect of public investment on output in countries with large fiscal

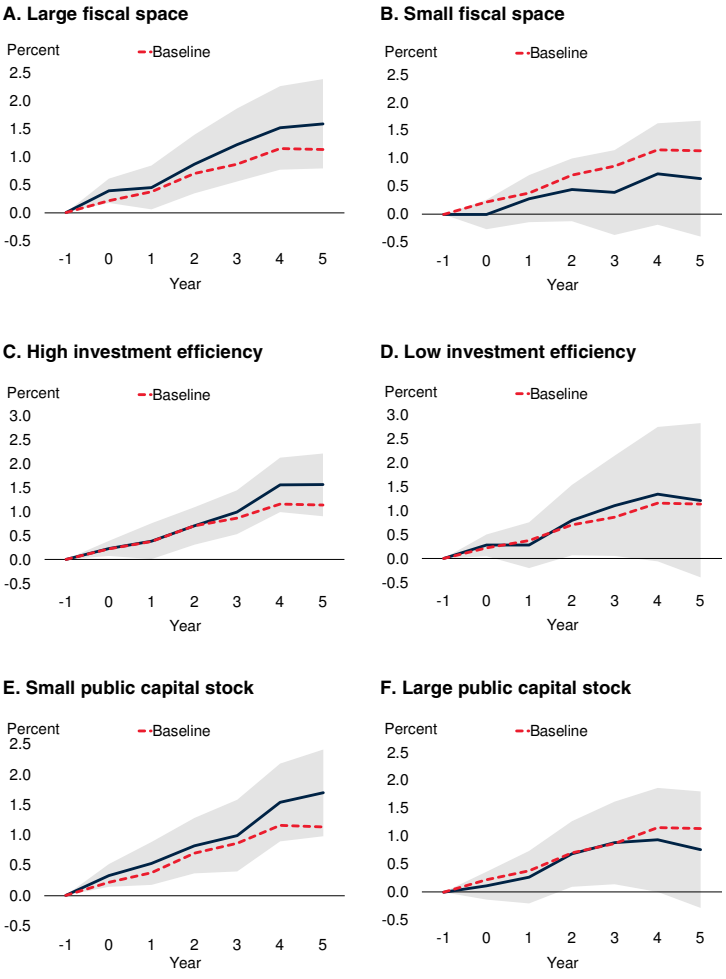
[18] Larger public investment multipliers in recessions are reported in Auerbach and Gorodnichenko (2012 and 2013); Caggiano et al. (2015); Furceri and Li (2017); Honda et al. (2020); Riera-Crichton et al. (2015). That said, such estimates may not be fully robust with significant heterogeneity across countries (Ramey 2019).

[19] That said, during expansions public investment also has a positive effect on output in EMDEs. This is in line with the view that EMDEs often have underutilized capacity because of infrastructure gaps, limited access to finance constraining the ability of the private sector to expand production capacity, and unused available labor resources, which can be engaged in expansions through public investment.

[20] These results thus are in line with the literature, arguing that in countries with high debt, public spending multipliers can be insignificant or even negative (Huidrom et al. 2020; Ilzetzki Mendoza, and Végh 2013).

FIGURE 3.4 Effects of public investment on output conditional on country characteristics

EMDEs with lower fiscal sustainability concerns, as measured by public-debt-to-GDP ratios, experience much stronger positive impacts of public investment: output increases by up to 1.6 percent over the horizon of five years. Conversely, public investment in countries with high and rising debt appears to be ineffective. The estimates suggest a greater effect on GDP in response to public investment shocks in EMDEs with the highest efficiency, culminating in an increase in output of about 1.6 percent after five years. In countries with the lowest efficiency, the effects of public investment are lower and not statistically significant (albeit still positive). Public investment multipliers in capital-scarce economies tend to be larger.



Source: World Bank.

Note: EMDEs = emerging market and developing economies. Responses of real GDP (cumulative change in year t relative to year t = -1, in percent) to a public investment shock equivalent to one percent of GDP; t = 0 is the year of the shock. Shaded areas denote 90 percent confidence bands, based on standard errors clustered at the country level. Dashed lines indicate the baseline unconditional responses. Sample includes up to 129 EMDEs.

A.B. Large-fiscal space and small-fiscal space responses are based on local projections with the smooth transition function that uses public-debt-to-GDP ratio as the conditioning variable. Large fiscal space state corresponds to the transition function value of 1, reflecting historically lowest debt ratio for a given country, and small fiscal space state corresponds to the transition function value of 0, reflecting the highest debt ratio for a given country in public investment shock years (the debt ratios of about 30 and 80 percent of GDP for a median EMDE, respectively).

C.D. High-efficiency and low-efficiency samples are based on the top and bottom quartiles of the IMF (2021b) public infrastructure efficiency index, which ranges from 0 to 100 (the values above 81 and below 47, respectively).

E.F. Small public capital stock and large public capital stock responses are based on local projections with the smooth transition function that uses public-capital-stock-to-GDP ratio as the conditioning variable to capture historically lowest and highest capital stock ratios of a given country in public investment shock years (the values of public capital stock of 68 and 113 percent of GDP for a median EMDE, respectively).

space is up to one percentage point higher than in countries with small fiscal space, on average.[21]

Fiscal space influences the output effects of public investment through two channels. The first is associated with the effects on private sector, as additional public spending in countries with weak fiscal positions may lead to lower disposable income of liquidity-constrained households, as well as increased tax burdens for the private sector in the future (which may also be anticipated). The second channel relates to the interest rate effect, as scaling up of government expenditures in countries with high levels of debt may lead to higher international interest rate spreads, on account of higher sovereign risk and inflation, thus increasing borrowing costs for the private sector (Blanchard 1990; Huidrom et al. 2020; Sutherland 1997).

Infrastructure investment projects, given their large upfront costs and long time horizons, are often financed by borrowing rather than from current government revenues. Larger fiscal space implies that the sovereign has more capacity to service its borrowing and therefore is more creditworthy, allowing it to finance such investment at a lower interest rate.

Public investment efficiency. Efficiency of public investment plays a crucial role in driving its growth effects.[22] The estimates suggest a greater effect on GDP in response to public investment shocks in EMDEs with the highest efficiency,

[21] The high-debt and low-debt states are defined using the smooth transition function that reflects the historical dynamics of public-debt-to-GDP ratios on a country-by-country basis. For a median EMDE, a low-debt state over the sample period corresponds to about 30 percent of GDP and a high-debt state corresponds to about 80 percent of GDP for EMDEs that experienced a public investment shock.

[22] The analysis uses the IMF (2021b) public infrastructure efficiency index, which is a cross-sectional index available for 120 countries (including 93 EMDEs), produced using the data envelopment analysis. The index ranges from 0 to 100, with higher values indicating better efficiency (the distribution is shown in figure 3.7.A). The model was also estimated using the Devadas and Pennings (2018) infrastructure efficiency index and the Dabla-Norris et al. (2012) public investment management index, available for 69 EMDEs in the sample. Estimations using alternative measures also suggest statistically insignificant and lower output effects of public investment in low-efficiency economies (table A3.2.4).

culminating in an increase in output of about 1.6 percent after five years—one-half percentage point higher than the effect of public investment in EMDEs with the lowest efficiency (figures 3.4.C and 3.4.D). In countries with the lowest efficiency, the effects of public investment are lower and not statistically significant (albeit still positive).

These results are consistent with empirical studies using other samples and methods, and provide support for the argument that low public investment efficiency is problematic.[23] Poor design, evaluation, and implementation of investment projects, including issues with corruption and governance, can deplete valuable fiscal resources without necessarily increasing the quantity or quality of public infrastructure that supports growth (Dabla-Norris et al. 2012; IMF 2014; Pritchett 2000). Therefore, well-designed public investment management processes are essential to ensure the effectiveness of public investment.

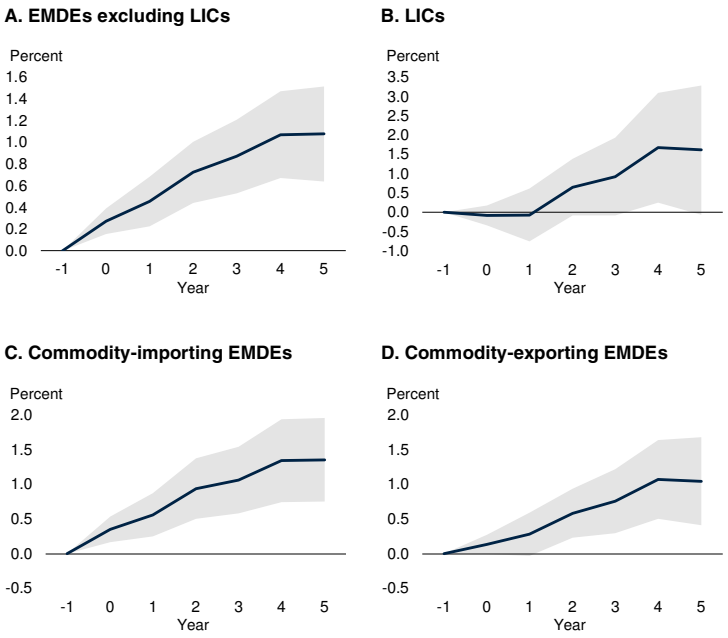
Public capital stock scarcity. The impact of public investment on output also varies with the initial level of the public capital stock (figures 3.4.E and 3.4.F). The magnitude and statistical significance of public investment multiplier tends to decrease with the level of public capital stock relative to GDP, consistent with expectations of diminishing marginal returns to capital. Specifically, a one percent of GDP increase in public investment is associated with a 1.7 percent increase in GDP after five years in capital-scarce countries. This contrasts with 0.9 percent (not statistically significant in the medium term) when the public-capital-stock-to-GDP ratio is high. Similar results are found in empirical studies using other samples and methods (for instance, Izquierdo et al. 2019).

Heterogeneity across EMDEs. In higher-income EMDEs, positive public investment shocks lead to strong and persistent impacts on output. In LICs, however, the effects on output are characterized by a wide dispersion, which translates to much lower statistical significance of public investment multipliers. Small sample size may play a part, but this could also be the result of lower efficiency in their public investment. That said, the average effect tends to be larger in LICs than in higher-income EMDEs, reaching up to 1.7 percent over the horizon of five years after a public investment shock equivalent to one percent of GDP (figures 3.5.A and 3.5.B). Public investment effects are slightly lower in commodity-exporting EMDEs than in other EMDEs (figures 3.5.C and 3.5.D).

[23] See Cavallo and Daude (2011); Furceri and Li (2017); IMF (2014); Izquierdo et al. (2019); Leduc and Wilson (2012); Leeper et al. (2010).

