5. Infrastructure in Latin America and the Caribbean

Inadequate infrastructure has been widely viewed as one of the principal barriers to growth and development in Latin America and the Caribbean (LAC). Despite the fact that the region's infrastructure network has been upgraded over the past decade and is broadly comparable with those in other emerging market economies, infrastructure quality across individual countries often compares poorly with their export rivals and, more importantly, considerable catch-up is still required relative to advanced economies. The improvement in infrastructure quality over the past decade reflected both an increase in public investment, facilitated by the commodity boom, and greenfield investment by the private sector, notably in sectors where regulatory impediments had been alleviated. Deepening domestic capital markets helped finance an increasing fraction of private investment in local currency. For most LAC countries, the efficiency of public investment remains below that achieved by advanced economies, notwithstanding improvements in fiscal institutions. Reasonably sound frameworks for public-private partnerships in some large economies should be replicated by others to crowd-in greater private participation.

In the past several years, many countries in the region have turned their attention to investment in infrastructure to support near-term demand and, more important, bolster the economy's productive capacity. In particular, investment in infrastructure increases the productivity of other factors of production, improves competitiveness, and expands export capacity. Insufficient infrastructure will usually be reflected in bottlenecks and other inefficiencies that create social dissatisfaction and hurdles to investment, which, in turn, will be a drag on current and prospective growth. This chapter explores the state of economic infrastructure and trends in public and private infrastructure investment in Latin America and the Caribbean (LAC) relative to comparable countries in other regions;[1] policies and institutional frameworks that can affect the efficiency or "bang for the buck" in infrastructure investment, as well as crowd-in private participation while minimizing fiscal risks; and the key policy challenges that countries in LAC need to address to bolster the quality of infrastructure.

Note: This chapter was prepared by Valerie Cerra, Alfredo Cuevas, Carlos Góes, Izabela Karpowicz, Troy Matheson, Rania Papageorgiou, Issouf Samake, Kristine Vitola, and Svetlana Vtyurina.

Stock and Quality of Infrastructure: Where Does LAC Stand?

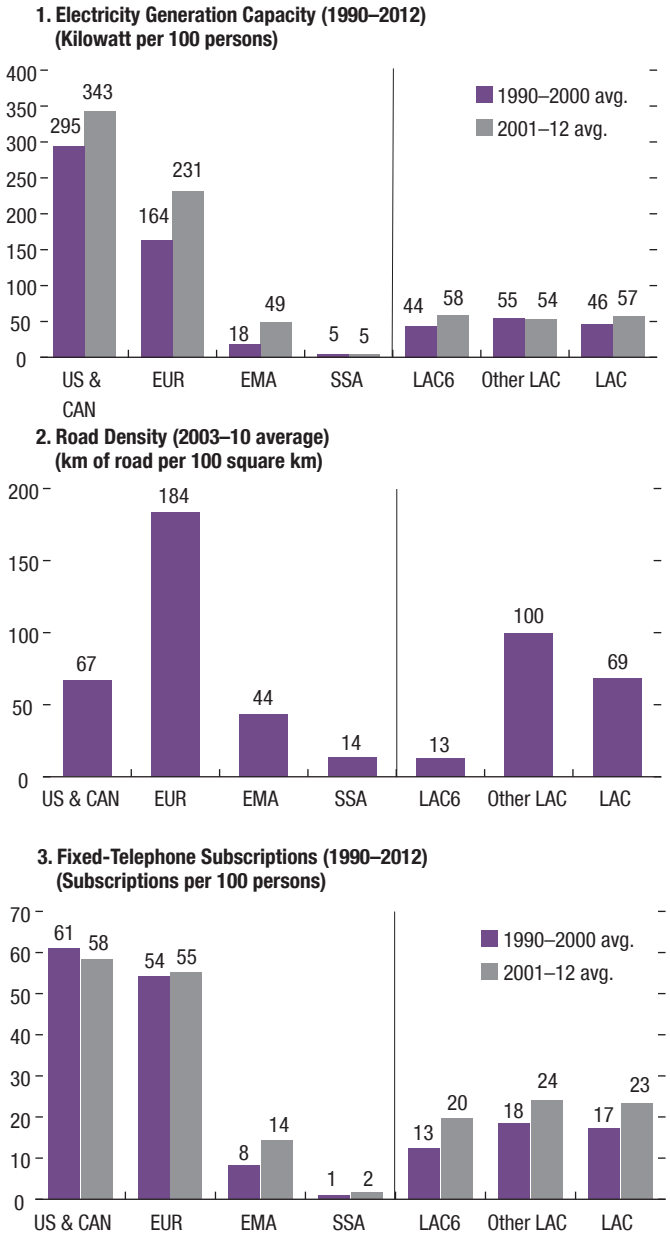
On average, the stock of economic infrastructure—notably power generation capacity, road networks, and telephone lines—in LAC economies compares favorably with that of peers in other emerging market regions, but still lags behind advanced economies by most standard measures, with differences being most stark with respect to electricity generation capacity (Figure 5.1).[2] Infrastructure stocks have been rising in LAC countries, but the gains do not compare favorably with those in fast-growing regions (for example, emerging Asia). Similarly, infrastructure quality (Figure 5.2)—measured by *reductions* in electricity distribution losses, unpaved roads, and telephone faults—has also been improving in LAC countries, although infrastructure quality remains below that in Asia, particularly as it pertains to roads.

Although a proper standard for infrastructure is often hard to define, the proximity to the "ideal" of

[1]The measurement of infrastructure and the analysis of "infrastructure gaps" should be interpreted with caution because of conceptual and data problems. Available indicators are sometimes based on indirect proxies or provide incomplete information, as when describing road networks by reference to the ratio of kilometers of roads to country surface area, or are based on subjective surveys of perception.

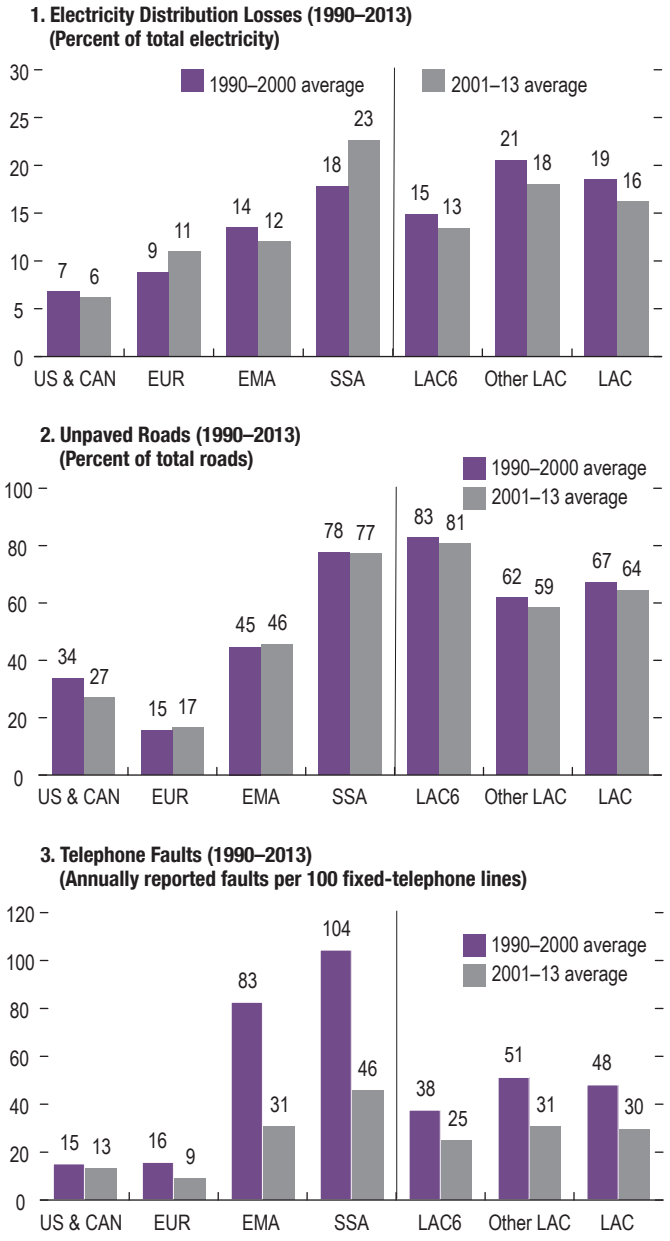
[2]We focus our comparisons in this section on advanced economies, emerging Asia, and sub-Saharan Africa, which provide a wide spectrum of experiences. Comparisons (using slightly different metrics) against other regions, such as the Commonwealth of Independent States, emerging and developing Europe, and the Middle East and North Africa, can be found in IMF (2014).

Figure 5.1. World: Infrastructure Stock Indicators



Sources: Energy Information Administration; International Road Federation, World Road Statistics; International Telecommunications Union; World Bank; and IMF staff calculations.
Note: EMA = emerging Asia; EUR = advanced Europe; LAC = Latin America and the Caribbean; LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, and Peru; SSA = sub-Saharan Africa; US & CAN = United States and Canada.

Figure 5.2. World: Infrastructure Quality Indicators

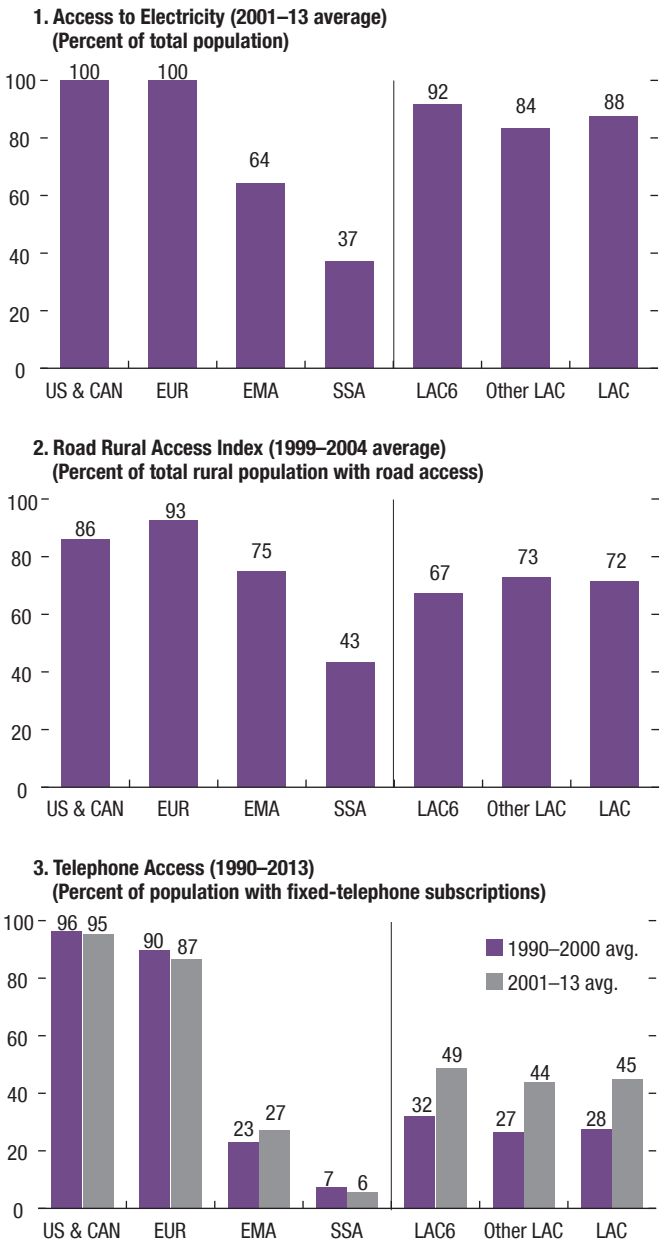


Sources: Energy Information Administration; International Road Federation, World Road Statistics; International Telecommunications Union; World Bank; and IMF staff calculations.
Note: EMA = emerging Asia; EUR = advanced Europe; LAC = Latin America and the Caribbean; LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, and Peru; SSA = sub-Saharan Africa; US & CAN = United States and Canada.

universal access constitutes a clear benchmark, as it relates to the well-being of the population. In this dimension, LAC countries are in a better position than other emerging market and developing economies in terms of access to electricity, but not so much concerning other measures such as rural access to roads (Figure 5.3).

