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Highways to Heaven: Infrastructure Determinants and Trends in Latin America and the Caribbean

by Valerie Cerra, Alfredo Cuevas, Carlos Goes, Izabela Karpowicz, Troy Matheson, Issouf Samake, and Svetlana Vtyurina

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Abstract

Inadequate infrastructure has been widely viewed as a principal barrier to growth and development in Latin America and the Caribbean. This paper provides a comprehensive overview of infrastructure in the region and highlights key areas in which infrastructure networks can be enhanced. The public and private sectors play complementary roles in improving the infrastructure network. Therefore, it is critical to strengthen public investment management processes as well as the regulatory framework, including to ensure an appropriate mix of financing and funding for projects and to address environmental concerns.

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Keywords: Latin America and the Caribbean, infrastructure, public investment, investment efficiency, public-private partnerships.

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I. INTRODUCTION

Inadequate infrastructure has been widely viewed as one of the principal barriers to growth and development in Latin America and the Caribbean (LAC). 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 raise hurdles to investment, which, in turn, constrain growth. Recognizing this, many countries in LAC have recently turned their attention to investment in infrastructure to support demand and to bolster their productive capacity over the longer term.

This paper provides an overview of the current state of LAC's infrastructure using cross-country comparisons and highlighting areas in which infrastructure across the region can be enhanced.[1] The region's infrastructure has been upgraded over the past decade, reflecting both an increase in public investment, facilitated by the commodity boom, and private greenfield investment, notably in sectors where regulatory impediments had been alleviated. Deepening domestic capital markets have helped to finance an increasing fraction of private investment in local currency. Nonetheless, the region still faces considerable catch-up relative to advanced economies, and infrastructure quality in several countries is lower than in their export rivals. In addition, for most LAC countries, the efficiency of public investment remains well 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 foster greater private participation.

The paper is organized as follows. Section II presents cross-country comparisons of stock and quality of infrastructure; Section III discusses the determinants of infrastructure, including fiscal policies, and available financing options; Section IV discusses investment efficiency; Section V describes the evolution and the state of PPP frameworks; and

[1] An earlier version of this paper appeared in the IMF's April 2016 *Regional Economic Outlook* for the Western Hemisphere. The main improvements in this version are the use of a richer set of international comparators, the addition of new statistical analysis to the discussion of financing issues, and the inclusion of a discussion of environmental issues.

Section VI offers suggestions for developing green infrastructure. Section VII concludes with key policy challenges facing LAC countries.

II. INFRASTRUCTURE IN LAC: WHERE DO WE STAND?

In this section, infrastructure indicators from 24 countries in LAC and the region's 6 largest economies (LAC6) are compared with averages from several other regions, comprising 42 countries in Sub-Saharan Africa (SSA), 10 countries in Emerging Asia (EMA),12 countries in Emerging Europe, 20 countries in Advanced Europe (EUR), and Canada and the U.S. This group, although not universal, spans a broad range of experiences relevant for LAC and thus offers a useful benchmark. Due to data limitations related to data coverage of social infrastructure (schools and hospitals etc.), the focus here is on three key types of economic infrastructure, namely transport, energy, and telecommunications. The data are described in more detail in the Appendix Table 1.