FIGURE 3.5 Effects of public investment on output by EMDE groups

In higher-income EMDEs, public investment shocks lead to strong and persistent impacts on output. In LICs, however, the effects on output are characterized by a wide dispersion, which translates to much lower statistical significance of public investment multipliers. That said, the average effect tends to be larger in LICs than in higher-income EMDEs, reaching up to 1.7 percent over the horizon of five years after a public investment shock. Public investment effects are slightly lower in commodity-exporting EMDEs than in other EMDEs.



Source: World Bank.
Note: EMDEs = emerging market and developing economies; LICs = low-income countries. Responses of real GDP (cumulative change in year *t* relative to year *t* = -1, in percent) to a public investment shock equivalent to one percent of GDP; *t* = 0 is the year of the shock. Sample includes 129 EMDEs, of which 23 are LICs, 48 are commodity exporters, and 81 are commodity importers. Shaded areas denote 90 percent confidence bands, based on standard errors clustered at the country level.

Policies to improve the macroeconomic benefits of public investment

The need for additional public investment has grown in the last two decades, accentuated by objectives to deliver the SDGs, address climate change, and recover from multiple shocks. Public investment has a potential to mobilize private investment and to help spur economic growth. However, the analysis suggests its beneficial effects are muted when fiscal space is constrained and when government spending is inefficient. This has important policy implications for EMDEs, many of which suffer from elevated debt levels, deep structural challenges, and weak institutions. Furthermore, many EMDEs, especially LICs, have limited financial and technical capacity to advance the needed reforms; significant and timely support from the international community will be necessary.

While policies to promote public investment and boost its effectiveness should be tailored to individual country circumstances, there are three overarching priorities that are relevant for all EMDEs—the package of "Three Es": *expansion of fiscal space, efficiency of public investment,* and *enhanced global support.*

Expansion of fiscal space

Fiscal space—the room in a government's budget that allows it to engage in expenditures without jeopardizing the sustainability of its financial position or the stability of the economy—is a critical concept when considering public investment (Kose et al. 2022). Options to boost fiscal space are arguably more limited in EMDEs than in advanced economies, as they quickly come up against fiscal sustainability limits. On the revenue side, the tax collection and administration capacity in EMDEs is generally more constrained than in advanced economies. On the expenditure side, a high share of the budget allocated to interest spending on accumulated debt implies that fewer budget resources are available to spend on social and economic needs, including investment in infrastructure.

Policy interventions that can help expand fiscal space include reforms to strengthen debt management and fiscal frameworks, domestic revenue mobilization, and optimal allocation of public expenditure.

Domestic revenue mobilization

Many EMDEs suffer from weaknesses in mobilizing fiscal revenues, which are critical for securing fiscal space and delivering priority spending. Tax collection and administration capacity in EMDEs is generally more limited than in advanced economies. EMDEs, especially LICs, tend to lag advanced economies in the size of government tax revenues relative to GDP (figure 3.6.A). This also reflects, in part, the difficulty in establishing monitoring and compliance processes for broad direct income taxation (Besley and Persson 2014).

Options for greater revenue mobilization in the short term may be limited in EMDEs. Deep structural factors may influence tax collection capacity, including the resources available to tax and the level of economic informality (Bird, Martinez Vazquez, and Torgler 2008; Waseem 2018). Increasing tax rates as a part of a comprehensive fiscal reform may not always be politically or administratively feasible in the near term. However, efforts to broaden the tax base without raising statutory rates can go a long way in closing loopholes and simplifying tax collection. Inefficient tax expenditures—tax breaks, deductions, credits, and other exemptions granted to certain favored sectors or groups of taxpayers—constitute a significant challenge in some EMDEs. Eliminating these expenditures or at a minimum, transparently including their cost in the budget, can lead to more effective use of limited fiscal resources.

Reforms to improve tax policies and administration. Better tax administration can help tap underutilized sources of revenue (World Bank 2023b). Progress in tax administration could be aided, for example, by improving the management of the taxpayer registry, tax dispute resolution, transparency, and accountability functions. The simplicity of the tax structure itself can aid its administration. For example, a uniform sales tax on businesses may foster compliance and reduce

opportunities to exploit loopholes. Trade taxes at the border, such as value-added taxes, can take advantage of automated customs management systems for international trade and transport operations (UNCTAD 2022).[24]

Adoption of new technologies. Implementation of new technologies to process tax payments and monitor tax compliance can aid revenue mobilization (Gupta et al. 2017). For instance, wider adoption of mobile payment systems can help simplify tax payment processes in EMDEs, which helps gain efficiency in tax revenue collection, particularly for direct taxes (Dom et al. 2022). The implementation of mobile money platforms has helped reduce property tax evasion in Tanzania, and has been used to facilitate filing tax returns and increase non-tax revenue collection in Kenya and the Philippines (Arewa and Davenport 2022).

Reallocation of public spending

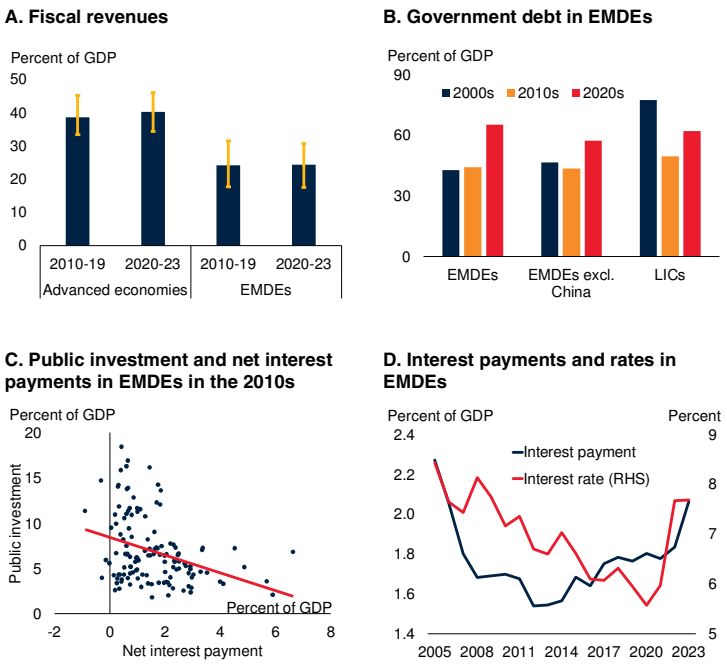
Although debt-service payments and other non-discretionary spending items reduce fiscal room for public investment, EMDEs generally also have some scope for increasing public sector spending efficiency. For example, reducing distortive subsidies can achieve greater allocative efficiency of public spending. Governments often choose to subsidize certain domestic industries to bolster their competitiveness, for national security interests, or to promote development in specific regions.

However, artificially propping up certain sectors through subsidies distorts market dynamics, diverts resources toward less efficient firms and industries, creates unfair advantages, and discourages competition, which ultimately impedes structural adjustments within the economy (World Bank 2023c). Globally, though estimates vary, subsidies for fossil fuels, agriculture, and fisheries are large, amounting to US$1.25 trillion per year, or more than one percent of global GDP according to a recent assessment (Damania et al. 2023). Such subsidies—popular in many EMDEs—can considerably reduce fiscal space, in addition to often being poorly targeted and distortionary. This can be done by using gradual increases in regulated gasoline and diesel prices, liberalizing fuel markets, reforming the excise tax on fuel, and introducing a carbon tax (Parry, Black, and Vernon 2021). Removing subsidies can be politically contentious. Nevertheless, some countries have been able to undertake fuel subsidy reforms. For example, Mexico was able to remove the fuel subsidy and turn fuel taxes into a net

[24] In particular, the UNCTAD Automated System for Customs Data (ASYCUDA)—an integrated customs management system for international trade and transport operations—increasingly adopted by countries globally, helps improve fiscal governance and revenue administration efficiency.

FIGURE 3.6 Fiscal space in EMDEs

EMDEs, especially LICs, tend to lag advanced economies in the size of government tax revenues relative to GDP. Government debt in EMDEs escalated significantly in 2020-23 to 65 percent of GDP—about 20 percentage points higher than the average over the previous two decades. EMDEs with higher interest payments tend to have lower public-investment-to-GDP ratios. Borrowing costs have risen sharply since 2020, as inflation and interest rates increased globally.



Sources: International Monetary Fund; Kose et al. (2022); World Bank.
Note: EMDEs = emerging market and developing economies; LICs = low-income countries.
A. Bars show group medians of the countries' period average fiscal revenues in percent of GDP. Whiskers indicate interquartile ranges. Sample includes up to 41 advanced economies and 154 EMDEs.
B. Aggregates are computed as weighted averages with nominal GDP in U.S. dollars as weights. Data for the 2020s cover 2020-23. Sample includes up to 153 EMDEs, including 23 LICs.
C. Relationship between public investment and net interest payments, computed as differences between primary balances and fiscal balances (in percent of GDP). Correlation coefficient is -0.34, statistically significant at the 1 percent level, based on data for 130 EMDEs.
D. Interest payment refers to net interest payment, and interest rate refers to long-term interest rate. Sample includes up to 149 EMDEs for interest payment and 77 EMDEs for interest rate.

fiscal revenue source (Arlinghaus and van Dender 2017).

Improving debt management and fiscal frameworks

Debt financing via bond issuance and loans from domestic and international borrowers allows governments to mobilize more resources for large-scale infrastructure projects, while spreading the costs of investment over time. However, incurring more public debt may be difficult: many countries have come up against borrowing limits. Government debt in EMDEs escalated significantly over 2020-23 to 65 percent of GDP—about 20 percentage points higher than the average over the previous two decades (figure 3.6.B).

In a time of elevated interest rates, higher debt levels are associated with larger debt-service costs, limiting the budgetary resources for public investment. When debt service is high, the first reaction in liquidity-constrained EMDEs is often to cancel or postpone public investment projects. Indeed, EMDEs with higher interest payments tend to have lower public-investment-to-GDP ratios (figure 3.6.C). Borrowing costs have risen sharply since 2020, as inflation and interest rates increased globally, increasing debt servicing obligations for many EMDEs (figure 3.6.D).

Credible, stable, and predictable fiscal frameworks can help to increase fiscal space by generating the capacity for the government to take on more debt without undermining sustainability. Improved public debt management, the implementation of medium-term expenditure frameworks, the introduction of effective fiscal rules, and the establishment or strengthening of institutions for building fiscal buffers (such as stabilization funds) can all reinforce fiscal discipline.

Public debt management. Implementing best practices in debt management regarding liquidity, maturity, currency, and coupon payment arrangements can reinforce EMDEs' capacity to borrow. Good public management makes government financing less vulnerable to short-term changes in market sentiment, exchange rate and interest rate fluctuations, and other shocks (Kose et al. 2021). Accurate and transparent monitoring of government balance sheets and contingent government liabilities is also important for effective debt management.