Alternatively, the level and quality of infrastructure can be compared to a country's

Figure 5.3. World: Infrastructure Access Indicators

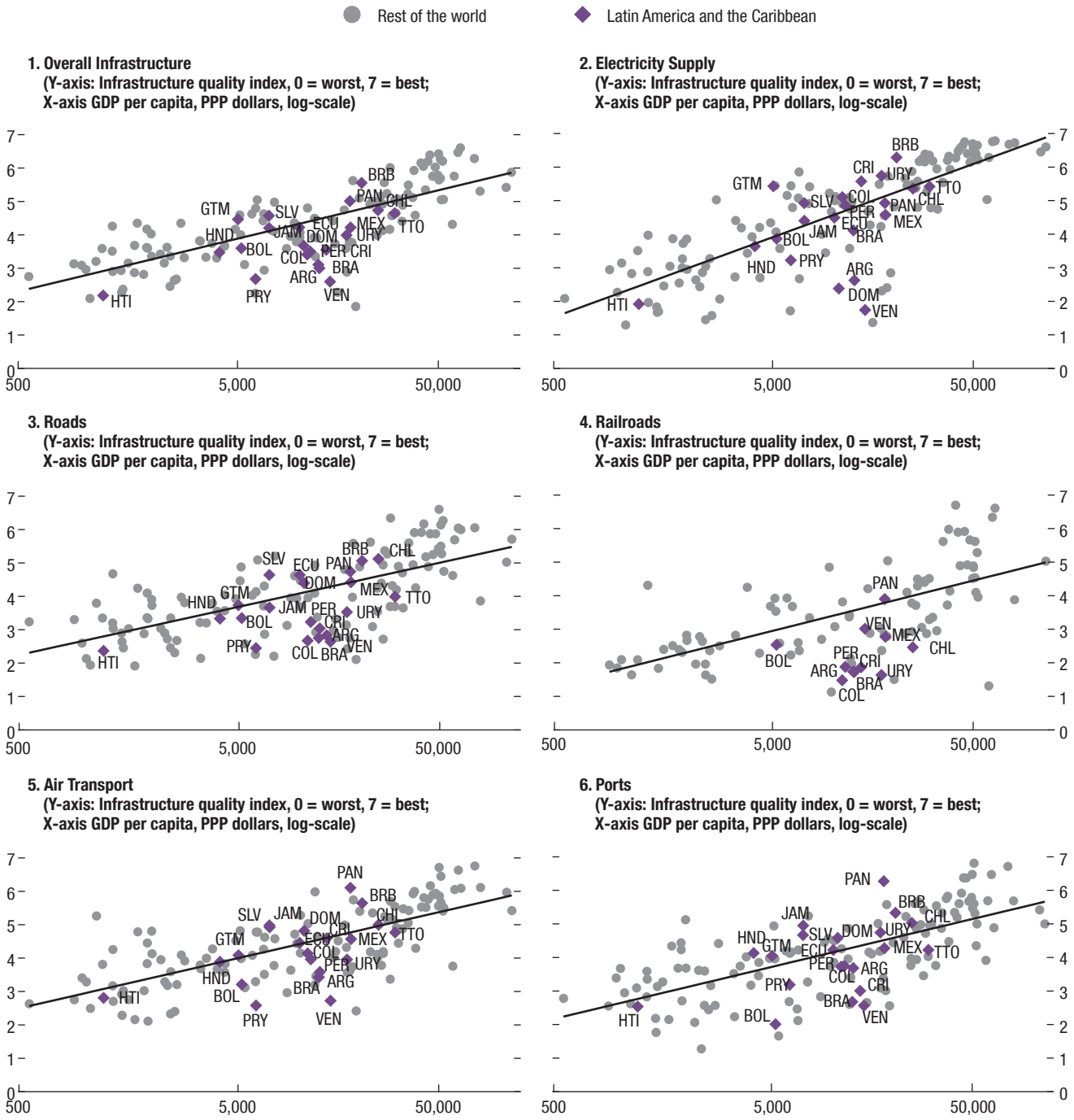


Sources: Energy Information Administration; International Road Federation, World Road Statistics; International Telecommunications Union; World Bank; and IMF staff calculations.
Note: EMA = emerging Asia; EUR = advanced Europe; LAC = Latin America and the Caribbean; LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, and Peru; SSA = sub-Saharan Africa; US & CAN = United States and Canada.

level of development, measured, for example, by income per capita. Economic development brings about the resources to raise infrastructure and, at the same time, improvements in infrastructure support future economic growth (Box 5.1). Some countries (for example, Argentina, Bolivia, Brazil, Paraguay, and Venezuela), where infrastructure investment has been relatively moderate in the past decade, tend to show lower-than-expected infrastructure quality for their income levels in several areas (Figure 5.4). More generally, and with notable exceptions (for example, El Salvador, Guatemala, and Panama), LAC countries generally tend to lie below the regression line, particularly in the case of railroads. Regarding port infrastructure, countries in the Western Hemisphere are undertaking substantial investments to accommodate post-Panamax ships that will be able to pass through the new locks being constructed to expand the capacity of the Panama Canal (Box 5.2).

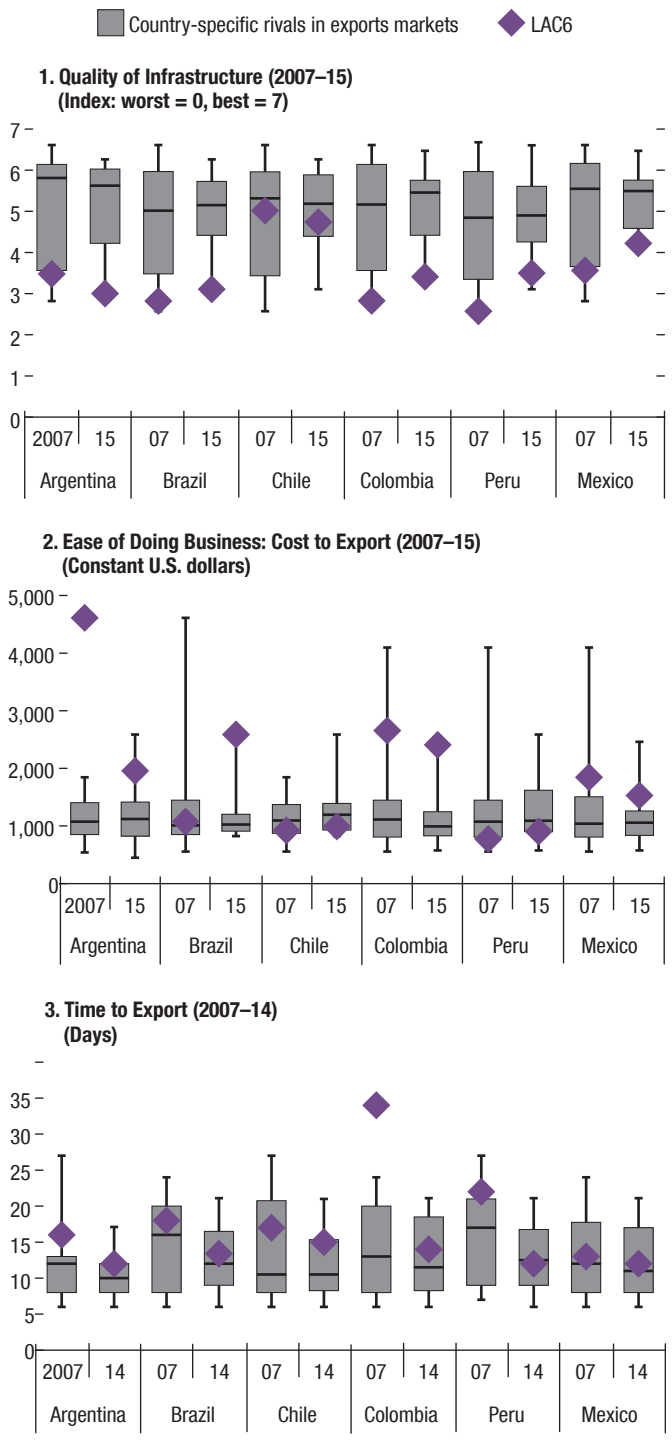
Infrastructure is also likely to be an important determinant of competitiveness. Producers will be more reluctant to develop a resource or invest in a project in a country lacking the transport or logistical infrastructure required to take the product to the point of shipment. Following that notion, country-specific benchmarks are created for the region's six largest economies (Argentina, Brazil, Chile, Colombia, Mexico, and Peru—LAC6) by identifying each country's top five competitors in each of its top five export products. The benchmark is the range of stock and quality of infrastructure in this rival group (Figure 5.5). On this metric, Chile stands out as being the only country with infrastructure quality similar to its trading rivals, although its position has also declined vis-à-vis its competitors, suggesting potential competitiveness concerns for the countries in the region. These comparisons are broadly coincident with time- and cost-to-export comparisons, but do not account fully for export competitiveness. Mexico, with many export-oriented firms located near its border with the United States, does better on time-to-export comparisons than it does on infrastructure quality. Peru is another counterexample, with relatively low cost of exporting. In this, as in other cases where exports include mining products, the existence of rents may allow companies to build proprietary infrastructure, and after such investments are sunk, their export

Figure 5.4. World: Infrastructure Quality Indicators Relative to GDP per Capita (2014)



Sources: World Economic Forum; and IMF staff calculations.
Note: PPP = purchasing power parity. Data labels use International Organization for Standardization (ISO) country codes, see page 108.

Figure 5.5. LAC6 and Trade Rivals' Comparison



Sources: IMF staff estimates with World Economic Forum and UN COMTRADE data.
Note: Trade rivals sample defined as the top five exporters of each of the top five goods exported by the respective country. LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, and Peru.

costs fall.[3] Also, these comparisons may not say much about the fitness of infrastructure to support other (new) export activities.

Evolution of Infrastructure Investment

Selected Determinants of Infrastructure Investment

With considerable variation among countries in the region with respect to the levels and quality of infrastructure, what factors explain these differences? Empirical analysis of some determinants of infrastructure investment is reported in full in Annex 5.1. A broad reading of the results suggests that, in addition to the dynamism of each economy, represented by its GDP growth, and regulatory frameworks, which were not modeled, the following factors matter:

- *The public sector's budget constraint.* Fiscal consolidation in the form of a higher primary fiscal surplus tends to reduce the indicator for telephone lines (although estimates are not statistically significant), but not necessarily other types of infrastructure; and higher public investment appears less important than one might expect in the regressions for road density and telephone lines. These results might, in part, reflect the increasing obsolescence of fixed telephone lines, and the increasing role of the private sector in the development of roads, discussed below. As explained in Annex 5.1, the estimated models also suggest that the way an increase in public investment is financed may matter.
- *Private sector participation.* An increase in private investment is generally associated with stronger infrastructure accumulation, especially in electricity generation. A negative association with fixed telephone lines may reflect again the obsolescence of fixed lines

[3]The dollar cost chart should be interpreted with caution because it might be influenced by exchange rate changes.

and the role of private firms in developing mobile telephony.

- *Interdependence among types of infrastructure.* Power, road, and telephone infrastructure stocks are positively linked in many of the specifications. This suggests a tendency among countries to adopt broad-ranging infrastructure strategies.
- *Other determinants of infrastructure.* Infrastructure investment in LAC generally appears responsive to controls such as the level of income, the degree of urbanization, and openness to trade.

These results should be interpreted with caution given the dispersion of regression estimates. More important, these results should be seen in the light of the discussion that follows.

Fiscal Policy

Major shifts in the size and composition of infrastructure investment have taken place during the past several decades. Perrotti and Sanchez (2011) observe that investment in infrastructure as a percent of GDP peaked in the first part of the 1980s, with the majority of investment provided by the public sector. This was followed by a fall in overall infrastructure investment, with a shift in its composition toward more private investment, helped by a wave of privatizations in the 1990s. Country experiences have varied significantly, however, and not all countries have followed the same script. Although Chile and Mexico saw virtually no public investment in the early 1980s in the aftermath of their debt crises, public and private investment eventually recovered. In contrast, Brazil had reasonable levels of investment in the 1980s, followed by a decline in infrastructure investment since the 1990s (Garcia-Escribano, Góes, and Karpowicz 2015).