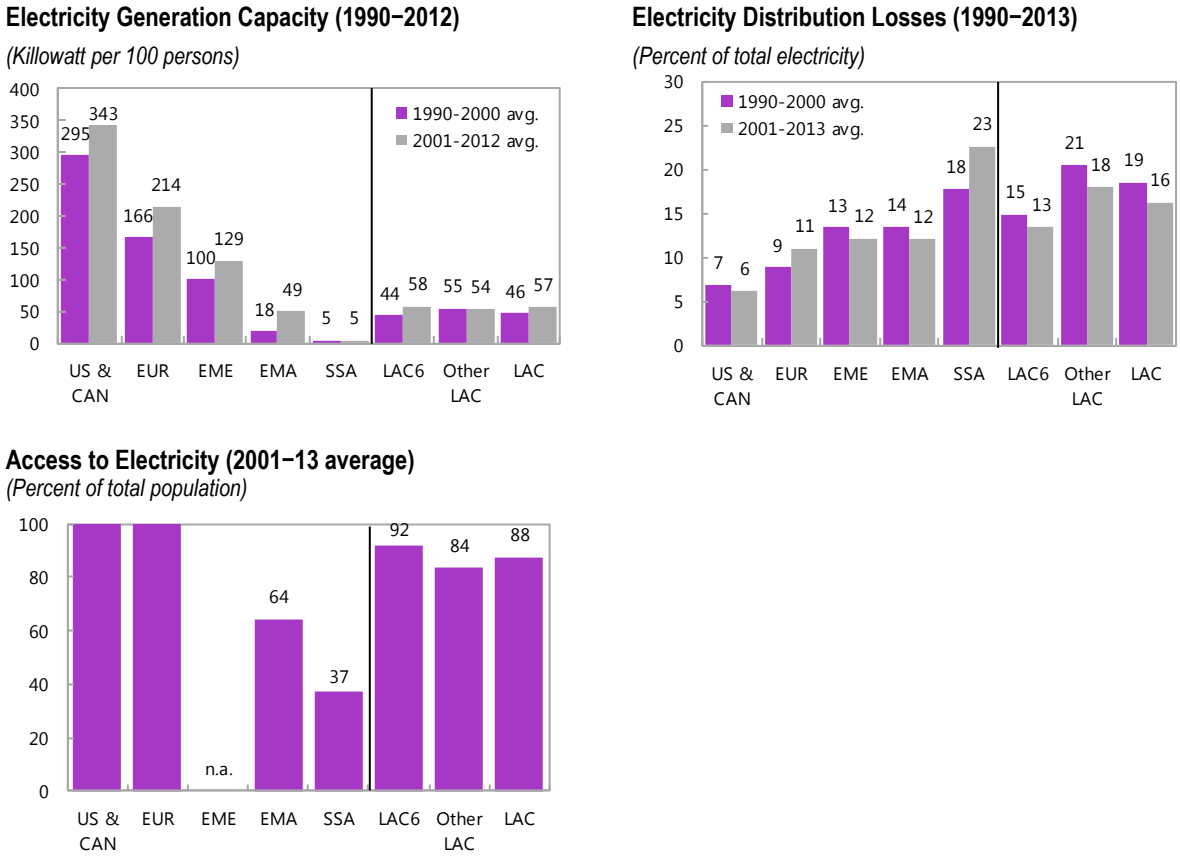
Comparing Infrastructure Levels across Regions

On average, the stock of economic infrastructure—power generation capacity, road networks, and telephone lines—in LAC economies compares favorably with that of peers in some other emerging market regions, but it still lags behind advanced economies by most standard measures, with differences being starkest in electricity generation capacity (Figure 1). While infrastructure stocks have generally been rising in LAC, the gains do not compare favorably with those in fast-growing regions (for example, Emerging Asia).

- Electricity infrastructure networks have expanded notably in LAC recently but gaps relative to advanced economies remain large. For example, the results show that 12 percent of the population in LAC did not have electricity coverage on average over 2001−13 compared to virtually full coverage in Advanced Europe, Canada and the U.S. over the same period. Although electricity generation capacity in LAC is similar to Emerging Asia, at slightly more than 50 kilowatts per 100 persons, it compares poorly with twice that level in Emerging Europe and more than 200 and 300 kilowatts per 100 persons in Advanced Europe and U.S. and Canada, respectively.[2]

[2] Gaps within the LAC sub-regions are relatively limited, partly due the relatively strong progress made by countries in six Central American countries (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama). These countries created the "Electricity Interconnection System of the Central American Countries" in late 1996, which has become a basis for a regional electricity market and is also connected to Mexico through a Mexico-Guatemala interconnection.