Medium-term expenditure frameworks. The adoption of multiyear planning frameworks helps to strengthen the credibility and transparency of budgetary process and establishes a formal connection between budgets and broad macroeconomic and fiscal policy objectives. This can help contain budgetary inertia, overspending, and near-term bias in budgeting. This is particularly important for the planning of public infrastructure projects that require medium-term financing commitments and large upfront costs.

Fiscal rules and stabilization funds. Fiscal rules can help reduce the influence of political actors by setting transparent numerical limits. Successful implementation of effective fiscal rules allows a government to establish credibility with its creditors, which can improve borrowing capacity and avoid the risks of sudden spending cuts during crises. Flexible fiscal rules that exclude public investment from the regulatory constraints on fiscal aggregates may help prevent abrupt investment cuts during fiscal adjustment periods (Guerguil, Mandon, and Tapsoba 2017; Rajaram et al. 2014; Schwartz et al. 2020). However, there may be trade-offs between flexibility and clarity. Fiscal rules have been implemented successfully in many EMDEs; examples include Chile and Indonesia. Well-designed fiscal rules and stabilization funds with strong institutional frameworks are especially important for commodity exporters, as they help mitigate the volatility and procyclicality that can result from exposure to commodity price volatility (Gill et al. 2014; World Bank 2024). Some EMDEs have been able to significantly expand fiscal space in recent years amid a low global growth environment. For example, Jamaica was successful in reducing its debt burden by introducing transparent fiscal rules and implementing its medium-term fiscal framework (Arslanalp et al. 2024).

Efficiency of public investment

Public investment efficiency is critical for realizing the macroeconomic benefits of public investment. In technical terms, public investment efficiency is

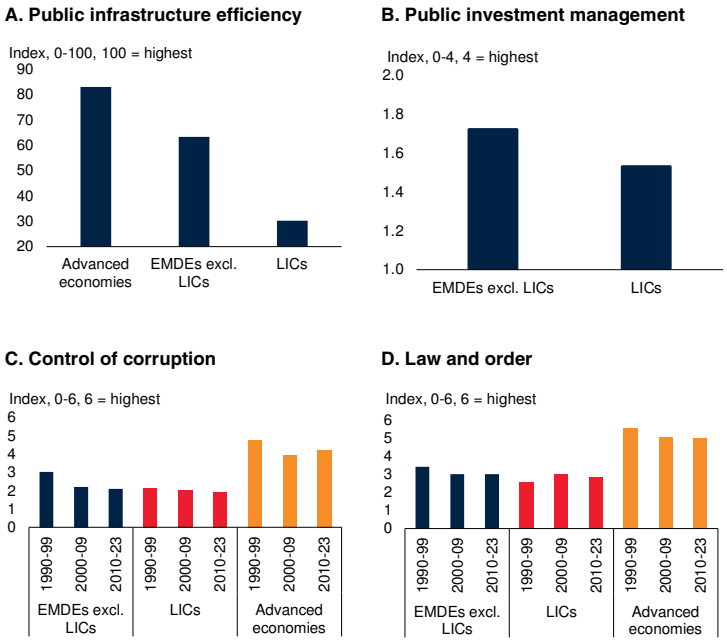
defined as the ratio between the actual increment of public capital and the amount spent (Pritchett 2000). The extent to which each dollar spent on public investment translates into a dollar of productive public capital depends on many factors, including the quality of institutions, the effectiveness of fiscal planning and execution, the quality of project evaluation, and the speed of implementation of public investment projects (Dabla Norris et al. 2012; Schwartz et al. 2020). In the worst case, low-quality public investment processes may result in "white elephant" infrastructure projects that are very costly to build and maintain, while bringing only limited economic returns.

EMDEs, especially LICs, generally lag advanced economies in terms of public investment efficiency (figures 3.7.A and 3.7.B). Institutional weaknesses such as government corruption, regulatory bottlenecks, and inefficient procurement systems are closely linked to low efficiency of public investment (Rajaram et al. 2014). Over recent decades, in the average EMDE, there has been little progress in improving the quality of institutions that are critical for overall public investment efficiency, including control of corruption and the strength of regulatory quality (figures 3.7.C and 3.7.D). According to some estimates, in EMDEs, over one-third of public investment may be lost because of inefficiency (Schwartz et al. 2020).

Public investment management is critical for the successful implementation of large-scale public investment projects with long development cycles and high risks, such as sustainable infrastructure projects. Robust risk management processes, along with transparent and well-monitored procurement frameworks, are particularly important for crowding in private investment for infrastructure projects (Davoodi 1998; Kim, Fallov, and Groom 2020). Besides structural reforms to enhance the quality of institutions, effective public investment management frameworks are also important to improve public investment efficiency, including at the project level.[25] Moreover, lack of human resources to design and manage a project often results in slow budget execution rates, which are intrinsically related to low efficiency. Poor execution often reduces returns on public investment. This is a particular challenge for many LICs and small states (chapter 4).

FIGURE 3.7 Public investment efficiency

EMDEs, especially LICs, generally lag advanced economies in terms of public investment efficiency. Over recent decades, in the average EMDE, there has been little progress in improving the quality of institutions that are critical for overall public investment efficiency, including control of corruption and the strength of regulatory quality.



Sources: Dabla-Norris et al. (2012); IMF (2021b); International Country Risk Guide (ICRG); World Bank.

Note: EMDEs = emerging market and developing economies; LICs = low-income countries.

A. Bars show group medians of the IMF (2021b) public infrastructure efficiency index. The index is based on data envelopment analysis (see table A3.2.3). Sample includes 27 advanced economies and 93 EMDEs, of which 15 are LICs.

B. Group medians of the Dabla-Norris et al. (2012) public investment management index. Sample includes 69 EMDEs, of which 16 are LICs.

C.D. Bars show group medians of institutional quality index values. The indexes are International Country Risk Guide's Control of Corruption and Law and Order. Sample includes 36 advanced economies and 97 EMDEs, of which 17 are LICs.

Public investment project management frameworks

Improvements in public investment project management frameworks can enhance the efficiency of public investment and avoid cost overruns, which are common in large projects. For instance, in a study of 258 transportation projects, Flyvbjerg et al. (2004) showed that costs were initially underestimated in nine out of ten cases.

[25] Public investment management frameworks developed by the World Bank and the IMF provide a taxonomy of essential policy elements to effective public investment management process (IMF 2018; Kim, Fallov, and Groom 2020; Rajaram et al. 2014).

International organizations have developed a range of frameworks to strengthen public investment management. For instance, the World Bank's public investment management framework helps countries assess the strengths and weaknesses of their public investment practices through eight features: guidance, appraisal, independent review, selection, implementation, adjustment, operation, and evaluation (Rajaram et al. 2014). Similarly, the IMF's Public Investment Management Assessment framework allows for a diagnostic assessment of the efficiency of the government procedures to provide infrastructure assets and identify shortcomings and reform priorities (IMF 2018). This framework also envisions a detailed list of key practices comprising planning, allocation, and implementation of projects, along with cross-cutting enabling factors.

Allocation. Effective public investment planning requires consolidated public investment programs aligned with long-run strategic economic priorities. A transparent, open, and well-monitored procurement process can help keep investment costs under control.

Implementation. Effective implementation of public investment projects requires full and timely financing, monitoring, and operational management processes. Risk management systems are also important and should include contingency planning for economic, design, technological, environmental, and other risk factors (Kim, Fallov, and Groom 2020). Digital innovations can improve spending efficiency, transparency, accountability, and public finance management more broadly (Amaglobeli et al. 2023; Gupta et al. 2017). The benefits of digitization in public investment management are already evident in many EMDEs. For example, in Honduras and Thailand, the use of digital technology has improved transparency and accountability in public infrastructure investments (World Bank 2020).

Maintenance, monitoring, and evaluation. Proper maintenance, and careful monitoring and evaluation are essential to improve the efficiency of public investment projects. Governments should include sufficient funds in medium-term budgets to ensure that public assets put in place are appropriately operated and maintained. This lengthens the life of these assets and thus the quality of the services provided. Moreover, transparent and systematic monitoring of projects, and evaluation of project implementation, can improve the assessment of the benefits and costs of public investment, for example, help to identify the reasons for cost overruns, the social and economic benefits derived from the project. This is particularly important for countries with less experience implementing large-scale investment projects, and when the projects are financed through external borrowing (World Bank 2021).

Public-private partnerships

Public-private partnerships (PPPs) can be important in enabling governments to gain greater efficiency by leveraging private sector resources. Besides directly crowding in private capital, in principle PPPs can help governments share project risks and delegate project operations to the private sector, which may be more efficient from a commercial standpoint. For example, private sector investment in infrastructure, or private participation in infrastructure (PPI), may lead to better spending efficiency if innovations at the design and construction stage underpin lower maintenance and operation costs. Moreover, charging fees for use of services can help depoliticize public service delivery and thus improve public perception. For example, paying tolls for the use of a road that is clearly well-maintained may be perceived as more transparent than paying the equivalent tax.

PPI has been increasing throughout the 1990s and 2000s in EMDEs, with more than 300 projects ongoing every year and an annual investment value of almost two percent of GDP, on average (figure 3.8.A). However, PPI declined significantly in the past decade. The number of PPI projects dropped by almost two-thirds. PPI engagement is especially low in LICs with just a handful of projects operating across these countries in any given year (figure 3.8.B).

Despite substantial efforts in many EMDEs to set up appropriate institutional structures to attract PPI, the evidence on the effective savings from PPI has been mixed (Fabre and Straub 2023). PPP

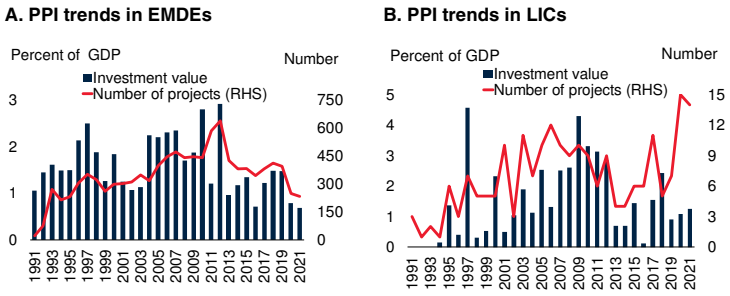
agreements sometimes end up costing society more than the benefits they produce, as these come most of the time with either explicit or implicit guarantees, funded by the government. This can lead to future public liabilities, which can be especially problematic when they are not explicitly accounted for in public budget (Herrera et al. 2023). Moreover, by letting private investors take on the projects, the public sector can sometimes forego the benefits associated with the stream of operational revenues (Engel, Fischer, and Galetovic 2013 and 2014; Fabre and Straub 2023).