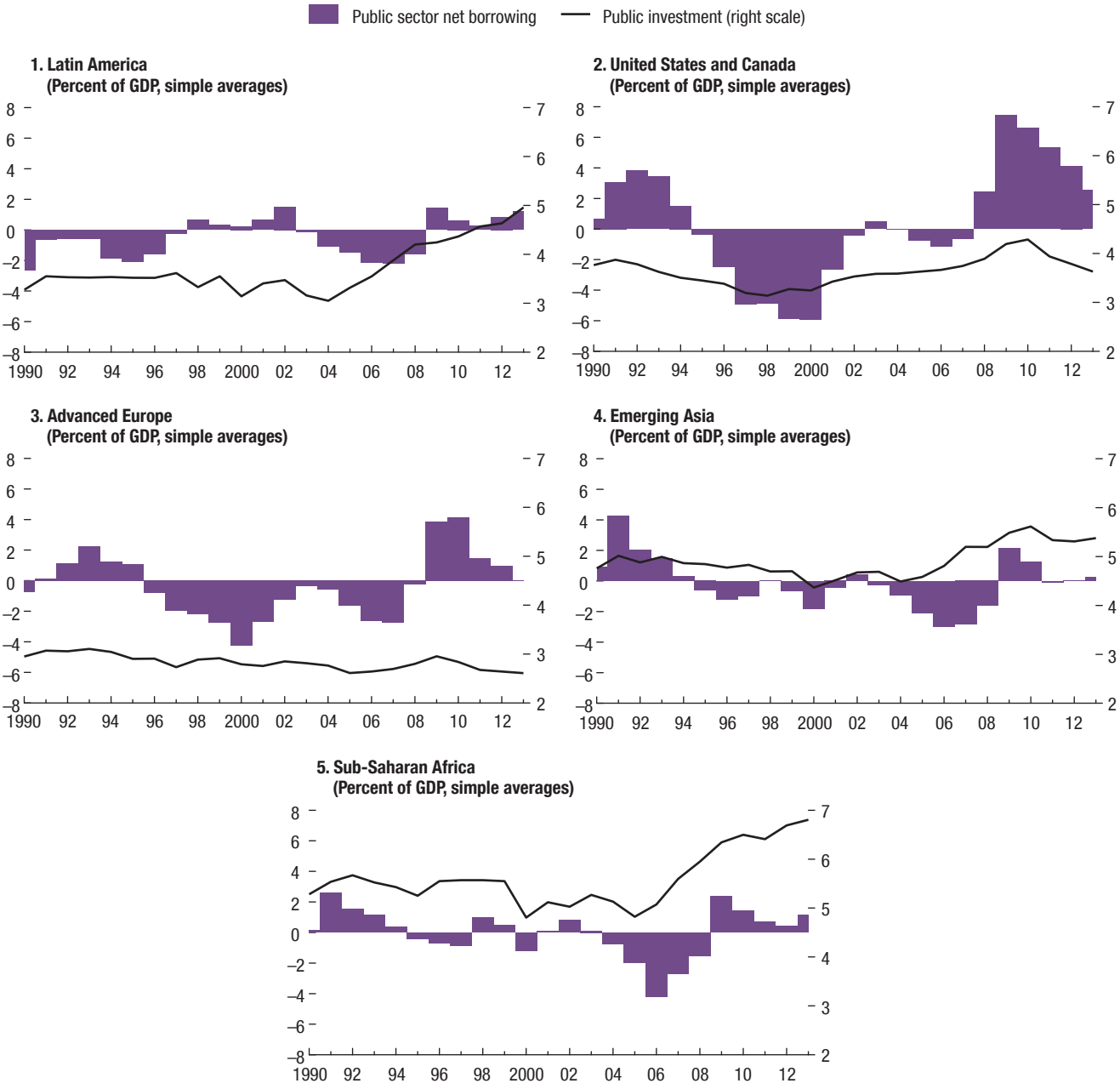
The state and stance of *public finances* have influenced the evolution of infrastructure investment across the region, with the *commodity supercycle* allowing investment in some resource-based countries in the LAC region to rise even as public finances strengthened. Although fiscal consolidation tends to fall disproportionately on investment, the variation in public investment since the 1990s (Figures 5.6 and 5.7) does not show a simple relationship to government deficits (measured by public sector borrowing), particularly in the case of Peru (Vtyurina 2015). Notably, in the early- to mid-2000s, public investment rose in the region even as public finances were strengthening. When the great recession came, countries in LAC were typically able to accommodate the drop in revenues without resorting to cutting public investment. However, in many countries fiscal buffers have been eroded in the years since then (Celasun and others 2015), and it is thus likely that the sensitivity of public investment to possible revenue weakness may increase again in the period ahead. Meanwhile, since the mid-2000s, infrastructure (and overall) investment by the private sector has also been steadily rising; similar trends can be observed among other emerging market and developing economies, especially in sub-Saharan Africa.

In addition, *natural disasters* have repeatedly affected infrastructure in LAC, especially in the Caribbean. Hurricanes have periodically destroyed infrastructure and other structures in several small states. For example, in 2010, a large earthquake caused catastrophic damage in Haiti, subsequently leading to a large reconstruction effort. More recently, in 2015, Dominica was hit hard by Tropical Storm Erika, resulting in significant damage to the country's physical infrastructure (about 17 percent of roads and 6 percent of bridges were fully damaged, and 24 percent of roads and 44 percent of bridges were partially damaged). Caribbean countries are not alone in facing reconstruction challenges following natural disasters. Chile, for example, has had to respond to earthquakes (Iquique in 2014) and floods (Atacama in 2015).

Private Participation

Funding models influence the characteristics and evolution of private sector participation in infrastructure. Funding refers to the ultimate source of the funds that will pay for creating and operating a piece of infrastructure, with the basic

Figure 5.6. Fiscal Performance and Public Investment (1990–2013)

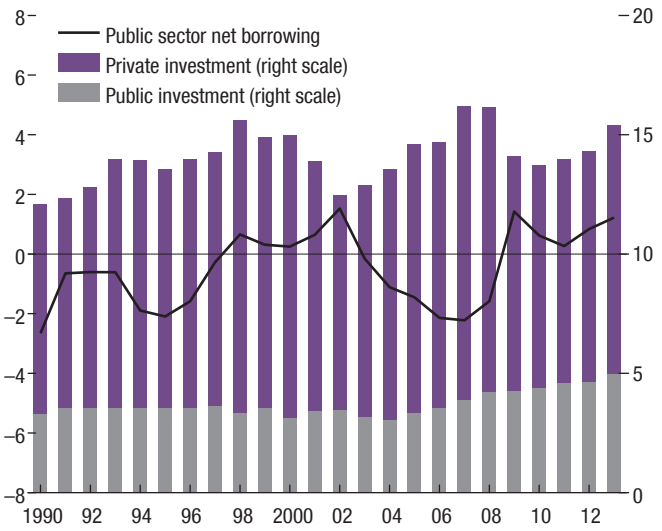


Sources: IMF, World Economic Outlook database; and IMF staff calculations.

funding decision being the fraction of the cost borne by the taxpayer as opposed to the direct user of infrastructure.[4] Although infrastructure typically has some characteristics of a public good (such as nonrivalry in the case of roads, at least up to a point), excludability is a characteristic that permits private participation. In practice, excludability depends not just on the availability of a technology for charging users, but also on the public's expectations regarding the obligations of the state

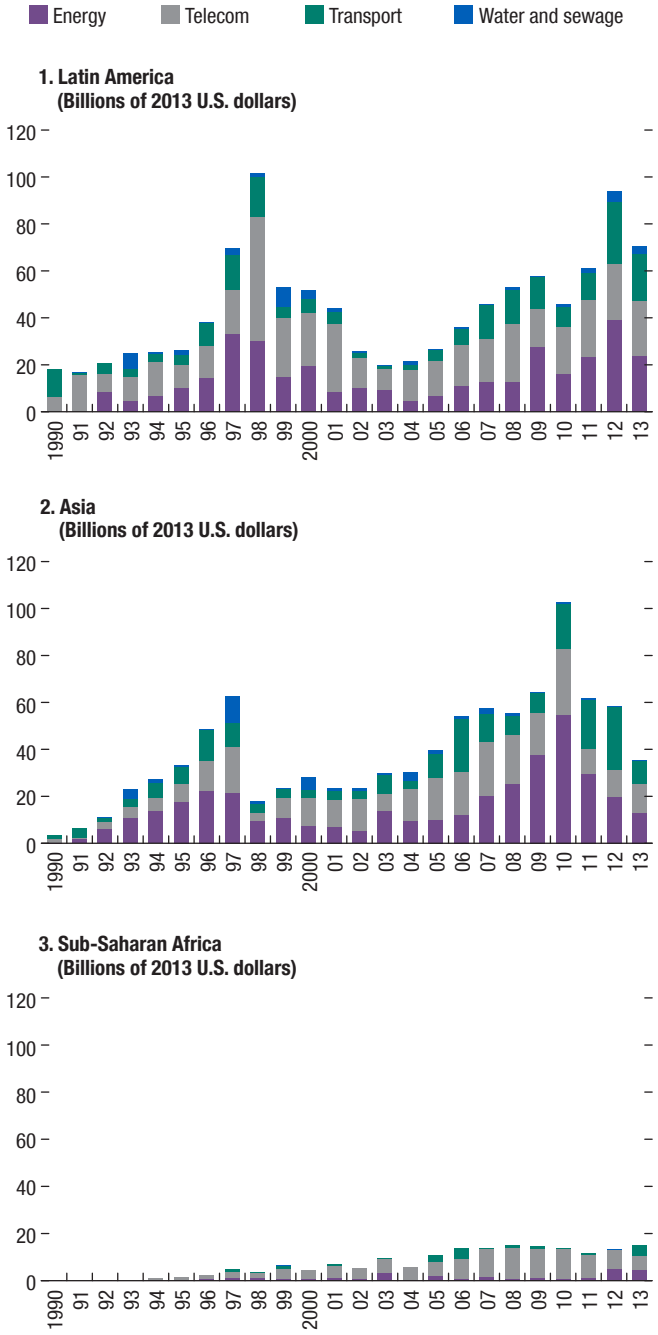
[4]Funding is thus different from financing, with the latter referring to the immediate sourcing of the cash needed to undertake a project, rather than to the ultimate origin of the resources needed to pay for its construction and operation.

Figure 5.7. Latin America: Public Sector Net Borrowing and Investment (1990–2013)
(Percent of regional GDP)



Sources: IMF, World Economic Outlook database; and IMF staff calculations.

Figure 5.8. Private Participation in Infrastructure Investment Commitment, by Region and Sector (1990–2013)



Sources: World Bank, Private Participation in Infrastructure database; and IMF staff calculations.

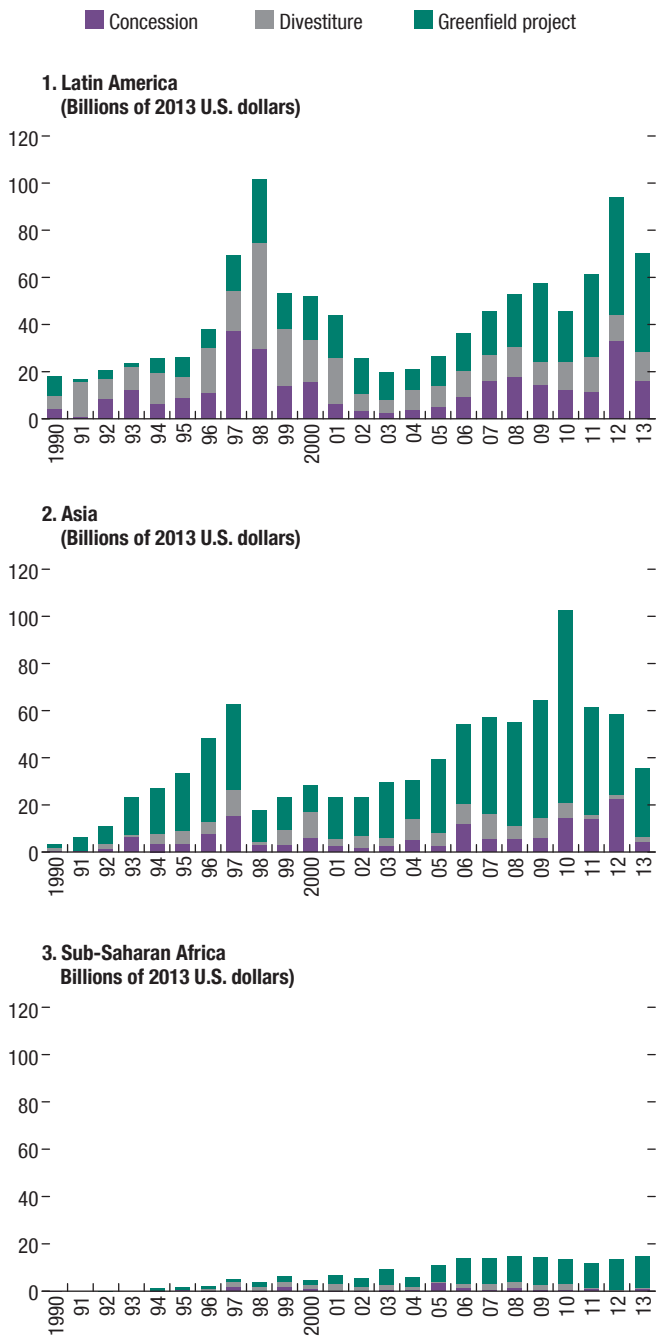
(that is, expectations of how the services from a given infrastructure project should be funded). In that regard, private investment in infrastructure appears to have concentrated in sectors in which collecting user fees has been technically feasible and has become viewed as politically acceptable. Electricity, telecommunications, and transportation are clearly in this category, and to a lesser extent, water and sewage, for which municipal provision remains important. These sectors have been the focus of private participation not just in Latin America, but also in emerging Asia (Figure 5.8).