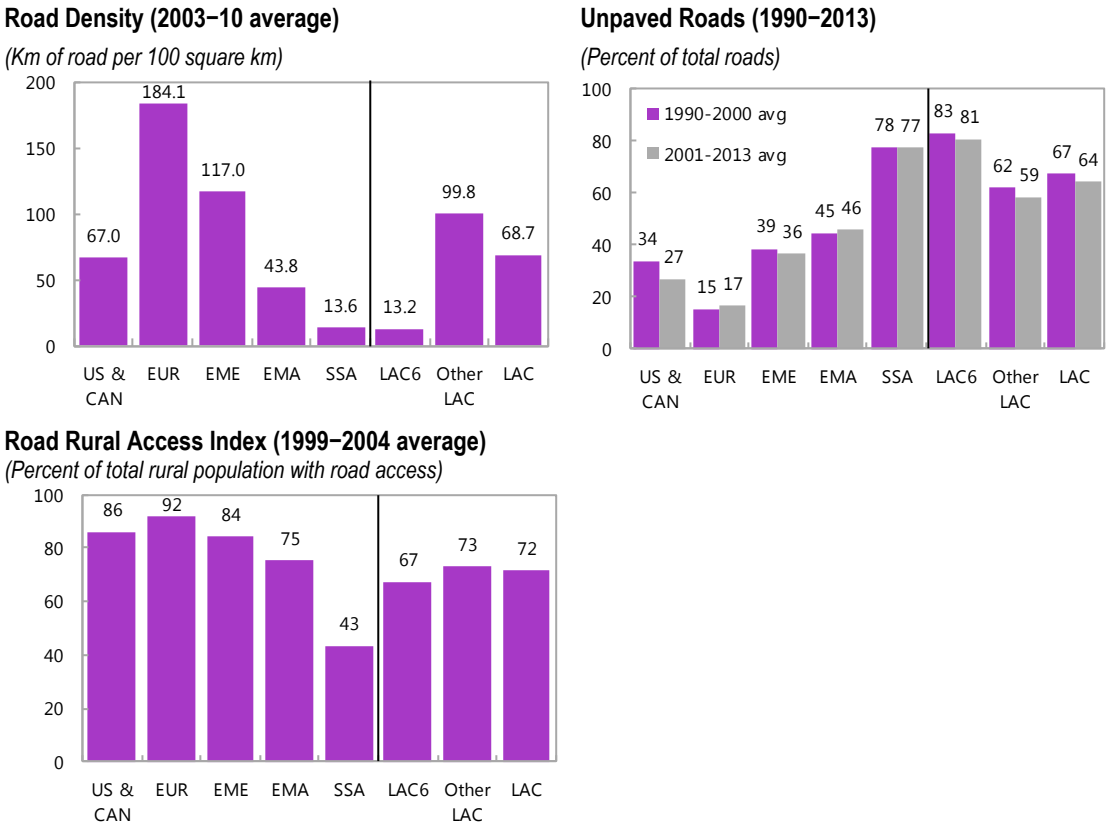
Figure 1 − Electricity Infrastructure Indicators



Sources: Energy Information Agency; World Bank; and IMF staff calculations.
US & CAN = United States and Canada; EUR = Advanced Europe; EME = Emerging Europe; EMA = Emerging Asia; SSA = Sub-Saharan Africa; LAC = Latin America and Caribbean; LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, Peru. Sources: Energy Information Agency; World Bank; and IMF staff calculations.

LAC's road infrastructure availability also faces large gaps (Figure 2). LAC6 lags behind both emerging and advanced economies in terms of road density, measured as km of road per 100 square km of land area. For every 100 km^2 of land, there is only 13.2 km of road in LAC6 on average compared to 43.8 km in Emerging Asia; the gap is even wider when compared to Canada, the U.S., and Europe. At the same time, the quality of LAC's roads (measured by the share of unpaved roads to total roads) is poorer than all regions except Sub-Saharan Africa.