The complexity and long-term nature of projects involving the private sector often leads to demands for renegotiation. This can significantly raise costs over the life of the project. Governments are often less able to renegotiate a favorable contract, reflecting the limited choice of private sector partners in EMDEs willing and able to develop bankable projects. For example, a series of renegotiations of transport PPI in some EMDEs led to taxpayers essentially bailing out firms for a significant share of highway construction costs (Moore, Straub, and Dethier 2014).

Even if intentions and agreements on both sides are aligned, getting the contract terms right to account for all risks can be daunting for the private sector partner. Infrastructure investments can involve sizeable sunk costs, making managing risk and uncertainty one of the most important factors in attracting private financing. Elevated global uncertainty over the last decade has undermined the appetite of the private sector to invest in infrastructure. Many types of risks could hamper the flow of investment financing and implementation, including project-specific risks, as well as regulatory risks (Bonaglia et al. 2015). While the private sector seeks a return on investment, governments find themselves caught between cost recovery and affordability. Therefore, if the affordability of the service is a priority, governments would need to subsidize the gap to ensure it is attractive to private investors. This may imply trade-offs regarding coverage which could make the project less advantageous from a development perspective (Fay, Martimort, and Straub 2019a).

FIGURE 3.8 Private sector participation in infrastructure

PPI has been increasing throughout the 1990s and 2000s, with more than 300 projects ongoing every year and an annual investment value of almost two percent of GDP, on average. However, PPI declined significantly in the past decade. The number of PPI projects dropped by almost two-thirds. PPI engagement is especially low in LICs with just a handful of projects operating across these countries in any given year.



Sources: International Monetary Fund; World Bank (PPI Database).
Note: EMDEs = emerging market and developing economics; LICs = low-income countries; PPI = private participation in infrastructure. Sample includes up to 128 EMDEs, of which 24 are LICs. Bars show average values of PPI investment in percent of GDP. Lines show the total number of PPI projects in a given year.

Nonetheless, private sector participation can come in different forms. With new technologies that create network externalities, many services that used to be traditionally funded or provided through public investment can now be provided by the private sector (such as information and communication technology, digital, finance, and sections of the energy supply chain). These are areas in which public intervention in the form of appropriately designed regulation can correct various market failures such as the ones mentioned above, with the risks and rewards borne by the private sector. In this way, public involvement can ensure that outcomes are aligned with social welfare criteria, even when investment is undertaken by private entities.

More generally, policy interventions to promote macroeconomic stability, strengthen banking sector regulation and supervision, improve the legal and contractual environment to protect the rights of creditors and borrowers, and enhance project de-risking can all help bolster private sector participation in development. Besides PPPs, certain types of public infrastructure can be acquired by institutional investors, which could generate additional financing for the government

and might facilitate the efficiency of operation and maintenance.

Given that EMDEs often have relatively weak domestic private sectors, attracting foreign financing, particularly greenfield investment, can increase competition in domestic markets and raise efficiency. Besides providing private capital, foreign investors can help improve efficiency through technology spillovers and competitive business management practices, and can facilitate integration into global production networks. However, positive spillovers from foreign direct investment to the domestic economy tend to depend on the quality of the regulatory environment, skills endowment, and absorptive capacity (Farole and Winkler 2014). Domestic investor partners are also important because they contribute local know-how, so policy makers could encourage programs that link domestic firms with foreign firms.

Enhanced global support

Many EMDEs, especially LICs, have deep structural challenges and limited fiscal space. Without external support, they may not be able to embark on significant public investment. Considering their large investment needs in an environment of sustained growth slowdowns and growing challenges (including the need to address climate change and deliver the SDGs), there is an urgent need for enhanced support from the global community to accelerate structural policy interventions and improve their investment prospects (see Chrimes et al. 2024; G20-IEG 2024).

The international community, including multilateral organizations, can play a critical steering role in facilitating globally coordinated policies to mobilize resources toward urgent public investment in EMDEs and ensure their effective use. Of particular importance is financial support to fund those priority public investment projects that have the greatest potential to mobilize private investment, facilitate equitable access to critical public infrastructure, address climate change mitigation and adaptation needs, facilitate the green transition, and boost long-run productivity through human capital development.

International organizations have also developed a range of frameworks to help strengthen public investment management. In addition to the World Bank's public investment management framework (Rajaram et al. 2024) and the IMF's Public Investment Management Assessment framework (IMF 2018), other initiatives have been utilized: the IMF-World Bank Public-Private Partnership Fiscal Risk Assessment Model, which assesses the fiscal costs and risks of PPPs, and the framework for better infrastructure governance by the Organisation for Economic Co-operation and Development (OECD 2017). Policy advice and capacity development across the public investment management process could increase efficiency and improve borrowing capacity.

For countries with limited fiscal space and restrained access to financial markets, including highly vulnerable small states and countries facing fragility and conflict, official development assistance in the form of grants or concessional lending may be the only feasible source of continued funding. International organizations could help unlock financing for the riskier phase of greenfield investment projects (Arezki and Sy 2016). They can also provide essential expertise in project preparation to EMDEs, thus helping to solve the often-cited problem of lack of capacity to prepare a pipeline of bankable projects (Arezki et al. 2017).

Besides stepping up financial aid to countries in need, the international community should also actively push ahead with the debt restructuring and relief processes to adapt to the changing sovereign debt landscape given the increasing number of creditors and growing complexity of debt instruments (World Bank 2024).

Conclusion

Significant investment is necessary for EMDEs to address structural challenges, including to tackle climate change and make progress toward achieving SDGs. This requires redoubled policy efforts to mobilize both public and private resources. Empirical analysis in this chapter suggests that raising public investment can help trigger a virtuous cycle of development via positive

supply-side and demand-side effects: crowding in private investment, enhancing productivity, and boosting economic growth.

However, the effectiveness of public investment hinges on whether it is efficient and whether there is adequate fiscal space. If a government has room to spend without jeopardizing its fiscal sustainability, and public investment projects are selected and implemented well, EMDEs can raise output by up to 1.6 percent in the medium term for every one percent of GDP increase in public investment. The estimates in the chapter consider the direct effect on output from public investment. However, public investment can also provide other benefits that are difficult to quantify, for example ensuring equitable access to essential public goods and services, as well as improving quality of life.

Proactive support from the global community could help jump-start virtuous development cycles in EMDEs, particularly those that are fiscally constrained and have weak public spending efficiency. High debt levels in EMDEs in the wake of the COVID-19 pandemic compound the challenges for these countries in advancing reforms and boosting productive investment (World Bank 2022). This strengthens the case for timely and substantive support from the global community.

While reforms need to be tailored to specific country circumstances and aligned with their long-term development strategies, three overarching policy priorities are critical for EMDEs—the package of "Three Es": expansion of fiscal space, efficiency of public investment, and enhanced global support.

Expansion of fiscal space. Given limited capacity for revenue mobilization and reallocation of public resources toward public investment, policy makers in EMDEs need to undertake reforms to improve tax collection efficiency, enhance fiscal frameworks, and prioritize public spending with an eye on productive public investment projects.

Efficiency of public investment. EMDEs should enhance the efficiency of public investment—maximize the quality and quantity of productive public capital that each dollar of public investment yields. This requires reforms to tackle corruption and poor governance, and to improve public investment project management frameworks. Project selection should focus on advancing those investments which have the greatest potential to mobilize private investment, spark productivity gains, and facilitate green transition—in particular, health, education, digital networks, and renewable energy infrastructure projects.

Enhanced global support. Many EMDEs with limited fiscal space and deep structural issues, especially LICs, may not be able to finance beneficial large-scale public investment projects and implement the wide range of necessary reforms to improve the efficiency of public investment without additional help. With investment gaps particularly large in such countries, enhanced financial support and technical assistance from the global community are essential. The findings of this chapter underscore the importance of reforms to strengthen public investment management frameworks and improve institutions. Financial support may therefore be most effective if it helps improve the fiscal sustainability of the recipient country and the efficiency of its public investment.

Increasing investment in EMDEs is a crucial component of delivering strong, sustainable growth in these countries. Yet despite large investment gaps, investment growth has been weakening. Public investment has an important role to play, in its own right as well as to help catalyze private sector investment. Creating the conditions for effective and efficient public investment should therefore be a priority both for domestic policy makers and for the international community.

BOX 3.1 Public investment dynamics around adverse events

Public investment growth tends to decline sharply during recession years—by about 9 percentage points relative to periods of economic stability, on average, and remains subdued for an additional two years after the initial shock. Public investment also generally contracts after financial crises hit. These effects reflect the diversion of fiscal resources toward immediate stabilization needs, disruptions in financial markets and higher borrowing costs, lower fiscal revenues following contraction in private sector activity.

Introduction

In emerging market and developing economies (EMDEs), public investment weakened significantly after the 2007-09 global financial crisis and the associated recession. Public investment growth in EMDEs decelerated from an average of 10 percent in the 2000s to 5 percent in the 2010s. More generally, during recessions and crises public investment might be expected to weaken, as fiscal revenues decline and governments may prioritize countercyclical public consumption policies over public investment. However, countries with sufficient fiscal space could in principle embark on additional scaling up of public investment as part of a countercyclical fiscal support package. Similarly, natural disasters may damage or destroy infrastructure such as roads and bridges, requiring public investment to rebuild it.

In order to find commonalities in the dynamics of public investment around potentially disruptive events, this box addresses the following question: How does public investment growth evolve around shock events—specifically, recessions, financial crises, and natural disasters?

To this end, this box examines the trajectory of public investment growth around these adverse episodes—during the event and across three-year windows either side of it. The analysis is based on a sample of 117 EMDEs over 1970-2019. Only countries with sufficient data in the windows around events are included in the sample for each event study. The data for public investment growth are from the International Monetary Fund's Investment and Capital Stock Dataset (IMF 2021a). Recession years are defined as years with negative real per capita income growth. Natural disasters data are from the EM-DAT the International Disaster Database. The data for financial crises, including systemic banking crises, debt crises, and currency crises, are from the Systemic Banking Crises Database II (Laeven and Valencia 2020). The mean response for the sample is shown along with the 90-percent confidence bands (figure B3.1.1).

Recessions

During a recession, the adverse macroeconomic effects exerting a downward pressure on investment in general might be partly offset by a boost in government spending, including public investment, in an effort to provide fiscal stimulus to the economy, particularly given that the empirical evidence points at larger output effects of public investment during recessions than expansions. That said, the event study analysis suggests that on average, recessions have an adverse impact on public investment growth, with effects lasting well beyond the shock episode itself. Public investment contracts by 4 percent on average in a recession year—a decline of about 9 percentage points relative to public investment growth in the year before a recession (figure B3.1.1.A). Public investment growth remains lower for two more years after the initial shock. Recessions triggered by financial crises are associated with deeper negative effects, with public investment contracting by about 6 percent in the year of the recession.