An important contrast between LAC and Asia is the extent to which privatizations and concessions have played a role. Although privatizations were particularly important in LAC in the late 1990s, and concessions remain important today, Asia has experienced a much larger proportion of greenfield investment, especially after the Asian crises of the late 1990s (Figure 5.9).

Infrastructure Financing

Access to finance has been a constraint in both public and private investment. Infrastructure firms in LAC have invested at levels similar to firms in emerging Asia and at higher levels than firms in advanced economies and sub-Saharan Africa. Debt financing is growing but remains very low in sub-Saharan Africa because of lower levels of financial development, higher levels of

Figure 5.9. Private Participation in Infrastructure Investment Commitment, by Region and Type of Contract (1990–2013)



Sources: World Bank, Private Participation in Infrastructure database; and IMF staff calculations.

risk, and more reliance on development banks for financing. In contrast, low levels of debt financing among advanced economies is associated with deeper financial markets, allowing greater access to a broader range of financing options (for example, direct investment from institutional investors, such as pension and sovereign wealth funds).

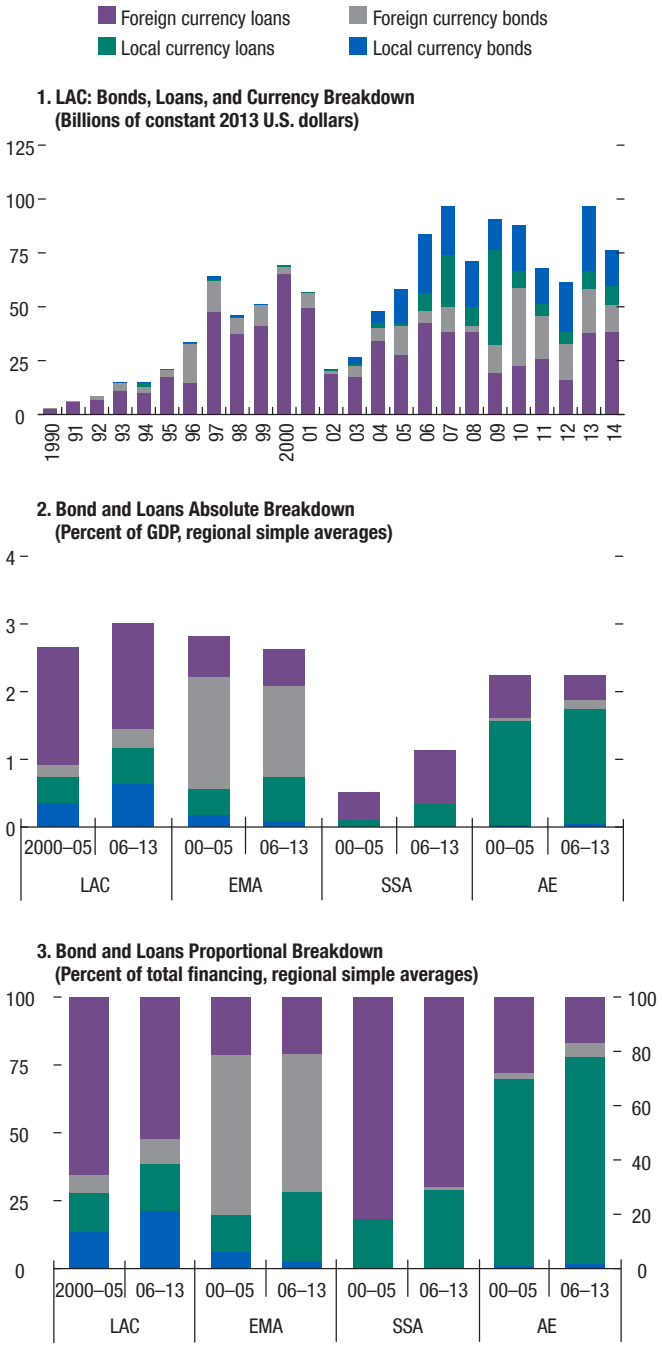
Bonds versus Bank Loans

Infrastructure-focused firms across LAC are currently financing more investment by issuing bonds than in the past (Figure 5.10). The total volume of loans issued to infrastructure firms has remained broadly stable since the mid-1990s, while the volume of bonds issued has steadily increased to nearly half of total financing by the end of 2014. The switch toward bond financing over time appears to reflect economic development and greater integration into global financial markets. Brazil is complementing the long-term financing available from its state-owned development bank (BNDES) with new infrastructure bonds, which are also expected to contribute to a further deepening of the private fixed-income market (Box 5.3). On this point, the role of national development banks in LAC is relatively limited, with BNDES being an exception. Although BNDES also caters to other financing needs, it covers a significant fraction of infrastructure financing needs in Brazil (Frischtak and Davies 2014).

Local versus Foreign Currency Debt

More new debt is now denominated in local currency. Policy frameworks and fundamentals have gradually improved across the region during the past two decades, while real interest rates in advanced economies have trended down. Over this time, borrowing in domestic currency has increased with the deepening of domestic financial markets and likely also owing to the search for yields on the part of foreign investors; the volume of borrowing in foreign currency has remained broadly stable. The switch to financing in local currency has also likely been facilitated by improved public debt management strategies, with a lengthening of sovereign maturities and greater shares of sovereign debt denominated in local currency contributing to financial deepening (Arslanalp and Tsuda 2014).

Figure 5.10. Total Capital Raised by Infrastructure-Focused Companies (1990–2013)



Sources: Dealogic; and IMF staff calculations.
Note: AE = advanced economies; EMA = emerging Asia; LAC = Latin America and the Caribbean; SSA = sub-Saharan Africa. Includes all bonds and syndicated loans to infrastructure-focused companies, defined as those falling in the following categories: (1) transportation; (2) construction/building; (3) telecommunications; (4) utilities; (5) water and sewage.

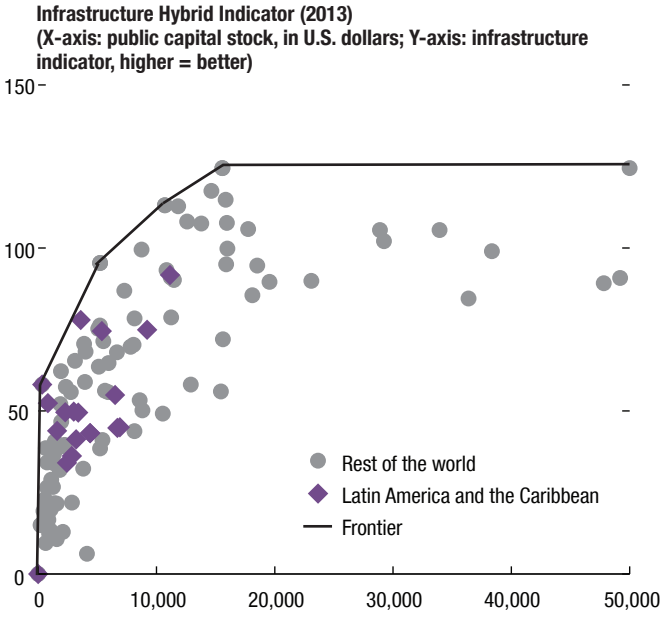
The trend toward local currency financing is evident globally, but the mix of bond versus loan financing differs across regions. Emerging Asia stands out with a relatively large share of infrastructure financing coming from bonds denominated in foreign currency. In contrast, debt financing by firms in advanced economies occurs mainly through local currency loans, rather than bonds, which may be a consequence of larger and more sophisticated banking systems, where risks can be more easily diversified and collateralized.

Development Financing and Current Constraints

For many LAC countries, infrastructure financing has also relied on resources from development banks and quasi-fiscal entities, official lenders, nontraditional sources and new initiatives. For example, the World Bank and the Inter-American Development Bank (IDB) have historically been key multilateral strategic partners providing budget and project support to the public sector. In recent years, the IDB has also increased its role in nonsovereign guaranteed activities. Bilateral and multilateral donors have provided resources, including through grants, such as for post-earthquake reconstruction of Haiti's infrastructure. For many countries in Central America and the Caribbean, energy cooperation agreements with Venezuela (for example, PetroCaribe) have included subsidized financing for oil imports that supported energy-related infrastructure and investments in other productive activities (Belize, Guyana, Haiti, and Nicaragua were the top recipients of PetroCaribe financing in 2014).

Donor fatigue, the decline in PetroCaribe financing associated with lower oil prices, and fiscal pressures have recently constrained the availability of finance for many countries. In response, some countries are increasingly exploring public-private partnership arrangements, new development partners (for example, China and Taiwan Province of China), and new initiatives (for example, raising resources through citizenship programs in a few Caribbean countries). In resource-based countries, lower

Figure 5.11. Efficiency Frontier



Sources: Center for International Comparisons (2013); IMF, World Economic Outlook database; OECD (2014); World Economic Forum (2014); World Bank, World Development Indicators database; and IMF staff calculations.

commodity prices have also put pressure on public capital spending. In some of these countries, public enterprises are expected to rely increasingly on production and exploration partnerships with private companies. In Mexico, the state-owned oil company, Pemex, is looking to securitize assets and use equity financing for some of its operations; good governance would require that the operations are recorded transparently in the public accounts.

Investment Efficiency

The chapter turns now to consider the payoffs to infrastructure investment. One approach to benchmarking value for money relative to peers is to construct an efficiency frontier, as developed in IMF (2015b—Figure 5.11). The vertical axis corresponds to the "output" dimension, representing the value of an aggregate or hybrid indicator of the access to, and quality of, a country's infrastructure. The horizontal axis corresponds to the "input" dimension, measuring the public capital stock, estimated by the perpetual inventory method as cumulative real net public investment, as a proxy for infrastructure investment. (The output and input dimensions are both scaled by the country's population.) For any given level of input, the highest observed value of the hybrid indicator is taken to be part of the efficiency frontier, which has the familiar shape of a production function with diminishing returns. Most LAC countries are well below the efficiency frontier, with a few exceptions, such as Chile.

Countries' relative public investment efficiency can also be measured (Box 5.4). In particular, the ratio of a country's output indicator to that of a country on the efficiency frontier with a similar level of public capital and income per capita defines the Public Investment Efficiency Indicator (PIE-X).[5] The most efficient country receives a value of 1, whereas any value of the PIE-X below 1 can indicate that an "efficiency gap" exists. The distribution of the PIE-X in a LAC sample (of 17 countries) is broadly comparable with the distribution for emerging markets as a group. However, although the averages for these two groups are broadly similar, within-group variation in the PIE-X is larger for the group of emerging markets than for the LAC group.