Figure 2 – Road Infrastructure Indicators

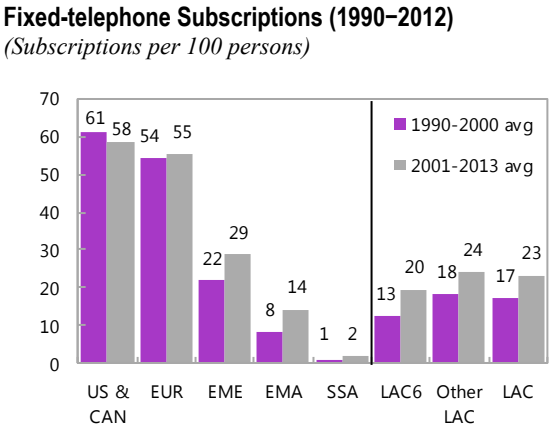


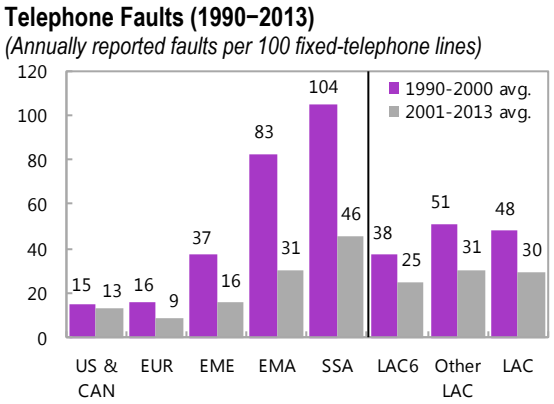
Sources: World Bank; International Road Federation; and IMF staff calculations.
US & CAN = United States and Canada; EUR = Advanced Europe; EME = Emerging Europe; EMA = Emerging Asia; SSA = Sub-Saharan Africa; LAC = Latin America and Caribbean; LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, Peru.

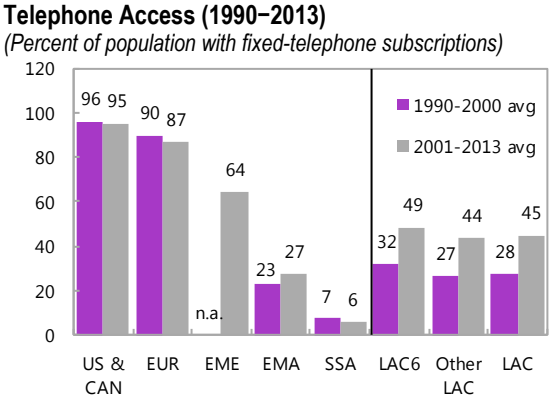
The mixed record on telecommunications suggested by Figure 3 is heavily influenced by technological progress. As in a number of emerging economies, the gap in utilization of fixed telephone lines in LAC was filled through more extensive usage of mobile phone networks that serve a variety of needs, including by providing payment and money transfer services. Indeed, while LAC lags behind its main comparators on fixed telephony, the region has made impressive advances in mobile phone and broadband services. While only 45 percent of the region's population has a fixed-line telephone, mobile phone coverage exceeds 98 percent of the population. From less than 3 percent of the population in early 1990, computer and internet usage rose to 19 percent of the population in 2014. The region's average use of broadband at 7 percent is, however, low compared with other emerging and advanced economies, at 25 percent and 34 percent

respectively. Similar to Emerging Asia, Emerging Europe, and Sub-Saharan Africa, telephone infrastructure service quality in LAC (measured by annually reported faults per 100 fixed telephone lines) has improved significantly recently and the region is now on par with Emerging Asia, though still remains below advanced economies standards.

Figure 3 – Telecommunication Indicators







Sources: International Telecommunications Union; and IMF staff estimates.
US & CAN = United States and Canada; EUR = Advanced Europe; EME = Emerging Europe; EMA = Emerging Asia; SSA = Sub-Saharan Africa; LAC = Latin America and Caribbean; LAC6 = Argentina, Brazil, Chile, Colombia, Mexico, Peru.

Although a proper standard for infrastructure is often hard to define, the proximity to the "ideal" of 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 Emerging Asia and Sub-Saharan Africa in terms of access to electricity, but not so much concerning other measures such as rural access to roads.

Comparing Infrastructure Quality across Regions

LAC's overall infrastructure service quality, as summarized in the World Economic Forum (WEF) index, has improved more slowly than some of the other regional comparators. LAC's overall infrastructure service quality perception increased by 2.3 percent over 2006–15 compared with 4.9 percent in Emerging Asia, 4.4 percent in Emerging Europe, and 7.4 percent in Sub-Saharan Africa (Table 1 and Figure 4). The overall rankings of Argentina, Brazil, Chile, and Venezuela have worsened for a variety of reasons: because of worse electricity supply (Argentina), roads (Argentina, Chile, and Venezuela), ports (Argentina, Brazil, Venezuela), air transport (Argentina, Brazil, Chile), and railroads (Argentina, Brazil, and Venezuela).