Government revenues in recessions decline as a result of lower economic activity. At the same time, during economic downturns, EMDEs often choose to prioritize immediate needs such as macroeconomic stabilization, unemployment relief, and support to firms and households. These measures take precedence over public investment projects. The combination of lower revenue and increased spending often leads to deterioration of fiscal space in the aftermath of recessions, constraining the government's ability to invest in infrastructure.

Financial crises

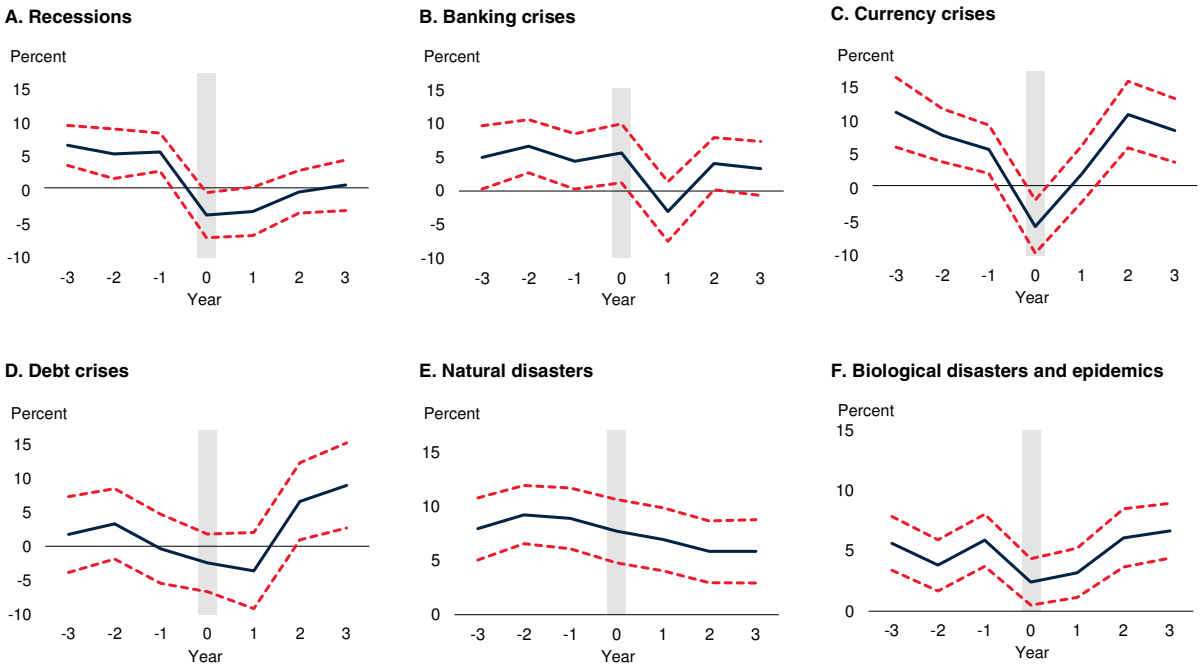
Systemic banking, currency, and debt crises have an adverse impact on public investment growth and are generally followed by quicker public investment

Note: The analysis in this box draws from Adarov et al. (forthcoming).

BOX 3.1 Public investment dynamics around adverse events (*continued*)

FIGURE B3.1.1 Public investment dynamics around adverse events

In recessions, public investment contracts by about 4 percent and remains subdued for additional two years after the initial shock. Currency crises are also associated with a decline of about 6 percent in public investment during the crisis year, while debt and banking crises tend to have the largest impact in the year that follows the crisis—with public investment contracting by 3.5 and 3 percent, respectively. There are no statistically significant changes in public investment growth associated with natural disasters.



Sources: EM-DAT (database); Investment and Capital Stock Dataset (IMF 2021a); Laeven and Valencia (2020); World Bank.
Note: Public investment refers to general government gross fixed capital formation in billions of constant 2017 international dollars. Sample includes 117 EMDEs over the period 1970-2019. Gray areas indicate the event year. Solid lines indicate mean public investment growth, dashed lines indicate 90 percent confidence bands.

recoveries relative to recessions (figures B3.1.1.B-D). Debt and banking crises have the deepest adverse effect in the year that follows the initial shock, with public investment contracting by 3.5 and 3 percent, respectively. Public investment growth declines in the run-up to a debt crisis itself, as markets respond to the deteriorating fiscal position before the crisis actually crystallizes. On average, public investment growth remains in negative territory in the year following a debt crisis—unlike systemic banking crises and currency crises (figure B3.1.1.D).

Like in recessions, governments during financial crises may prioritize short-term measures aimed at macroeconomic stabilization rather than long-term infrastructure investment spending. Furthermore, financial crises can disrupt credit markets, making it more challenging and expensive for governments to borrow, leading to a decline in government investment (Laeven and Valencia 2018; Reinhart and Rogoff 2011).

Currency crises are associated with a sharper drop in public investment than other types of financial crises—a 6 percent contraction on average in the year of the shock. Currency crises, in addition to the adverse effects discussed above, can also lead to a reduction in external financing, as international lenders become concerned about repayment risk demanding higher risk premiums. Currency crises may also increase the cost of imported goods and services needed for public investment projects, making them more expensive to undertake.

BOX 3.1 Public investment dynamics around adverse events (*continued*)

That said, currency and banking crises are associated with faster recoveries of public investment growth, compared with more entrenched adverse effects associated with recessions and debt distress episodes. The latter have more direct and profound adverse effects on the fiscal positions, necessitating cuts or delays in discretionary government spending—including sizable public investment projects—during the shock episodes, as well as lasting impact on the sovereign's creditworthiness, which affects the ability of the government to tap financial markets in the longer run.

Natural disasters

Analysis of the evolution of investment around natural disasters incorporates the years in which geophysical, climatological, and biological disasters (including epidemics) occurred. Whether considering each event type separately, or on aggregate, there are no statistically significant changes in public investment growth (figure B3.1.1.E). Two opposing forces at work might explain this result: while disasters cause physical damage to infrastructure and have a negative impact on public investment, the affected economy may also invest more to recover from the consequences of the disaster. Only in the case of biological disasters does public investment register a slowdown in growth—perhaps as budget resources are diverted to spending on health-related public services and relief to the affected populations—but even this effect is not statistically significant (figure B3.1.1.F).

Conclusion

Negative macroeconomic shocks tend to have adverse effects on the fiscal positions of EMDEs, including expenditure patterns. This translates to lower public investment growth. During recessions, public investment tends to contract, remaining low for an additional two years after the initial shock. In response to systemic banking crises, currency, and debt crises, public investment growth also declines. Although decelerations during currency crises are more severe, investment reductions during debt crises are typically more prolonged, extending up to two years. Thus, while empirical evidence supports the conjecture that scaling up of public investment tends to generate greater output effects in recessions, in practice EMDEs find it challenging to prioritize public investment owing to limited borrowing capacity and restrained fiscal revenues during periods of macroeconomic distress.

BOX 3.2 Macroeconomic impacts of public investment: A literature review

Public investment is viewed by some policy makers as a powerful policy tool that can help promote economic growth. However, empirical evidence on the impact of public investment on growth is mixed. The empirical work to date suggests that the impact of public investment on growth tends to be greater in countries with better government spending efficiency, larger fiscal space, greater trade openness, lower economic informality, greater financial and economic development, as well as during recessions and periods of elevated uncertainty.

Introduction

Public investment is often viewed as one of the important policy tools that can accelerate growth, as well as address pressing infrastructure needs. At the same time, sceptics argue that public spending in general is inefficient, especially in emerging market and developing economies (EMDEs) with greater institutional challenges, and public investment therefore is wasteful. The literature on the subject matter has been rapidly evolving, and the evidence presented to date is rather sporadic with the size of the public investment multipliers—the change in output in response to a unit-increase in public investment—varying significantly across studies. This box synthesizes the growing literature on the topic and explores the following questions:

- What are the implications of public investment for output growth?
- What factors and country characteristics influence the impact of public investment on growth?

Theoretical foundations

The early literature examined the effects of government investment on economic growth in the context of the endogenous growth model, in which public capital enters the production function as one of the productive inputs (Aschauer 1989a,b; Barro 1990; Barro and Sala-i-Martin 1992; Futagami, Morita, and Shibata 1993; Glomm and Ravikumar 1994; Turnovsky 1997). Subsequent studies built on this framework, incorporating features such as aid-funded public investment, infrastructure networks, and public debt accumulation to facilitate a more nuanced analysis of the transmission channels of public investment to growth (Adam and Bevan 2006; Berg et al. 2010; Chatterjee and Turnovsky 2007; Agenor 2010; Berg et al. 2012). More recently, Chakraborty and Dabla-Norris (2011) studied the quality of public investment and distortionary effects of corruption within a general equilibrium growth model.

Empirical estimates of public investment multipliers

While the empirical work on total public spending multiplier across a broad range of countries is voluminous, the subset of the literature that distinguishes public investment multipliers is limited and primarily focuses on advanced economies. In general, there is an emerging consensus that public investment tends to have a positive growth impact in the medium term (Auerbach and Gorodnichenko 2013; Eden and Kraay 2014; Furceri and Li 2017; Izquierdo et al. 2019; Ilzetzki, Mendoza, and Végh 2013; Leduc and Wilson 2012). However, there remains considerable variation in the estimates of output elasticity to public investment; in a meta-analysis of 68 studies, Bom and Ligthart (2014b), report that the range is -1.7 to 2.0. In reviews of the literature, Gechert and Rannenberg (2018) and Vagliasindi and Gorgulu (2021) also report that public investment multiplier estimates range widely with an average of about 1.5. Table B3.2.1 provides a comprehensive review of public investment multipliers in the literature over the past two decades.

Empirical work focusing on EMDEs has been especially scarce, given data constraints and methodological challenges in identifying public investment shocks (see annex 3.1 for a discussion of existing identification frameworks). Nevertheless, limited research on EMDEs also documents important growth impacts of public investment. For instance, Miyamoto et al. (2020) report an increase in output by 0.4 percent over four years for a sample of 39 EMDEs. Ilzetzki, Mendoza, and Végh (2013) estimate a public investment multiplier of 0.6 on impact, increasing to 1.6 in the longer run, for a panel of 24 developing countries. Furceri and Li (2017) report smaller magnitudes for a sample of 79 EMDEs: a 10-percent increase in public investment induces

BOX 3.2 Macroeconomic impacts of public investment: A literature review *(continued)*

growth of 0.4 percent over four years. Smaller effects are reported in Warner (2014) using a sample of 124 EMDEs: a change in public investment equivalent to one percent of GDP is found to spur only meagre output growth in the short run (0.1 percent) with no significant effect in the long run. The observed wide range of estimates of multipliers has prompted additional inquiry into the factors that may explain these differences.