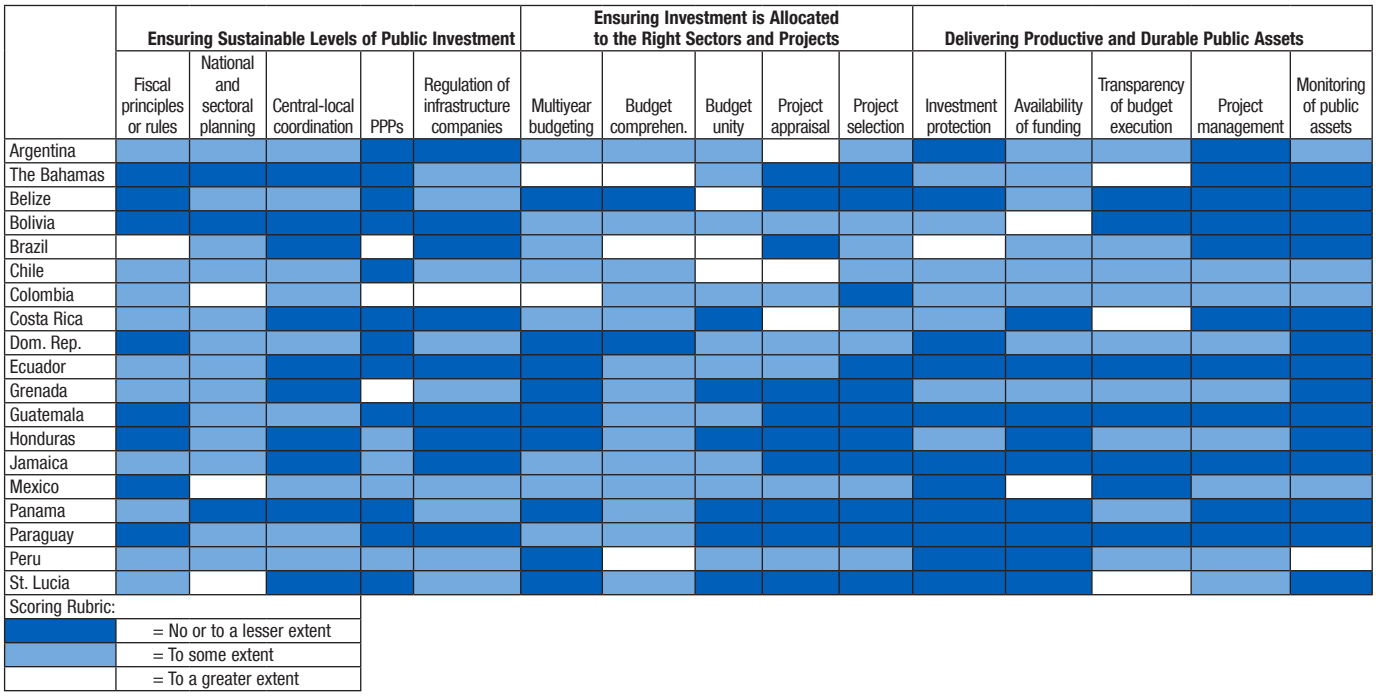
Public Investment Management

Managing public investment is a challenging undertaking. A growing body of literature underscores the role that the legal, institutional, and procedural arrangements for public investment management, including risk management, play in determining the level, composition, and impact of public investment on the economy. IMF (2015b) develops a framework to make broad assessments of public investment management in a country.[6] This

[5]The computation of the PIE-X takes into account, in addition to the public capital input shown in Figure 5.12, a country's income per capita, and uses data enveloping analysis techniques, as detailed in IMF (2015b). In this fuller framework, the efficiency frontier is a surface in three-dimensional space.

[6]This assessment tool considers the practices and frameworks underpinning the entire investment process across the whole public sector.

Figure 5.12 Public Investment Management in Latin America and the Caribbean



	Ensuring Sustainable Levels of Public Investment					Ensuring Investment is Allocated to the Right Sectors and Projects					Delivering Productive and Durable Public Assets				
	Fiscal principles or rules	National and sectoral planning	Central-local coordination	PPPs	Regulation of infrastructure companies	Multiyear budgeting	Budget comprehen.	Budget unity	Project appraisal	Project selection	Investment protection	Availability of funding	Transparency of budget execution	Project management	Monitoring of public assets
Argentina															
The Bahamas															
Belize															
Bolivia															
Brazil															
Chile															
Colombia															
Costa Rica															
Dom. Rep.															
Ecuador															
Grenada															
Guatemala															
Honduras															
Jamaica															
Mexico															
Panama															
Paraguay															
Peru															
St. Lucia															

Scoring Rubric:	
	= No or to a lesser extent
	= To some extent
	= To a greater extent

Sources: IMF staff calculations based on a public investment management survey designed by the IMF Fiscal Affairs Department (FAD), completed by country desks, FAD economists, and several country authorities.

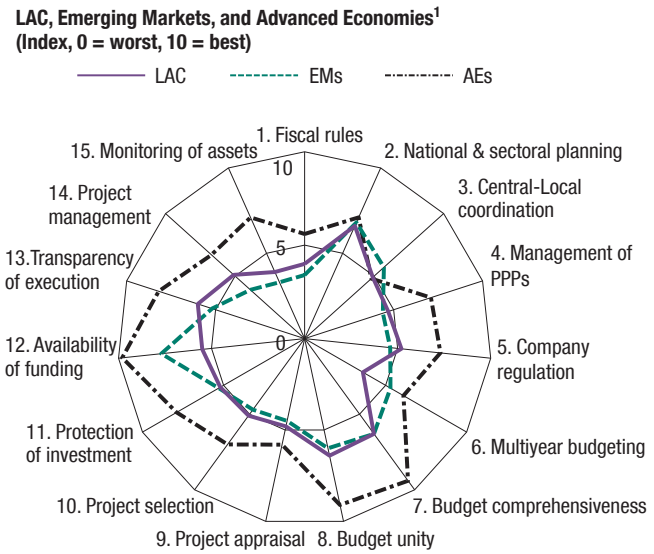
Note: PPPs = public-private partnerships.

assessment tool considers the practices and frameworks underpinning the entire investment process, including planning, project selection, budgeting, execution, project management, and monitoring and maintenance of built assets. Based on a survey of relevant features of public investment management frameworks in the sample of LAC countries, Figure 5.12 provides a broad picture of the institutional strength. Most countries have room for improvement. General planning processes have received attention, but project selection still needs upgrading in many countries. Almost universally, the monitoring and maintenance of built assets is a weakness in LAC countries.

According to the survey, country experiences also provide useful lessons for integrating public investment with macroeconomic policy management. Countries should have a rigorous framework for scaling up public investment in the event of revenue windfalls to preserve macroeconomic stability, safeguard against declines in investment efficiency, and ensure that the overall level of investment in the economy, including by the private sector, is consistent with absorptive capacity. Quasi-fiscal entities and development banks should be integrated into the budget process, and rules for transfers to the budget should be clarified. Projects should be well coordinated among line ministries, quasi-fiscal entities, and donors to improve efficiency and prevent duplication of efforts and funding of low-priority projects.

The strength of public investment management institutions appears to be correlated with indicators of investment efficiency. For example, Chile and Costa Rica, which have some of the highest PIE-X indicators for the region, appear to have some of the strongest public investment management frameworks among LAC countries. However, the correlation is not perfect: Mexico and Peru, with strong rules and practices (Box 5.5), rank lower in the PIE-X than Chile and Costa Rica do. This may, in some cases, be due

Figure 5.13. Public Investment Management



Source: IMF staff calculations.
Note: AEs = advanced economies; EMs = emerging markets; LAC = Latin America and the Caribbean; PPPs = public-private partnerships.
[1] Includes 25 advanced economies, 12 emerging market economies, and selected LAC (The Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Grenada, Guatemala, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, and St. Lucia).

to the possibility of fast-tracking or exempting specific projects, which thus would not benefit from the full application of the more rigorous standard framework.[7]

More generally, a similar message emerges when comparing the average indicators of institutional strength in the region against other groups of countries (Figure 5.13). Although national and sectoral planning institutions are in place, there is much to improve in all other phases of investment. Interestingly, LAC does better than other emerging markets in the transparency of project execution and project management, although it still scores well below advanced economies in these areas. The region compares least favorably in terms of financing opportunities and multiyear budgeting.

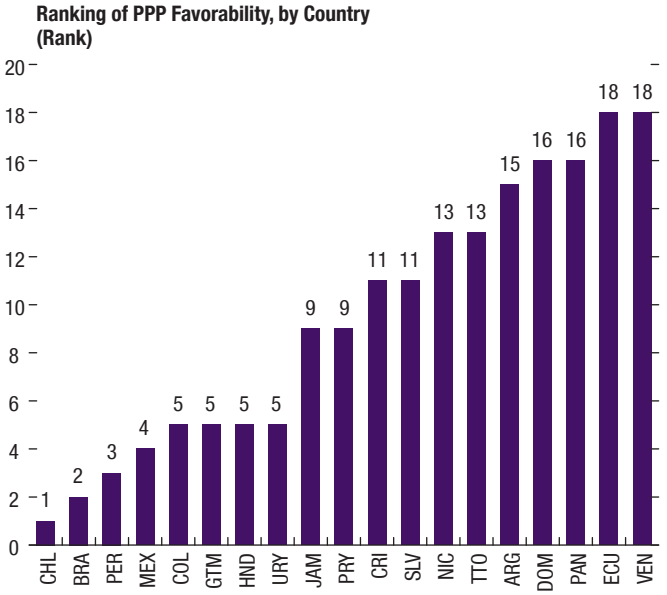
[7]For example, the Trans-oceanic highway connecting the coasts of Peru and Brazil, which was exempted by law from Peru's National Public Investment System, ended up with a large cost overrun.

Institutional and Regulatory Frameworks for Public-Private Partnerships

As slowing growth throughout the region reduces the available fiscal space for public investment, many governments may turn to public-private partnerships to boost capital expenditure on infrastructure. In public-private partnership arrangements, the private partner is usually responsible for investment and service provision for the construction and operational phases of an infrastructure project, and receives compensation either from the government or from user charges. Although private sector involvement can often generate efficiency gains, the right incentives and conditions are required to minimize risks to the budget. Thus, as the role of public-private partnerships in the provision of infrastructure continues to grow in the LAC region, building skills for managing complex long-term contractual relationships will have to go hand in hand with creating a sound legal and institutional framework and attractive business environment. The key elements include strong public-private partnership legislation, clear and consistent regulations, fair and consistent bidding procedures, the integration of projects into the budget cycle, clarity on roles and responsibilities across institutions responsible for public-private partnerships, a strong oversight framework, value for money, and fiscal affordability, transparent disclosure, and sound accounting systems.

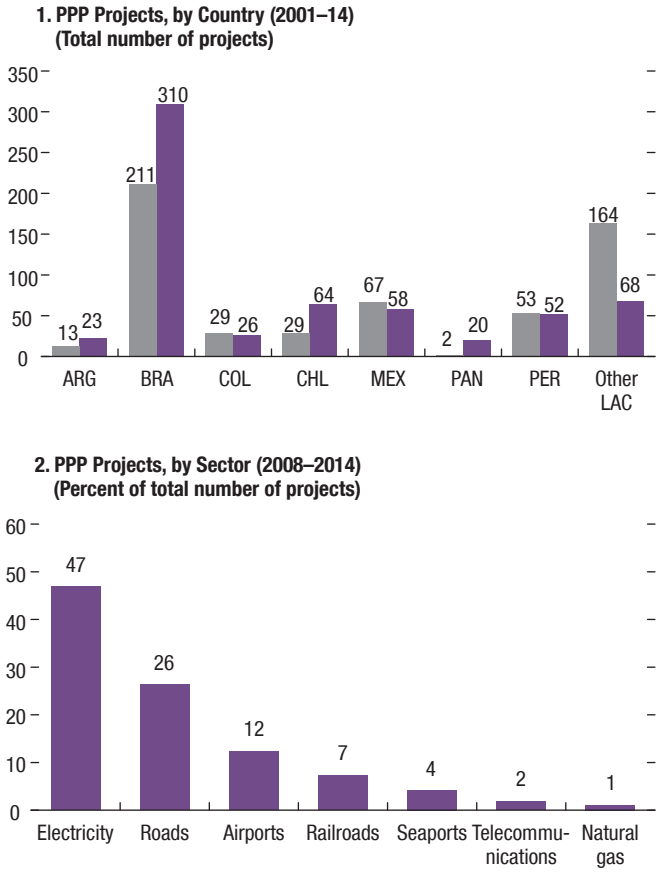
According to the Economist Intelligence Unit (2014), the LA5 (Brazil, Chile, Colombia, Mexico, and Peru) are the countries in the region with the most attractive overall environment for public-private partnerships (Figure 5.14). They are well placed in the global context and have consistently ranked high in terms of the overall environment for enabling public-private partnerships since 2009. They also rank highest across most subcategories: institutional framework, regulatory framework, operational maturity, financial facilities available for public-private partnerships, and use of public-private partnerships at the

Figure 5.14. LAC: Overall Public-Private Partnership (PPP) Environment



Source: Economist Intelligence Unit (2014).
Note: Data labels use International Organization for Standardization (ISO) country codes, see page 108.