The quality of infrastructure can also be compared to a country's 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 (Goes, 2016). Some countries (e.g., Venezuela, Bolivia, Paraguay, Argentina, and Brazil), where infrastructure investment has been modest recently, show lower-than-expected infrastructure quality in several areas (Figure 4). More generally, and with notable exceptions (e.g., El Salvador, Guatemala, and Panama), LAC countries tend to underperform relative to their per capita incomes, particularly in the case of railroads.

Table 1. Latin America: Changes in Infrastructure Quality (2006–15)

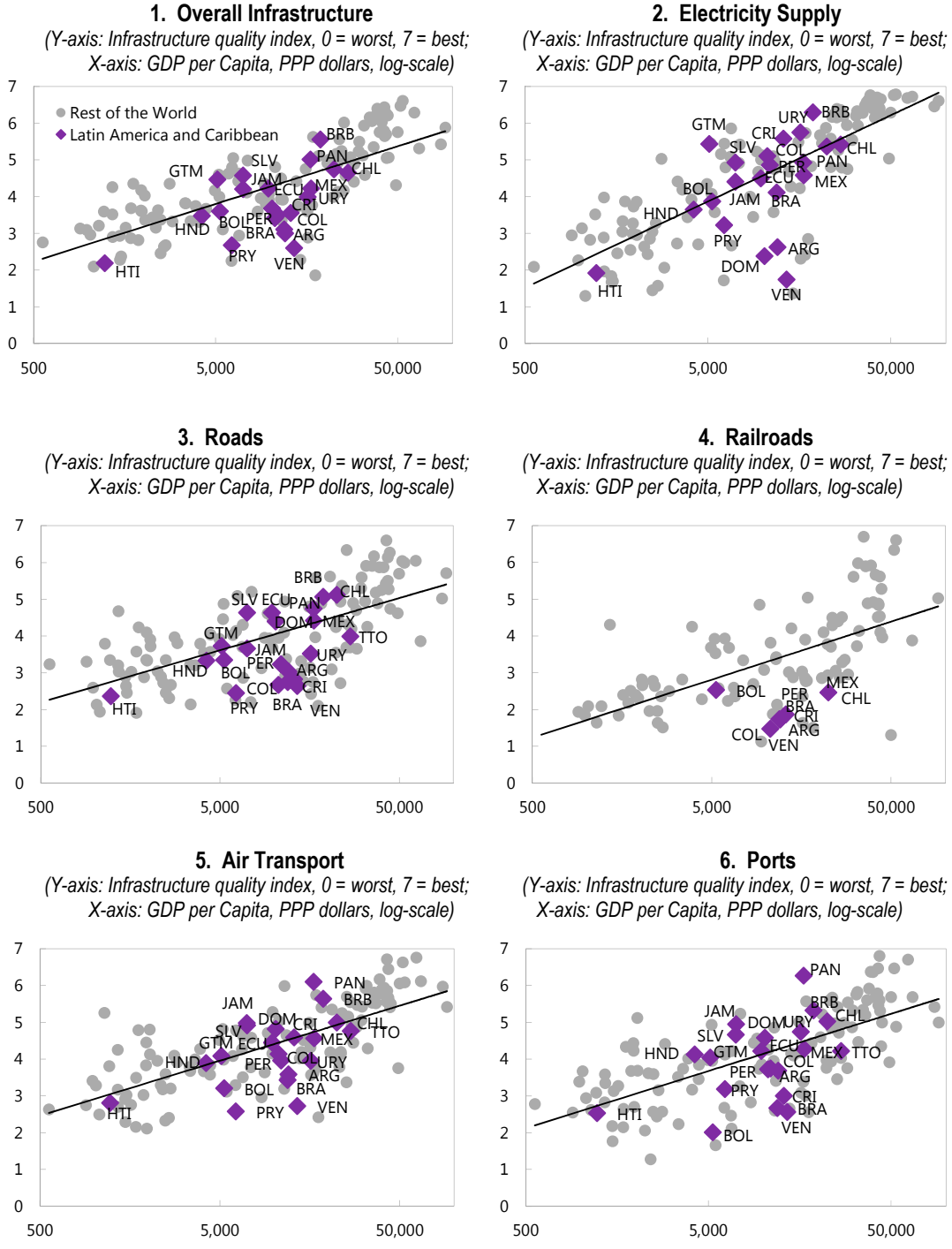
(Average annual percentage change)