Factors affecting the size of public investment multipliers

Macroeconomic conditions. In a synthesis review, Izquierdo et al. (2019) note that a position of economy in the business cycle, the degree of exchange rate flexibility, debt levels, and the monetary policy stance are important determinants of the size of multipliers. In this regard, the literature indicates that multipliers tend to be larger during recessions (Auerbach and Gorodnichenko 2012 and 2013; Honda et al. 2020; Riera-Crichton, Vegh, and Vuletin 2015). Ramey (2019) notes that these results may not be fully robust given their sensitivity to the sample composition and the methodology. Further, the output effects tend to be larger in supply-driven recessions compared with those in demand-driven recessions (Ghassibe and Zanetti 2022). The multipliers are found to be larger during periods of monetary policy easing and elevated macroeconomic uncertainty, particularly, when nominal interest rates are at very low levels and reach the "zero lower bound" (Christiano, Eichenbaum, and Rebelo 2011; Gbohoui 2021).

Country structural characteristics. Multipliers tend to be greater in countries with a fixed exchange rate regime, low levels of debt, greater trade openness, and lower economic informality (Colombo et al. 2022; Honda, Miyamoto, and Taniguchi 2020; Huidrom et al. 2020; Ilzetzki, Mendoza, and Végh 2013). Financial development and economic development are also positively associated with the size of spending multipliers (Ilzetzki, Mendoza, and Végh 2013; Koh 2017).

Initial stock of public capital. Public investment multipliers are greater in countries with a lower level of initial public capital stock (Izquierdo et al. 2019). Excessive levels of public capital stock and investment may be detrimental for growth if resources are diverted away from more productive uses or crowd out private investment (Canning and Pedroni 2008; Devarajan, Swaroop, and Zou 1996). Contrary to these studies, Honda, Miyamoto, and Taniguchi (2020) find that, in a sample of low-income countries (LICs), output effects of public investment are greater in economies with higher initial capital stock, and conjecture that in LICs the private sector may not be responsive to fiscal policy shocks when initial capital stock is too low.

Public investment efficiency. The quality of the public investment management process is important to reap the positive macroeconomic effects of public capital. The public investment management process encompasses multiple aspects, including project development, implementation, monitoring, and evaluation (Dabla-Norris et al. 2012). Gupta et al. (2014) compute "efficiency adjusted" public capital stocks and find that the growth effects of efficient public investment are higher. Positive impacts of higher efficiency of public investment are also documented in other empirical studies (Berg, Portillo, and Yang 2013; Cavallo and Daude 2011; Furceri and Li 2017; Izquierdo et al. 2018; Leduc and Wilson 2012; Leeper, Walker, and Yang 2010; Miyamoto et al. 2020).

Conclusion

The literature is generally in agreement that public investment tends to have positive impacts on economic growth, particularly in the longer run. The wide dispersion of the estimated magnitudes of public investment multipliers, however, motivated research that sought to reconcile the heterogeneity. Findings suggest that country-level characteristics—including public investment efficiency, debt levels, capital scarcity—and prevailing macroeconomic conditions at the time of public investment shocks impact the size of the multiplier. Methodological and sample differences may also explain some variation in results across studies. That said, the evidence on the impact of public investment on output in EMDEs is limited to date, owing in large part to associated data constraints. This important topic warrants further research to better inform the policies to stimulate economic growth and mobilize private investment.

BOX 3.2 Macroeconomic impacts of public investment: A literature review (*continued*)

TABLE B3.2.1 Output effects of public investment: Summary of the literature

Study	Public investment multiplier	Sample	Methodology	Notes
Abiad et al. (2016)	0.4 (year 0) – 1.4 (year 4)	17 OECD economies; 1985-2013	Local projections with forecast error shocks	Output growth in response to a one percent of GDP increase in public investment. Larger multipliers in low-growth episodes and in countries with high spending efficiency.
Auerbach and Gorodnichenko (2012)	2.12 (peak response over 20 quarters)	the United States; 1947-2008	SVAR with forecast error shocks	Cumulative output effect in dollars in response to a one dollar increase in public investment. Larger multipliers in recessions that in expansion.
Barry et al. (2018)	0.16 (quarter 1) – 1.10 (quarter 12)	Cameroon; 1999-2015	SVAR with Blanchard and Perotti (2002) identification	Cumulative change in output in percent, in response to a one percent increase in public investment. Statistically insignificant for most of the forecast horizon and in the longer run.
Bom and Ligthart (2014b)	0.08 (short run) – 0.12 (long run)	68 studies over 1983-2008	Meta-regression analysis	Meta-regression estimates of output elasticity of public capital based on studies utilizing a production-function approach. Impact on output growth in response to a one percent increase in public capital.
David (2017)	0.1 (quarter 0) – 2.1 (quarter 20)	Paraguay; 1998-2015	SVAR with Blanchard and Perotti (2002) identification	Output growth in percent, in response to a 1 percent increase in public investment. Larger multipliers for public investment than for public consumption.
Deleidi et al. (2020)	[0.9 – 1.2] in year 0; [1.9 – 3.4] in year 6	11 euro area countries; 1970-2016	Local projections	Output growth in response to a one percent increase in public investment. Smaller multipliers in the pre-2007 period. The ranges of individual country estimates are in parentheses.
Demetriades and Mamuneas (2000)	[0.36 – 2.06] in the short run; [0.36 – 1.97] in the long run	12 OECD countries; 1972-91	Simultaneous equations system	Output elasticities. Impact on output of a one percent increase in public capital. The ranges of individual country estimates are in parentheses.
Eden and Kraay (2014)	1.5 (year 1)	39 low-income countries (IDA borrowers)	2SLS with Kraay (2012) identification	Output increase in dollars in response to a one dollar increase in public investment. Lower multiplier using OLS estimation (0.2).
Elkhdari et al. (2018)	0.3 (year 1) – 1.2 (year 5) 0.5 (year 1) – 1.8 (year 5)	Algeria; 2008-15 9 MNA countries; 2000-15	SVAR with Blanchard and Perotti (2002) identification; location projections	Output growth in response to a one percent increase in capital expenditures. Larger multipliers during periods with negative output gaps.
Espinoza and Senhadji (2011)	0.2-0.3 in the short term; 0.6-1.1 in the long term	Gulf Cooperation Council countries; 1975-2009	Panel models	Output growth in response to a 15 percent increase in capital expenditures. Larger multipliers for public investment than for public consumption.
Furceri and Li (2017)	0.2 (year 1) – 0.4 (year 4)	79 EMDEs; 1990-2013	Local projections with forecast error shocks	Output growth in response to a 10 percent increase in public investment. Larger multipliers during economic slack, in closed economies, in countries with fixed exchange rates, lower public debt, and higher investment efficiency.
Gbohoui (2021)	0.55 (year 0) – 0.07 (year 2) 0.22 (year 0) – 0.56 (year 2)	Advanced economies; 1996-2019 EMDEs; 1990-2019	Local projections with forecast error shocks	Output growth in response to a one percent of GDP increase in public investment. Larger multipliers during heightened uncertainty.
Gechert and Rannenberg (2018)	0.6	98 empirical studies	Meta-regression analysis	Output growth in response to a one percent of GDP increase in public investment. Larger multipliers during economic downturns.
Gonzales-Garcia et al. (2013)	0.12 (year 0) – 0.44 (after 4 years)	Eastern Caribbean Currency Union; 1994-2009	SVAR with Blanchard and Perotti (2002) identification	Cumulative output growth in response to a one percent of GDP increase in public investment. Larger multipliers for public investment than for public consumption (the latter are not statistically significant).

BOX 3.2 Macroeconomic impacts of public investment: A literature review (*continued*)

TABLE B3.2.1 Output effects of public investment: Summary of the literature

Study	Public investment multiplier	Sample	Methodology	Notes
Honda et al. (2020)	0.1 (year 1) – 0.2 (year 2)	42 low-income countries; 1995-2017	Local projections with forecast error shocks	Output growth in response to a one percent of GDP increase in public investment. Larger multipliers in recessions, under a fixed exchange rate regime, in countries with better institutions.
Ilzetzki et al. (2013)	0.4 (quarter 0) – 1.5 (quarter 20) 0.6 (quarter 0) – 1.6 (quarter 20)	High income countries; 1985-2013 Developing countries; 1985-2013	SVAR with Blanchard and Perotti (2002) identification	Cumulative output multipliers (ratio of cumulative increase in output and cumulative increase in public investment). Larger multipliers in countries with fixed exchange rates, closed economies, countries with low debt (not stat. significant in high-debt countries).
IMF (2014)	0.4 (year 0) – 1.5 (year 4)	Advanced economies; 1985-2013	Local projections with forecast error shocks	Output response to a one percent of GDP increase in public investment. Larger multipliers during low growth and in countries with higher spending efficiency.
	(1) 0.3 in year 0 – 0.5 in year 4; (2) 0.5 in year 0 – 0.9 in year 4	Developing economies; 1990-2013	Local projections with shocks based on Corsetti et al. (2013) and Kraay (2012)	Output response to a one percent of GDP increase in public investment. Shock identification: (1) Corsetti et al. (2013) approach based on fiscal rules; (2) Kraay (2012) methodology based on official development assistance.
Izquierdo et al. (2019)	0.2 – 1.4 after two years	31 European countries; U.S. states; Argentine provinces	Local projections with Blanchard and Perotti (2002), forecast error, and IV identification	Output growth in response to a one percent increase in public investment. Larger multipliers in countries with low public capital stock; statistically insignificant multipliers in countries with low spending efficiency.
Jong-A-Pin and de Haan (2008)	Ranging from about -2.5 to 2.5	21 OECD countries; 1960-2001	VAR	Output elasticity of public capital at the horizon of 20 years. Output growth in response to a one percent increase in public capital.
Minea and Mustea (2015)	0.53 (year 1) – 1.18 (year 10)	Mediterranean countries; 1980-2012	PVAR	Cumulative output growth in response to a one percent increase in public investment. Heterogeneous multipliers across country groups within the sample: larger in Asian, smaller in African countries.
Miyamoto et al. (2020)	0.2 (year 0) – 1.2 (year 4) 0.2 (year 0) – 0.5 (year 4)	17 advanced economies 39 EMDEs	Local projections with forecast error shocks	Output growth in response to a one percent of GDP increase in public investment. Statistically insignificant in low-income countries. Larger multipliers in countries with better governance.
Petrovic et al. (2021)	0.7 – 0.8 (after one year)	10 Central and Eastern European countries	Local projections and SVAR with Blanchard and Perotti (2002) identification	Cumulative output growth in percent in response to a one percent increase in public investment. Larger multipliers in low-growth periods.
Puig (2014)	1.03 over two years	Argentina; 1993-2012	SVAR	Increase in output in dollars in response to a one dollar increase in public investment. Greater impact of public investment than public consumption.
Rafiq and Zeufack (2012)	2.7 in recessions; 2.0 in expansions (year 1)	Malaysia; 1981-2004	SVAR with Blanchard and Perotti (2002) identification	Output growth in response to a one percent increase in public investment. Greater impact of public investment than public consumption.
Warner (2014)	0.14 (year 0)	124 EMDEs; 1960-2011	OLS	Output per capita growth in response to a one percent increase in public investment. Insignificant impact in the long run.