Figure 5.15. LAC: Public-Private Partnerships (PPPs)



Source: IMF staff estimates with World Bank data.
Note: LAC = Latin America and the Caribbean. Data labels use International Organization for Standardization (ISO) country codes, see page 108.

subnational level. These rankings tend to reflect their experience in the use of public-private partnerships. Indeed, the vast majority of projects have been undertaken in the LA5, led by Brazil, with energy projects being the most numerous (Figure 5.15). Most other countries in LAC have, nonetheless, made notable progress over time in creating conditions suitable for scaling up public-private partnerships, building on the experience of LA5 countries.

Although public-private partnerships can ease the fiscal burden and increase the efficiency of service provision, they entail fiscal risks. Contingent liabilities can arise from poor contract design and unexpected changes in the regulatory framework or macroeconomic environment. In addition, the private partners can engage in substantial efforts to renegotiate contracts, calling for modifications of terms or additional contributions from the public sector to respond to changes in demand, quality standards, or other evolving circumstances. Renegotiations may undermine the budget process and result in higher government outlays and lower value for money when done outside a competitive tender process. To minimize these risks, governments must set limits on contract renegotiations. Chile introduced limits on renegotiation when it reformed its public-private partnership framework in 2010. Incentives for renegotiation could be reduced by including all government obligations associated with public-private partnerships in the balance sheet of the government and applying the same oversight as for other budgetary expenses (Engel, Fischer, and Galetovic 2014). Putting in place platforms and strict rules for renegotiation of contracts (Chile and Peru) and the use of expert panels has proven successful. Based on these lessons, Colombia

enacted a law in 2012 to systematically regulate public-private partnerships, minimize incentives for renegotiation, and facilitate financing (Box 5.6).

LAC countries are well placed to continue to reap the benefits from improvements in institutional frameworks and lessons from past experience but some important challenges lie ahead. The operational maturity and technical capacity needed to scale up investment will come only over time, with more on-the-job skills development and training. Planning and execution will continue to pose challenges until technical capabilities and know-how are fully developed across lower government levels, including in countries where subnational public-private partnerships enjoy an already strong legal framework and presence (for example, Brazil and Mexico). Preserving political support and building popular trust will also be important. Transparent communication and public consultations have been crucial for building communities' support for the infrastructure agenda in Colombia and Peru, although with still limited success in the latter. Finally, bringing clean energy products and environmentally friendly options into the design of public-private partnership projects, currently at an incipient stage in many LAC countries but prominent in Brazil, will become paramount for building sustainable infrastructure in the near future.

Conclusions

On the state and growth of infrastructure in LAC, the key findings include the following:

- Infrastructure indicators in the region compare, on average, reasonably well with those in the group of emerging markets at large, and emerging Asia in particular.
- However, a comparison of each country against the group of its rivals in export markets suggests that competitiveness is compromised in many LAC countries by the state of their infrastructure.
- As other IMF research has found, infrastructure affects growth potential (IMF 2014). Unless progress continues, there is a risk that the observed infrastructure shortfalls, relative to rivals and what might be expected given LAC countries' development levels, may increasingly hamper the region's growth over the medium term.

Fiscal policy and fiscal institutions play a critical role in improving the infrastructure network.

- The extent of fiscal space, and the level and composition of public financing instruments matter significantly for infrastructure stock accumulation.
- Closing infrastructure "gaps" is not just a matter of public money. Strengthening public investment management processes and practices is important for ensuring that the money mobilized is put to effective use.
- Infrastructure investment and maintenance of existing infrastructure capital need to be protected over the economic cycle to preserve the quality of the stock.

Public policy should also set appropriate conditions to crowd-in private investment in infrastructure. These are especially important in the current environment, characterized by reduced prospects for growth compared with those envisioned a few years ago.

- Private sector participation should be fostered in sectors that have the most potential interest, especially by improving the regulatory framework, enabling economically sound fee structures, and protecting contracts.
- Public-private partnerships should be welcomed where they offer efficiency gains compared with more traditional investment models, and any implications for fiscal risk should be proactively managed (including by reducing incentives for contract renegotiation) and transparently recorded. Countries in the region can benefit from the experience of

LA5 countries in improving their public-private partnership frameworks.

- Developing deep local bond markets for infrastructure bonds and other innovative forms of finance, including through private pension and sovereign wealth funds, can help mobilize resources for projects while containing currency risk.
- Several countries have made important strides in these areas, and offer useful examples for the region at large. Addressing remaining impediments on a country-specific level or through regional cooperation and leading by example can help the region to raise its potential growth over the coming decades.

Box 5.1. Endogenous Dynamics of Infrastructure and Growth

Causality in the relationship between infrastructure and growth runs in both directions. On the one hand, better infrastructure is likely to increase productivity and GDP. On the other hand, as national income increases, governments are able to raise more taxes in absolute terms and financial markets tend to deepen, facilitating both public and private infrastructure investment.

To assess the mutually reinforcing nature of this relationship, we estimate a panel structural vector autoregressive (panel VAR) model. The endogenous variables consist of the natural log of (1) GDP per capita, corrected by purchasing power parity; (2) electricity generation capacity; (3) number of fixed telephones per capita; and (4) road density. The model uses difference generalized method of moments equations, which control for time-invariant characteristics of the 104 countries in the sample. The methodology follows the panel VAR strategy described in Góes (2016).

To avoid overestimating the short-term income effect of infrastructure, we identify the model with GDP per capita as the most exogenous variable. The results shown in Figure 5.1.1 are average responses across countries of endogenous variables to an exogenous shock in any variable, assuming homogeneous and linear dynamics. They take into consideration all the simultaneous dynamics in the system of equations.

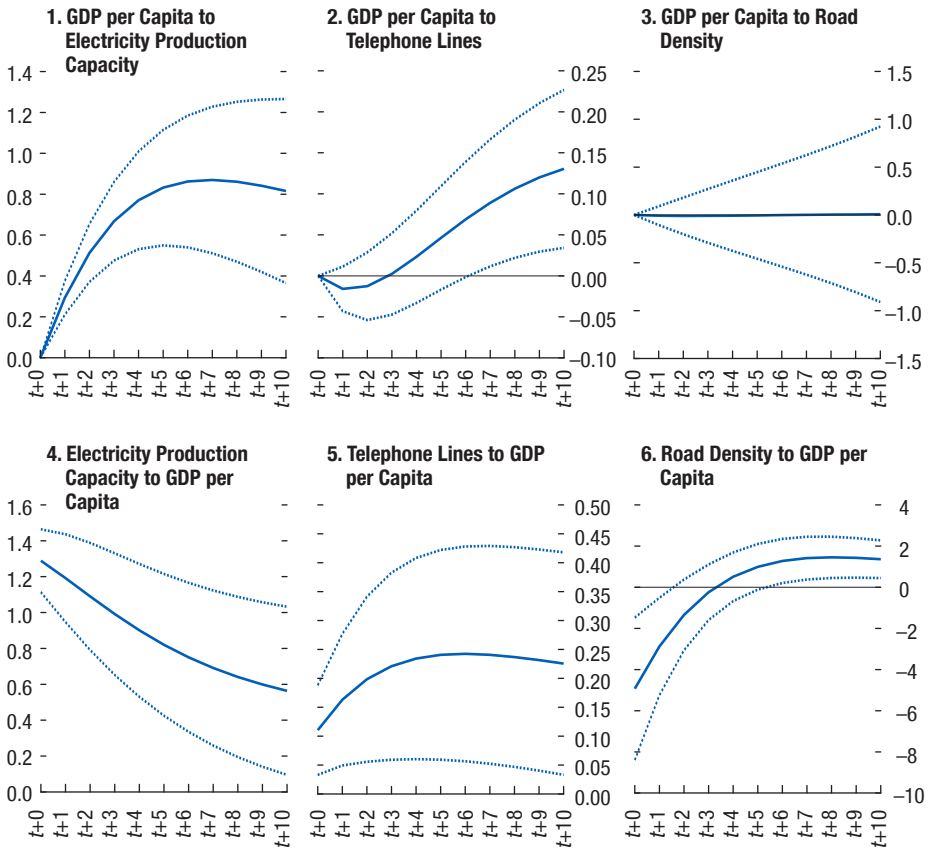
Responses of GDP per capita to a 1 percent temporary shock in both electricity generation capacity and the number of telephone lines are positive and statistically significant. They peak at 0.85 percent and 0.15 percent, respectively. The income response to an innovation in road density is positive but statistically insignificant. All infrastructure variables respond positively to income shocks. A 1 percent exogenous shock to GDP per capita leads to peak 1.3 percent, 0.25 percent, and 1.4 percent increases in electricity generation capacity, telephone lines, and road density, respectively.

These results support the idea that the relationship between infrastructure and growth is bidirectional. This is relevant because by ignoring the positive feedback loops between infrastructure and GDP per capita one might underestimate the beneficial effects of increased infrastructure.

Note: This box was prepared by Carlos Góes.

Box 5.1 *(continued)*

Figure 5.1.1. Panel Vector Autoregressions: Impulse Response Functions
(Noncumulative responses to a 1 percent innovation in the impulse variable, percent)



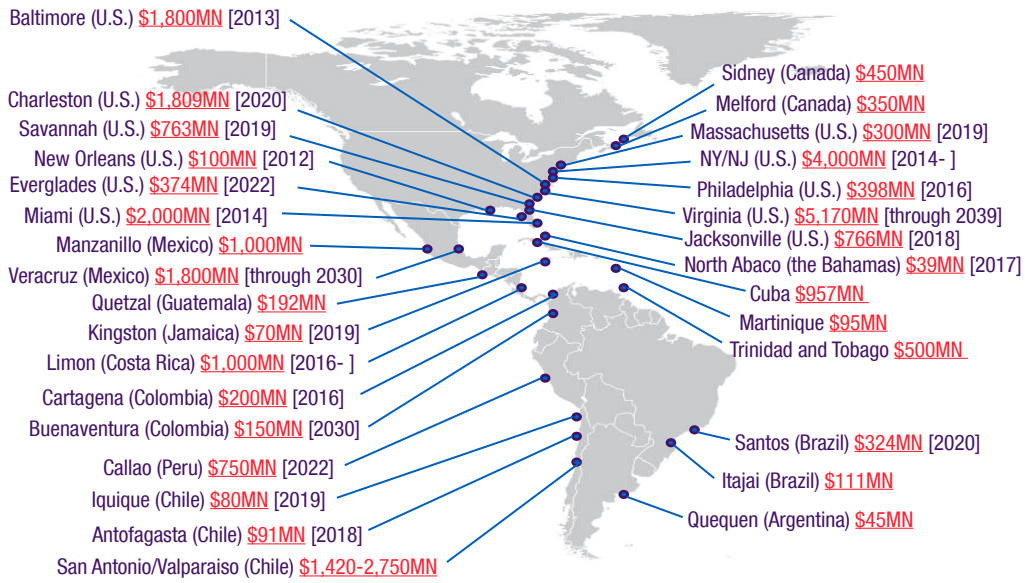
Source: IMF staff estimates.
Note: Dashed lines denote 90 percent confidence intervals.

Box 5.2. Post-Panamax Port Investments in the Western Hemisphere

The Panama Canal is a 50-mile waterway connecting the Atlantic and Pacific Oceans, which guides more than 13,000 ships a year through a system of locks that lifts them 26 meters (85 feet) above sea level. A new $5.3 billion expansion will install a third, larger lane of locks and provide additional depth throughout the long passage. The project, expected to be completed in mid-2016, will double the canal's capacity, allowing it to accommodate larger post-Panamax vessels that now carry a significant percentage of shipping containers worldwide.[1] This project is having large multiplier effects spread across the region's logistics network. About $25 billion of port investments have been executed or are ongoing or planned throughout the Western Hemisphere to accommodate the post-Panamax ships that will go through the new set of locks—nearly five times the value of the expansion project (Figure 5.2.1).

The expansion will also generate large spillovers by reducing transportation costs. International cargo shipping involves economies of scale; the annual operating cost per unit of transportation capacity is estimated to be 37.4 percent lower for post-Panamax than for Panamax vessels. Assuming a conservative scenario in which the canal maintains its current share of 5 percent of global trade and post-Panamax vessels continue to transport 45 percent of cargo, we estimate that the total reduction in transportation costs would amount to at least $8 billion each year.

Figure 5.2.1. Planned Port Investments to Accomodate Post-Panamax Ships



Source: IMF staff estimates based on various news and government sources.

Note: This box was prepared by Ana Ahijado, Diego Cerdeiro, Metodij Hadzi-Vaskov, and Fang Yang.

[1]Post-Panamax vessels accounted for 16 percent of container ships and 45 percent of the fleet's capacity in 2012, and are expected to comprise 27 percent and 62 percent, respectively, by 2030. ("U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels," Institute for Water Resources, U.S. Army Corps of Engineers, June 20, 2012.)

Box 5.3. Brazil: Infrastructure Bonds

Infrastructure bonds are a relatively recent and promising instrument. One of the barriers for private investors to finance infrastructure in Brazil is the difficult access to long-term financing. The state-owned development bank BNDES is the dominant provider of long-term funding at below-market rates. But it cannot be expected to provide all financing for infrastructure. To address this situation, in 2011 the government decided to grant tax benefits for fixed-income products created specifically to finance infrastructure investments,[1] one of them being infrastructure bonds, whose buyers benefit from income tax exemption.[2] Government certification that the infrastructure project is in fact a priority in one of several targeted sectors is required for the issuance of the bonds with tax benefits for the holder.

Infrastructure bonds also aim to bring broader benefits for the development of capital markets, supporting the objectives of lengthening the private sector yield curve. To obtain the tax benefits, it must be a fixed rate bond or linked to an inflation index or a referential rate. Floating rate bonds (for example, linked to the central bank's Selic rate) are not allowed. Its average maturity must be of at least four years and the issuer cannot buy it back in the first two years, and it cannot be prepaid.

The importance of infrastructure bonds is still relatively modest (Figure 5.3.1). Since 2012, 74 infrastructure bonds associated with projects authorized by the ministries were issued, totaling 5.8 billion reais. This represents about 5.2 percent of total private bonds issued over the period. On average, spread of infrastructure bonds over the benchmark public bond is 124 basis points, although some of them have been issued at a lower cost than the government funding.

The share of infrastructure bonds in total private bonds is expected to grow, but their growth faces obstacles. The usefulness of the bonds has been boosted because projects included in the second phase of the government's program of investment in logistics (PIL II), with the exception of railway projects, will have access to a greater share of BNDES loans at low interest rates provided that at least 10 percent of the project capital is financed using infrastructure bonds. An obstacle to the growth in infrastructure bonds, however, is their relatively low liquidity and low premium compared with standard government bonds. Foreign investors, who still typically owe taxes on income from these bonds in their own jurisdictions, are therefore not sufficiently attracted to them.

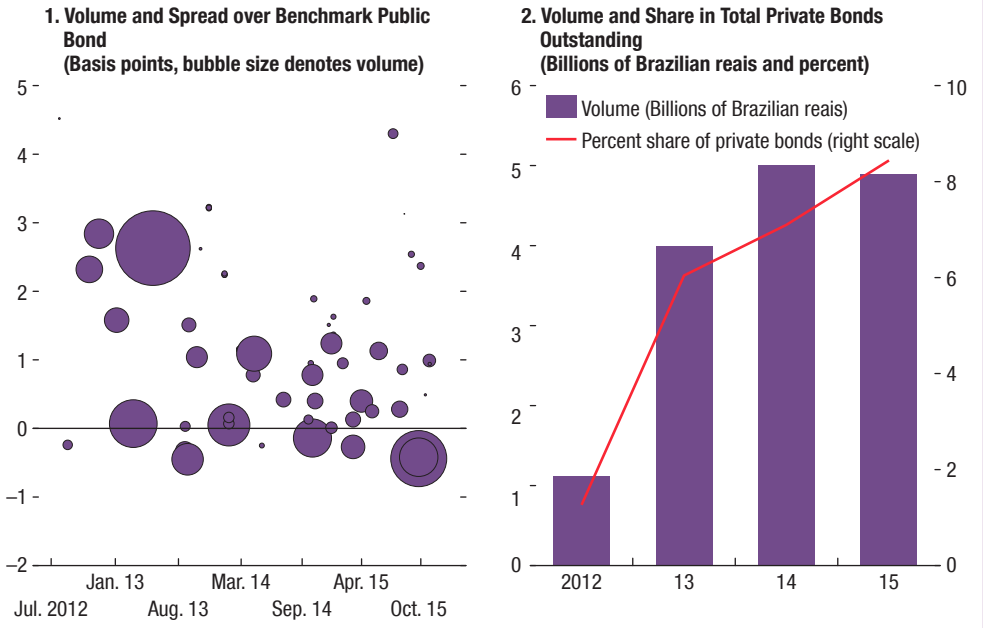
Note: This box was prepared by Flávia Barbosa.

[1]Federal Law 12,431, of June 24, 2011.

[2]Foreign and resident investors benefit from zero income tax, while domestic corporate investors pay 15 percent (instead of the regular 25 percent). Special provisions apply also for investment funds with at least 85 percent of capital invested in corporate bonds related to an investment project.

Box 5.3 *(continued)*

Figure 5.3.1. Brazilian Infrastructure Bonds
(Volume, spread, and share)



Sources: IMF staff estimates with national authorities' data.

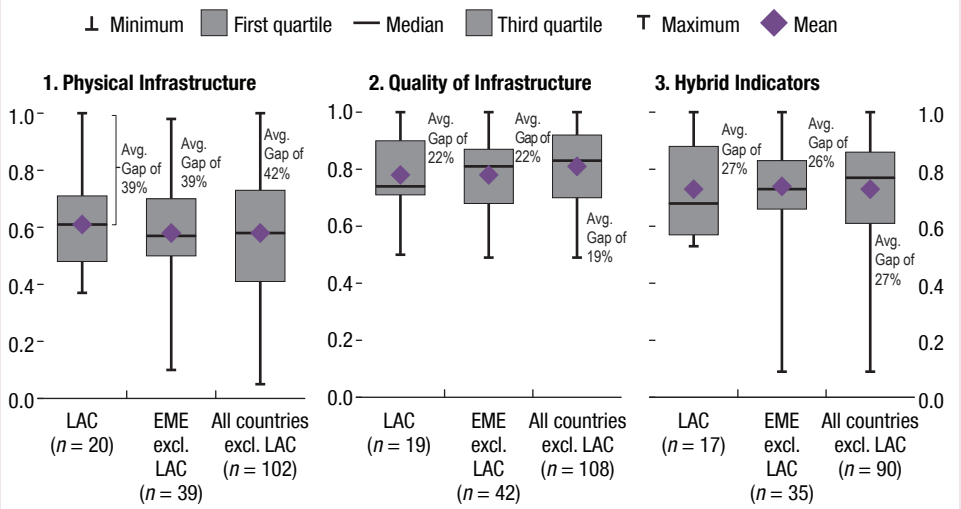
Box 5.4. Estimating Public Investment Efficiency

The Public Investment Efficiency Indicator (PIE-X) estimates the relationship between the public capital stock and income per capita, on the one hand, and indicators of access to (and the quality of) infrastructure assets in more than 100 countries on the other.[1] Countries with the highest levels of infrastructure coverage and quality (output) for given levels of public capital stock and income per capita (inputs) form the basis of an efficiency frontier (a surface in three-dimensional space that envelops the data points). Countries are assigned a PIE-X score of between 0 and 1 based on their vertical distance to the frontier (countries right on the frontier get a score of 1). The indicator of infrastructure quality and access combines physical and survey-based indicators into a synthetic index (see Figure 5.11 in the main text):

- The physical indicator combines data on the volume of economic infrastructure (length of road network, electricity production, and access to water) and social infrastructure (number of secondary school teachers and hospital beds).
- The survey-based indicator relies on the World Economic Forum's survey of business leaders' impressions of the quality of key infrastructure services.
- A hybrid indicator combines the physical and survey-based indicators into a synthetic index of the coverage and quality of infrastructure networks.

The *efficiency gap* is measured as the distance between the average country and the frontier for a given level of public capital stock and income per capita (Figure 5.4.1).

Figure 5.4.1. Public Investment Efficiency Index



Source: IMF staff estimates.
Note: EME = emerging market economies; LAC = Latin America and the Caribbean.

Note: This box was prepared by Svetlana Vtyurina and adapted from IMF (2015b).

[1]A more detailed discussion of the measurement of infrastructure performance as well as the construction of PIE-X can be found in Annex II of IMF (2015b). The number of countries with available PIE-X scores ranges from 114 to 134 depending on the model used.

Box 5.5. Peru: Public Investment Management

Peru's system of national public investment (SNIP), created in 2000, is the main instrument to manage the country's investment projects. The SNIP is comprehensive and is mandatory for all projects implemented by the central and subnational governments (the nonfinancial public sector). The system centralizes the control of all phases of the project (feasibility, implementation, and ex-post assessment). During the feasibility phase, alternatives are studied, and project selection is based on the highest expected socioeconomic return. During the implementation phase, the project is further detailed through final studies and the preparation of executive projects. Then, as the project enters the operational and maintenance phases, an ex-post assessment is performed.

The SNIP is supported by the Investment Project Bank, which registers each phase of investment projects from the feasibility study to the ex-post evaluation.[1] The system is publicly available and provides information on the status of ongoing projects. The Directorate General of Investment Policy at the Ministry of the Economy and Finance is responsible for SNIP management, and a unit in each ministry and subnational government is responsible for operating the SNIP. The system controls five stages of each project: (1) feasibility study, (2) feasibility statement, (3) implementation, (4) monitoring, and (5) ex-post assessment.

Several units are involved in the project approval process: (1) the implementation units propose the projects, (2) sectoral programming and investment offices or regional and local governments evaluate and prepare the feasibility statement, (3) authorities at the different levels of government have the responsibility for project identification, and (4) implementation units at the different levels of government are responsible for implementation, monitoring, and ex-post assessment.

The Multiannual Public Investment Program details the implementation of investments for the year and projected expenditure for the following three years. Information is available on the total cost of each project and the amount invested to date, although the system could be updated in a more timely fashion, especially with information on the stage of project execution at the municipal level. Information is available on the SNIP website (http://www.snip.gob.pe).

Note: This box is based on Pessoa, Fainboim, and Fernandez (2015).

[1]In certain cases, the evaluation of projects depends on the Ministry of the Economy and Finance, as in the case of projects proposed by subnational governments that need a central government guarantee.

Box 5.6. Colombia: Regulatory and Institutional Changes to the Public-Private Partnership Framework

The legal and regulatory framework governing Colombia's public-private partnerships has evolved over time since its first adoption in the mid-1990s. Under an earlier framework, the license holders and institutional investors contributed a low share of equity capital to projects (for example, first-, second-, and third-generation road projects). This created a system of poor incentives for private sector participants and led to delays in completion of the works, with legal and financial implications.

During 2010−14, the authorities undertook regulatory and institutional changes to enhance the efficiency of infrastructure investment and facilitate financing by institutional investors. They created the Vice-Ministry of Infrastructure, the National Infrastructure Agency (ANI), and the National Development Bank (FDN). The Infrastructure Law was expedited to address bottlenecks in the relocation of utilities networks and purchase of land. In 2014, amendments were made to the regulatory framework related to investment regimes and larger individual credit limits for institutional investors to provide incentives for domestic private sector participation in projects, including from pension funds and insurance companies.