Source: World Bank.
Note: 2SLS = two-stage least squares; EMDEs = emerging market and developing economies; IDA = International Development Association; IV = instrumental variables approach; MNA = Middle East and North Africa; OECD = Organisation for Economic Co-operation and Development; OLS = ordinary least squares; PVAR = panel vector autoregression; SVAR = structural vector autoregression; VAR = vector autoregression.

ANNEX 3.1 Identification of public investment shocks

This annex provides technical details on the new methodology utilized in this chapter to identify public investment shocks and reviews alternate identification methods adopted in the existing literature.

Review of public spending shock identification frameworks

To gauge the extent to which public spending shocks—including public investment—impact economic growth, it is first necessary to identify changes in public spending that are independent of prevailing macroeconomic conditions.[26] To date, the main methods deployed to tackle this identification challenge are the structural vector autoregression (SVAR) estimation with recursive identification, frameworks relying on instrumental variables, the narrative approach, and identification based on forecast errors.

- *SVAR with recursive identification of public spending shocks.* The relatively prevalent SVAR approach employs recursive identification schemes and other parameter restrictions to pin down unexpected public spending shocks. Specifically, the Cholesky decomposition exploits an assumption that government spending does not respond to macroeconomic shocks in the same period (Blanchard and Perotti 2002). A drawback is that this rationale becomes less compelling at an annual frequency, yet availability of higher frequency data is often constrained, especially for EMDEs.
- *Official lending as an instrument for exogenous public spending.* This approach, pioneered by Kraay (2012, 2014) uses data on official creditor loan disbursements to identify public spending shocks in the recipient country based on the lag between loan approval and subsequent disbursements to isolate a component insulated from contemporaneous macroeconomic developments. However, this framework is only applicable to countries that are recipients of official development assistance and requires the calculation of "predicted" disbursements for each loan.
- *Military spending as an instrument for exogenous public spending.* Building on the "natural experiment" framework proposed by Barro (1981), the narrative approach, developed in Ramey and Shapiro (1998), Ramey (2011a, 2011b), and Ramey and Zubairy (2018), uses fluctuations in governments' military expenditures—assumed to be driven by external geopolitical factors as opposed to domestic macroeconomic conditions—to isolate exogenous changes in public spending. This approach, however, would not work well for EMDEs, in which military spending is typically less prone to fluctuation. More broadly, a pitfall of this method is that the resulting growth responses may be largely attributable to the military spending sub-component as opposed to more general fiscal stimulus.
- *Forecast errors in public spending as a proxy for fiscal shocks.* In more recent empirical research, Auerbach and Gorodnichenko (2012, 2013) use differences between actual public spending and the level predicted by professional forecasters to identify unanticipated public spending shocks.[27] The methodology has the advantage of overcoming the issue of fiscal foresight, whereby, anticipated fiscal policy changes may be incorporated into current economic decisions (Forni and Gambetti 2010; Leeper, Richter, and Walker 2012, 2013). However, this approach relies on the availability and quality of public spending forecast data. Additional caveats relate to the nature of fiscal projections: first, they may not

[26] Failure to do so would obfuscate the "pure" effect of public spending on output, given the bidirectional relationship between economic activity and fiscal policy. For instance, a change in economic growth can affect government spending through fiscal policy responses or the operation of automatic stabilizers. The objective of public spending shock identification methods is to identify a component of government spending that is exogenous with respect to the economic conditions.

[27] This approach was utilized recently in Abiad et al. (2016), Furceri and Li (2017), Honda et al. (2020), and Miyamoto et al. (2020) to estimate unconditional and state-dependent public spending multipliers.

be fully orthogonal to past macroeconomic trends; and second, they rely on subjective, heterogeneous assumptions about future macroeconomic developments.

An approach based on cyclically adjusted public spending

This chapter applies a new approach introduced in Adarov, Clements, and Jalles (forthcoming) to identify public spending shocks, separately for public investment and public consumption. The methodology builds on the work of Alesina and Ardagna (1998, 2010) and related studies that assess the macroeconomic effects of changes in cyclically adjusted fiscal variables. Conceptually, the approach is consistent with the literature arguing that large and apparent scaling up of public investment tends to reflect exogenous decisions by the public authorities (Deleidi, Iafrate, and Levrero 2020; Warner 2014). The shock identification framework for public investment involves four steps:

1. For each country, output elasticities of public investment are estimated by regressing the logarithm of real public investment on the logarithm of real GDP.

2. Measures of potential output, GDP^{pot}, are obtained via a Hodrick-Prescott filter. Alternative filters, including the Baxter-King, Christiano-Fitzgerald, and the Hamilton (2018) filters, are used as a robustness check.

3. Cyclically adjusted real public investment (*CAPI*) is then computed as follows:

$$CAPI = PI\left(\frac{GDP^{pot}}{real\,GDP}\right)^{\varepsilon_{PI}} \quad (3.1.1)$$

where PI is real public investment and ε_{PI} is the output elasticity computed in step 1.

4. For each country i, measures of public investment shocks *(PIS)* are constructed as the variable that takes the value of one when a country's first difference of *CAPI* exceeds its country-specific mean by one standard deviation:

$$PIS = 1\,if\ \Delta CAPI_{it} > \overline{\Delta CAPI_i} + SDCAPI_i, 0\,otherwise \quad (3.1.2)$$

Focusing on country-level public investment adjustments greater than one standard deviation is in the spirit of Alesina and Ardagna (2010), who argue that honing in on large fiscal adjustments helps identification of changes in fiscal variables that are induced by discretionary policy, rather than influenced by the business cycle. Some examples of the episodes identified using this approach include rapid scaling up of public investment in Poland in 2005-06 and 2018, in Brazil in 2007, and Morocco in 2008. In Poland, the episodes followed significant EU fund inflows and reforms as part of its EU integration.[28] In Brazil, the episode followed the launch of the Growth Acceleration Program—a major infrastructure program including investment projects and policies to boost growth. In Morocco, the episode involved major public investment in infrastructure projects, such as the Green Morocco Plan to bolster the agricultural sector and the expansion of the Tanger Med port.

This approach to the identification of public investment shocks has several advantages. Given the focus only on large episodes of public investment increases, the results are more robust to imperfections in measuring the effect of the business cycle on fiscal variables, as small changes in cyclically adjusted public spending are excluded from the estimation. The proposed framework eschews certain limitations of existing identification methods that rely on data that are not publicly available (for instance, methods based on government spending forecast errors) or yield estimates for a limited set of countries (for instance, frameworks relying on narrative shock identification or quarterly-frequency data). As such, identification of disaggregated public spending shocks—public investment and public consumption—can be undertaken for a broad sample of countries with available annual data. The large sample, in turn, facilitates estimation of multipliers conditional on country characteristics.

In contrast to one-size-fits-all approaches, this framework accounts for heterogeneity across countries by considering the magnitude of public spending shocks within country-specific historical contexts. This is an important feature in the

[28] See also World Bank (2024) for a review of associated investment accelerations, and IMF (2023) for a discussion of the role of EU funding for boosting public investment in Poland.

analysis of EMDEs, which may exhibit fiscal procyclicality (commodity exporters) or budgetary process-driven volatility of public spending (LICs).[29] The approach can be expanded to allow for time-varying or state-dependent thresholds.

At the same time, a few caveats should be noted. First, issues related to endogeneity and fiscal foresight may persist, despite focusing on large cyclically adjusted public spending innovations to mitigate business cycle effects. Second, the methodology relies on the measure of potential output, which are generally estimated with a certain degree of imprecision. Third, the measure of public investment shock is a binary variable and does not yield an estimate of a multiplier directly in regression. Rather, the output effects need to be interpreted in the context of the average change in public investment for the effective sample subject to the shock, rescaling to obtain the public investment multiplier values.

ANNEX 3.2 Estimation of public investment multipliers

This annex discusses the methodological framework to estimate the effects of public investment on output and other macroeconomic variables.

Estimation framework for unconditional public investment multipliers

Responses of real GDP to public investment shocks are estimated using the local projections method proposed by Jordà (2005). The method lends itself to the analysis in this chapter, given that fiscal shocks are already orthogonalized and do not need further identification, as would be required for vector autoregression (VAR) models. There are distinct advantages to this approach, which has been endorsed by Auerbach and Gorodnichenko (2012) and Romer and Romer (2019) as a flexible alternative to VAR models.[30]

First, it does not impose dynamic restrictions and obviates the need to estimate the equations for dependent variables other than the variable of interest, thereby economizing on the number of estimated parameters. Second, it is well-suited to estimating nonlinear effects of public investment conditional on country-characteristics (state-dependent multipliers). Third, it is relatively simple to deal with correlation in error terms—a likely complication in cross-country analysis. Against this background, the following baseline specification is estimated:[31]

$$\log(y_{i,t+k}) - \log(y_{i,t-1}) = \alpha_i + \tau_t + \beta_k shock_{i,t} + \theta X_{i,t} + \varepsilon_{i,t} \quad (3.2.1)$$

in which $k = 0,...,5$ is the forecast horizon in years; $\log(y_{i,t+k}) - \log(y_{i,t-1})$ represents the cumulative change in real GDP (in percent) over the forecast horizon; α_i and τ_t are country and time fixed effects to account for time-invariant country heterogeneity and global factors (such as the world business cycle or oil price movements); $X_{i,t}$ is a set of control variables including—as in Abiad, Furceri, and Topalova (2016) and Furceri and Li (2017)—two lags of the shocks and two lags of real GDP growth.[32] To control for outliers, data points above the 99th percentile and below the 1st percentile are dropped in the estimations.

The coefficient β_k denotes the response of output in each period k to a public investment shock at $t = 0$, $shock_{i,t}$, identified using the methodology described in annex 3.1. Specifically, it measures the average cumulative real GDP change in period $t+k$ relative to period $t-1$ (in percent), in response to the public investment shock for the effective sample—the sample of countries used in the estimation. To ease interpretation, the estimated coefficients are scaled by the average change in

[29] See also a related discussion in De Haan and Klomp (2013) and Wiese, Jong-A-Pin, and de Haan (2018).

[30] See Plagborg-Møller and Wolf (2021) for a discussion on the trade-offs between VARs and local projections.

[31] The specification is based on the local projections model widely used in empirical literature on public spending multipliers—for instance, Abiad, Furceri, and Topalova (2015); Furceri and Li (2017); Honda, Miyamoto, and Taniguchi (2020); Miyamoto et al. (2020). A similar approach was also used in other empirical studies examining the impact of policy shocks (for instance, in De Haan and Wiese 2022).

[32] Among other robustness checks—discussed in this annex—the model is also estimated with additional control variables to examine the omitted variable bias, dropping lagged real GDP growth, and using the generalized method of moments estimator to address possible bias arising from the lagged dependent variable.

public investment as a percent of GDP for the effective sample that experienced the public investment shock, so that the impulse responses can be interpreted as the change in output (in percent) in response to a one percent of GDP increase in public investment.[33] The model is estimated for the broadest sample of countries available for robustness (table A3.2.1). For some exercises, however, the sample size is much smaller (for instance, for potential output, productivity estimations, subgroups of EMDEs), and thus the results are not directly comparable and should be interpreted with caution.

Descriptive statistics summarizing average changes in output and public investment during public investment shock episodes are reported in table A3.2.2. Impulse response functions are obtained by plotting the estimated multipliers for k = 0,...,5, with 90 percent confidence bands computed using robust standard errors clustered at the country level.

Estimation framework for state-dependent public investment multipliers

To examine heterogeneity across country groups (for instance, categorized using income levels, commodity exporter status, degree of public investment efficiency) and discrete macroeconomic states (negative and positive economic growth periods), the model is estimated separately for each subsample. State-dependent multipliers, conditional on the values of continuous time-varying variables, are estimated using a local projections framework with a smooth transition function:[34]

$$\log(y_{i,t+k}) - \log(y_{i,t-1}) = \alpha_i + \tau_t + \beta_k^L F(z_{i,t})\,\text{shock}_{i,t} + \beta_k^H [1 - F(z_{i,t})]\,\text{shock}_{i,t} + \theta X_{i,t} + \varepsilon_{i,t} \quad (3.2.2)$$

$$\text{with } F(z_{i,t}) = \frac{\exp(-\gamma z_{i,t})}{1+\exp(-\gamma z_{i,t})}, \gamma > 0$$

in which $z_{i,t}$ is the value of a conditioning variable, normalized to have zero mean and unit variance.[35]

The coefficients β_k^L and β_k^H capture the output impact of public investment shocks at each horizon k for the state characterized by low values of a conditioning variable, $F(z_{i,t}) \approx 1$ when z goes to minus infinity; and the state characterized by high values of a conditioning variable, $1 - F(z_{i,t}) \approx 1$ when z goes to plus infinity.

This approach is equivalent to the smooth transition autoregressive model developed by Granger and Teräsvirta (1993). The advantage of this methodology is twofold. First, it permits a direct test of whether the effect of public investment varies across high and low levels of a given conditioning variable. Second, it allows the effect of public investment shocks to change smoothly between the levels of a conditioning variable by considering a continuum of states to estimate the impulse response functions, thus making the responses more stable and precise. To compute multipliers conditional on the public capital scarcity and fiscal space, equation (3.2.2) is estimated using the following conditioning variables for $F(z_{it})$: (1) Gross government debt as a share of GDP, as a proxy for fiscal space; (2) Public capital stock as a share of GDP, to examine the implications of capital scarcity. Variable definitions are provided in table A3.2.3.

Robustness

A range of robustness checks were carried out, and results were corroborative of baseline findings. These included testing alternatives for public investment shock identification, sensitivity checks to the choice of statistical filters, robustness checks to the sample period, and model specifications (selected results are reported in table A3.2.4):

Sensitivity checks for public spending shock parameterization and statistical filters. Given that the identification of public investment shocks may be sensitive to the choice of the statistical filters or the cut-off level to isolate large changes in public investment, alternative threshold levels and filters were explored, including the Baxter-King, Christiano-Fitzgerald, and Hamilton filters.

[33] It is a standard approach in the empirical literature on spending multipliers to use an ex post conversion using the average public-spending-to-GDP ratio. As argued in Ramey and Zubairy (2016), this may however introduce a bias if the public-spending-to-GDP ratio varies significantly over the sample period.

[34] The same approach was used to estimate state-dependent public spending multipliers in Abiad et al. (2015); Furceri and Li (2017); Honda et al. (2020); Miyamoto et al. (2020).

[35] The weights assigned to each regime vary between 0 and 1 according to the weighting function so that can be interpreted as the probability of being in a given economic state. Following the literature that uses a similar approach, (Abiad et al. 2015 and Furceri and Li 2017), the parameter is set to 1.5, while the results do not change materially when other values are used.

The results are not statistically different from the baseline results. The focus only on large changes in cyclically adjusted public investment also mitigates the imprecision in the estimation of potential output. Using higher threshold levels to identify public investment shocks comes at the cost of lower number of shock episodes, resulting in less precise estimates.

Sensitivity to country fixed effects. A possible bias from estimating the baseline model using country fixed effects stems from the fact that the error term may have a non-zero expected value on account of the interaction between fixed effects and country-specific developments (Teulings and Zubanov 2014). Estimates excluding country fixed effects are similar to the baseline results.

Omitted variables and the choice of estimator. The baseline model was estimated with additional variables, introduced to control for inflation and trade openness. The results indicate no large differences relative to the baseline. As an additional check, the model was estimated dropping the lagged dependent variable. Results are also robust to using generalized method of moments as the estimator. As an alternative, the identified public investment shocks were also used as an instrument for a change in public investment as a share of GDP, in two-stage least squares (2SLS) estimation, yielding very similar results.

Sensitivity to the sample period and the sample composition. In order to examine whether the effects of public investment may have changed in the aftermath of the global financial crisis, the multipliers were estimated also for the pre-2007 period, with the findings confirming the baseline results. As a sensitivity check, the estimations were also carried out using the same common sample of countries across all empirical exercises, however this results in less reliable estimates on account of a much smaller sample, with larger error bands.

TABLE A3.2.1 Sample used in the estimation of public investment multipliers

Emerging market and developing economies (EMDEs)
Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, The Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, Colombia, the Comoros, the Democratic Republic of Congo, the Republic of Congo, Costa Rica, Côte d'Ivoire, Djibouti, Dominica, the Dominican Republic, Ecuador, the Arab Republic of Egypt, El Salvador, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Fiji, Gabon, The Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, the Islamic Republic of Iran, Iraq, Jordan, Kazakhstan, Kenya, Kuwait, Lao PDR, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, North Macedonia, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, the Philippines, Poland, Romania, the Russian Federation, Rwanda, São Tomé and Príncipe, Saudi Arabia, Senegal, Serbia, the Seychelles, Sierra Leone, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, the Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Togo, Tunisia, Uganda, Ukraine, the United Arab Emirates, Uruguay, Uzbekistan, Viet Nam, the Republic of Yemen, Zambia.

Source: World Bank.

TABLE A3.2.2 Summary statistics for public investment shocks

Variable	Value
Number of economies	129
Public investment shock = 1	
Number of observations	557
Mean real GDP growth (percent)	4.48
Mean public investment (percent of GDP)	8.11
Mean change in public-investment-to-GDP ratio (percentage points)	2.68
Public investment shock = 0	
Number of observations	3804
Mean real GDP growth (percent)	3.79
Mean public investment (percent of GDP)	6.76
Mean change in public-investment-to-GDP ratio (percentage points)	-0.43

Source: World Bank.
Note: Summary statistics for the sample of 129 EMDEs used in the estimation of public investment multipliers, differentiating between periods with and without public investment shocks.

TABLE A3.2.3 Definitions of data used and sources

Variable	Definition	Source
Real public investment	General government investment (gross fixed capital formation) in billions of national currency deflated using the GDP deflator	Investment and Capital Stock Dataset (IMF 2021a)
Real private investment	Private investment (gross fixed capital formation), in billions of national currency deflated using the GDP deflator	Investment and Capital Stock Dataset (IMF 2021a)
Real GDP	Gross domestic product, in billions of national currency deflated using the GDP deflator	IMF World Economic Outlook Database
Potential GDP	Index derived from real potential output growth estimated using the production function approach	Potential growth database (Kilic Celik et al. 2023)
Inflation	Growth rate of consumer price index, in percent	IMF World Economic Outlook Database
Labor productivity	Real GDP per average annual hours worked by persons engaged	Penn World Table 10.01
Total factor productivity	Total factor productivity in constant national prices (2017 = 1)	Penn World Table 10.01
Public debt	General government debt, percent of GDP	World Bank's Fiscal Space Database (Kose et al. 2022)
Public infrastructure efficiency index (IMF 2021b)	Public infrastructure efficiency index constructed based on the data envelopment analysis using the volume and quality of infrastructure as output, and public capital stock and per capita GDP as input variables	IMF (2021b)
Public infrastructure efficiency index (Devadas and Pennings 2018)	Infrastructure efficiency index constructed as a weighted average of the quality of electricity, water, and road infrastructure	Devadas and Pennings (2018)
Public investment management index (PIMI)	Index based on country performance scores in public investment project appraisal, selection, implementation, and evaluation	Dabla-Norris et al. (2012)
Public capital stock	General government capital stock, percent of GDP	Investment and Capital Stock Dataset (IMF 2021a)

Source: World Bank.

TABLE A3.2.4 Selected additional results and robustness checks

Model	Public investment multiplier	
	t = 1	*t* = 5
Baseline specification	0.4***	1.1***
IV (2SLS) estimation using public investment shocks to instrument public investment	0.4***	1.0***
GMM estimation	0.5**	0.8**
Dropping country fixed effects	0.4***	1.5***
Dropping lagged real GDP growth variable	0.3**	1.1***
Pre-global financial crisis period only (1980-2007)	0.3*	0.9***
Additional control variables: two lags of inflation and trade-to-GDP ratio	0.4**	1.1***
Alternative fiscal space specification		
Large increase in debt-to-GDP ratio (upper quartile = above 3.7)	0.3	0.7
Large decrease in debt-to-GDP ratio (lower quartile = below -3.2)	0.5*	1.4***
Alternative public investment efficiency measures		
Low efficiency: Dabla-Norris et al. (2012) PIMI below the sample mean	0.1	0.9
High efficiency: Dabla-Norris et al. (2012) PIMI above the sample mean	0.4***	1.2***
Low efficiency: Bottom quartile of Devadas and Pennings (2018) Infrastructure Efficiency index	0.2	0.3
High efficiency: Top quartile of Devadas and Pennings (2018) Infrastructure Efficiency index	0.2*	1.0***
Low efficiency: Bottom quartile of CPIA Public Sector Management and Institutions index	0.3	0.6
High efficiency: Top quartile of CPIA Public Sector Management and Institutions index	0.4**	1.1***

Source: World Bank.
Note: 2SLS = two-stage least squares; CPIA = Country Policy and Institutional Assessment; GMM = generalized method of moments; IV = instrumental variables approach; PIMI = Public Investment Management Index. The table shows responses of real GDP (cumulative change in year *t* relative to year $t = -1$, in percent) to a public investment shock equivalent to one percent of GDP; $t = 0$ is the year of the shock. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent levels, respectively.

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