In 2012, a new public-private partnership law was passed that significantly addressed the previously identified problems and aimed at regulating public-private partnerships in a systematic manner. The law eliminated the possibility for the private sector to request cash advances and limited amendments to contracts to a maximum of 20 percent of the value of the original contract. Government payments to the concessioner were linked to the quality of infrastructure services provided. A decision to pursue a public-private partnership would need to be based on sound socioeconomic and technical studies, and the responsibilities of the parties involved in the process needed to be clearly defined. The law also included an improved gateway process for the Ministry of Finance and Public Credit, and regulated unsolicited proposals for public-private partnerships. In addition, to improve the capacity of the government to manage fiscal costs and risks arising from public-private partnerships, the law introduced as a general principle that risks should be borne by the partner (that is, public or private sector) most suited to handle them.

Note: This box was prepared by Valerie Cerra and Kristine Vitola.

Annex 5.1

Determinants of Infrastructure: The Role of Fiscal Policy and Private Participation

This annex presents estimates of the determinants of infrastructure, based on Agénor and Neannidis (2015) and Calderón and Servén (2010). The model specification is as follows:

$$Infra^{n}_{it} = \beta^{n}_{0} GDP_{it-1} + \sum_{j=1}^{3} \beta^{n}_{1j} Infra^{j}_{it} +$$

$$\sum_{k=1}^{k-1} \beta^{n}_{2k} Fisc^{k}_{it} + \sum_{l=1}^{m} \beta^{n}_{3l} X^{l}_{it} + B^{n}_{4} DEBT_{it} + \mu_{it}$$

where i and t are the country and time indices, respectively; GDP_{it} is the log of GDP per capita (purchasing power parity, constant terms); $Infra^{j}_{it}$ denotes the log of infrastructure of type j (telecommunication, power, and transport, measured by fixed telephone lines per 100 people, electricity generation capacity (in gigawatts), and road density in kilometers of roads per square kilometer, respectively). This specification takes into account (1) the heterogeneity of infrastructure assets, (2) their interconnectedness in stock accumulation and the growth process, and (3) their different dynamics depending on policy priorities. As in Agénor and Neannidis (2015), the model imposes the government budget identity $\sum_{k=1}^{k-1} Fisc^{k}_{it} = 0$ (tax revenue, nontax revenue, noninterest current expenditure, capital expenditure, primary balance as a percent of GDP) excluding one fiscal variable (nontax revenue, in this analysis) to avoid linear dependence (multicollinearity is likely still present, though, potentially affecting the significance of individual coefficients). X^{l}_{it} is a set of standard control variables for growth and infrastructure (credit to the private sector, inflation, trade openness, fertility rate, urbanization rate, population density, rule of law, private sector participation in investment). ε_{it} and μ_{it} are the error terms, including both country- and time-specific effects.

The model is estimated using a dynamic panel of 110 countries (advanced Europe, Canada and the United States, emerging Asia, LAC, and sub-Saharan Africa) during 1990–2013. Data sources include Dealogic, the Energy Information Agency, IMF's *World Economic Outlook* and Government Finance Statistics, the IMF's Fiscal Affairs Department, the International Telecommunication Union, the World Bank, the World Economic Forum, and Worldwide Governance Indicators. To verify the robustness of results, four alternative model specifications are estimated: a least squares dummy variable (LSDV) and a bias corrected version (LSDVC), which follows Bruno (2005), as well as difference and system IV-generalized method of moments estimators based on Arellano and Bond (1991) and Arellano and Bover (1995).[1]

The results are qualitatively similar for both the full and LAC samples, although some of the results appear stronger in the LAC sample. The net impact of public investment on electricity and transport infrastructure stocks may depend on how the investment is financed (new debt, tax increases, or current spending cuts). For example, a 1 percent increase in the public-capital-to-GDP ratio financed through debt will lead to an increase in road density of up to 0.041 percent for the full sample and 0.175 percent for LAC. A 1 percent increase in the public-capital-to-GDP ratio fully financed (in the same year) by an equivalent 1 percent rise in the tax-to-GDP ratio[2] would lead to an average increase in road density of up to 0.035 percent for the full sample and to 0.163 percent for LAC. A 1 percent increase in capital spending financed by a 1 percent cut in current spending[3] will raise road density up to 0.062 percent for the full sample and up to 0.225 percent for LAC. A similar exercise for electricity generation suggests that the reaction to debt-financed public investment is stronger in LAC than in the full sample, whereas the reaction to public investment that is financed with savings elsewhere in the budget is stronger in the full sample. (The significance of these net effects has not been tested; Annex Tables 5.1.1 and 5.1.2 show individual coefficients' significance levels as measured by *p*-values.)

[1]The LSDVC estimator is also suitable for unbalanced dynamic panels. Typically, the LSDV bias is corrected by corrected LSDV estimator (Kiviet 1995, 1999; and Bun and Kiviet, 2003) compared with more traditional GMM estimators when N is only moderately large.

[2]This simulation neither distinguishes between types of taxes (trade, income, property, consumption taxes) nor whether the increase comes from a tax rate change or an increase in the tax base.

[3]The shock does not discriminate among the types of current spending (that is, wages, social benefits, or transfers, goods and services, and so on).

Annex Table 5.1.1. Determinants of Infrastructure: Latin America and the Caribbean

	Dependent Variable: Log Fixed Telephone Lines per 100 people				Dependent Variable: Log Electricity Generation Capacity				Dependent Variable: Log Road Density (km of roads per square km)			
	(1) LSDV	(2) LSDVC	(3) Diff. GMM	(4) Sys. GMM	(1) LSDV	(2) LSDVC	(3) Diff. GMM	(4) Sys. GMM	(1) LSDV	(2) LSDVC	(3) Diff. GMM	(4) Sys. GMM
Lagged Variables												
LN GDP per Capita, Constant PPP (t–1)	0.333**	0.304***	0.405***	0.007	0.356***	0.327***	0.359***	–0.039	–0.012	–0.032	–0.004	–0.029***
LN Fixed Telephone Lines per 100 people (t–1)	0.812***	0.918***	0.757***	0.985***	0.033	0.023	0.032	0.023	–0.046**	–0.03	–0.055**	0.025***
LN Electricity Generation Capacity (t–1)	0.154**	0.127*	0.18**	0	0.442***	0.526***	0.43***	0.998***	0.033	0.03	0.02	0.002
Road Density (km of roads per square km) (t–1)	–0.193	–0.06	–0.307**	–0.01***	–0.047	–0.05	–0.055	–0.001	0.72***	0.839***	0.696***	1.003***
Fiscal												
Tax Revenues, Share of GDP	0.517	0.303	0.187	0.105	–0.64	–0.651*	–0.649	–0.059	–0.238	–0.231	–0.28	–0.001
Current Expenditures, Share of GDP	0.438	0.43	0.505*	–0.105	0.541**	0.536*	0.541**	0.122	–0.159	–0.136	–0.199	–0.061
Capital Expenditures, Share of GDP	0.326	0.323	0.387	0.186	0.832**	0.788***	0.838**	0.339*	0.002	0.038	–0.035	0.164*
Primary Balance, Share of GDP	–0.036	–0.007	0.062	–0.156	0.815***	0.805**	0.802***	0.199	0.028	0.021	–0.014	–0.035
Debt-to-GDP ratio	0.015	0.014	–0.001	–0.041	–0.06	–0.056	–0.064	–0.074***	–0.001	0.005	–0.001	0.009
Macro												
Private Participation in Investment, constant U.S. dollars	–0.309***	–0.305***	–0.298***	–0.002	0.123*	0.094	0.13**	0.006	0.022	0.023	0.04	0.005**
Consumer Price Inflation, yearly average	–0.004	0.009	0.139	–0.028	0.013	0.018	0.01	0.116	–0.062	–0.061	–0.047	–0.079**
Trade Openness, Share of GDP	0.069	0.032	0.079	0.01	–0.031	–0.026	–0.027	0.005	0.033	0.034	0.052	0.004
Credit to Private Sector, Share of GDP	–0.203***	–0.185**	–0.207***	–0.019	0.031	0.022	0.033	0.022	0.047	0.044	0.063*	0.006
Observations	356	314	170	314	352	314	170	314	352	314	170	314
Number of countries	24	23	21	23	24	23	21	23	24	23	21	23
Chi-squared			137.3	174.5			152.3	200.6			137.3	174.5
Sargan-Hansen Statistic, p-value			0.78	0.81			0.79	0.89			0.79	0.81

Source: Authors' estimates.

Note: LSDV = least square dummy variable; LSDVC = least square bias-corrected dummy variable, following Bruno (2005); Diff. GMM = difference generalized method of moments (GMM), following Arellano and Bond (1991); Sys. GMM = system GMM, following Arellano and Bover (1995). All of the regressions also include a vector of control variables with the following variables that are not reported in the table: fertility rate; urbanization rate; population density; and rule of law governance indicator. PPP = purchasing power parity.

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Annex Table 5.1.2. Determinants of Infrastructure: Full Sample

	Dependent Variable: Log Fixed Telephone Lines per 100 people				Dependent Variable: Log Electricity Generation Capacity				Dependent Variable: Log Road Density (km of roads per square km)			
	(1) LSDV	(2) LSDVC	(3) Diff. GMM	(4) Sys. GMM	(1) LSDV	(2) LSDVC	(3) Diff. GMM	(4) Sys. GMM	(1) LSDV	(2) LSDVC	(3) Diff. GMM	(4) Sys. GMM
Lagged Variables												
LN GDP per Capita, Constant PPP (t–1)	–0.054	–0.095	0.126***	–0.014	0.084**	0.082**	–0.11	0.035*	0.006	0.001	0.009	–0.005**
LN Fixed Telephone Lines per 100 people (t–1)	0.937***	1.043***	0.67***	1.016***	–0.006	–0.006	–0.022***	0.007	–0.001	–0.002	0.007***	0.001
LN Electricity Generation Capacity (t–1)	0.068	0.063	0.132***	0.004	0.588***	0.674***	0.61***	0.998***	–0.001	–0.001	–0.005	0.001
Road Density (km of roads per square km) (t–1)	0.168*	–0.113	–0.385***	–0.004	–0.016	–0.015	0.459**	0.008	0.907***	0.969***	0.886***	1***
Fiscal												
Tax Revenues, Share of GDP	0.008	–0.113	0.602*	–0.088	0.015	–0.058	0.801**	–0.202	–0.011	0	0	–0.008
Current Expenditures, Share of GDP	–0.134	–0.189	0.077	0.11	–0.165	–0.145	0.245	–0.036	–0.025	–0.025	–0.019**	–0.019
Capital Expenditures, Share of GDP	0.089	0.033	–0.09	–0.137	0.438**	0.423**	0.322	0.223	0.038	0.049	–0.023**	0.043*
Primary Balance, Share of GDP	0.08	0.095	0	–0.047	0.166*	0.189**	0.296***	0.064	–0.011	–0.009	–0.03***	–0.038*
Debt-to-GDP ratio	0.01	0.027	–0.002	–0.028**	–0.056**	–0.047***	–0.063***	–0.021*	0	–0.003	–0.003*	–0.002
Macro												
Private Participation in Investment, constant U.S. dollars	0.017	0.012	–0.103***	0.002	0.073***	0.051**	0.268***	–0.005	0.005	0.001	0.01***	0.001
Consumer Price Inflation, yearly average	–0.042	–0.043	–0.001	–0.021	–0.014	–0.013	–0.056***	0.004	0.012	0.011	0.013**	0.004
Trade Openness, Share of GDP	0.079	0.074	0.034*	0.007	–0.052*	–0.056*	–0.044**	0.009	0.004	0	0.009***	0.003
Credit to Private Sector, Share of GDP	–0.01	0.007	–0.159	–0.025	0.009	0.007	–0.196**	0.009	0.005	0	0.009	0.001
Observations	789	789	702	789	790	790	703	790	713	713	630	713
Number of countries	83	83	78	83	83	83	78	83	79	79	73	79
Chi-sqared			43.46	48.36			47.16	49.96			47.77	43.62
Sargan-Hansen Statistic, p-value			0.99	0.99			0.99	0.99			0.99	0.99

Source: Authors' estimates.

Note: LSDV = least square dummy variable; LSDVC = least square bias-corrected dummy variable, following Bruno (2005); Diff. GMM = difference generalized method of moments (GMM), following Arellano and Bond (1991); Sys. GMM = system GMM, following Arellano and Bover (1995). All of the regressions also include a vector of control variables with the following variables that are not reported in the table: fertility rate; urbanization rate; population density; and rule of law governance indicator. PPP = purchasing power parity.

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.