		Telecommunications		Electricity		Transportation			
	Quality of Infrastructure	Mobile phones per capita	Internet Access	Electricity Generation Capacity	Quality of Electricity Supply	Quality of Roads	Quality of Ports	Quality of Air Transport	Quality of Railroads
Argentina	-1.6	18.2	15.7	2.4	-5.0	-0.8	0.5	-1.3	-1.8
Barbados	0.7	4.3	3.4	0.0	0.3	1.4	-0.1	-0.7	n.a.
Bolivia	6.3	19.2	29.3	1.7	-0.7	6.0	4.3	-0.2	4.4
Brazil	1.1	15.7	17.4	2.6	-1.8	1.6	0.0	-3.2	-0.6
Chile	-0.6	9.0	10.1	3.9	-0.5	-0.4	0.3	-1.3	2.0
Colombia	3.0	14.7	22.8	1.0	3.5	1.5	2.6	2.4	1.8
Costa Rica	2.1	18.3	21.5	3.9	0.6	0.4	2.9	-1.6	-0.3
Ecuador	3.8	23.6	7.7	3.1	0.5	3.2	3.1	0.4	4.4
Guyana	4.7	17.0	24.9	1.7	4.0	6.1	4.4	0.5	n.a.
Haiti	6.3	19.8	6.4	1.0	1.7	1.4	4.2	2.3	n.a.
Honduras	2.2	28.4	21.1	1.7	0.7	3.1	3.9	5.1	n.a.
Jamaica	1.8	2.2	-0.6	-2.6	0.5	1.1	0.1	0.1	n.a.
Mexico	1.2	9.9	14.0	1.3	-0.1	-0.2	-0.5	-1.0	n.a.
Nicaragua	1.9	27.0	24.2	5.2	1.7	1.8	2.7	-0.6	2.1
Panama	3.2	22.1	18.3	5.6	2.9	4.3	3.6	-0.7	n.a.
Paraguay	2.5	15.0	34.9	0.9	0.1	1.9	2.1	2.7	5.0
Peru	3.7	23.4	14.5	4.3	-0.6	2.9	3.2	-1.5	n.a.
Trinidad and Tobago	3.5	12.6	20.1	5.0	0.1	2.3	6.4	2.1	0.3
Uruguay	3.5	26.6	12.0	2.8	1.9	2.8	3.7	1.2	n.a.
Venezuela, RB	0.5	13.6	22.5	1.9	0.7	-1.4	1.0	1.9	-0.8
LAC	**2.3**	**15.9**	**13.1**		**0.4**	**1.7**	**2.3**	**-0.1**	**n.a.**
Emerging Asia	**4.9**	**23.2**	**16.9**		**4.3**	**4.5**	**3.7**	**2.2**	**n.a.**
Emerging Europe	**4.4**	**10.0**	**15.7**		**2.9**	**3.5**	**4.5**	**2.5**	**n.a.**
Subsaharan Africa	**7.4**	**32.4**	**26.8**		**4.2**	**7.6**	**8.0**	**5.1**	**n.a.**
Advanced Economies	**0.4**	**3.9**	**5.6**		**0.4**	**0.2**	**0.5**	**0.0**	**n.a.**

Source: Staff estimates, Energy Information Agency, and World Economic Forum

Above one standard deviation of LAC median
Within one standard deviation of LAC median
Below one standard deviation of LAC median

Figure 4 - World: Infrastructure Quality Indicators Relative to GDP per Capita (2014)

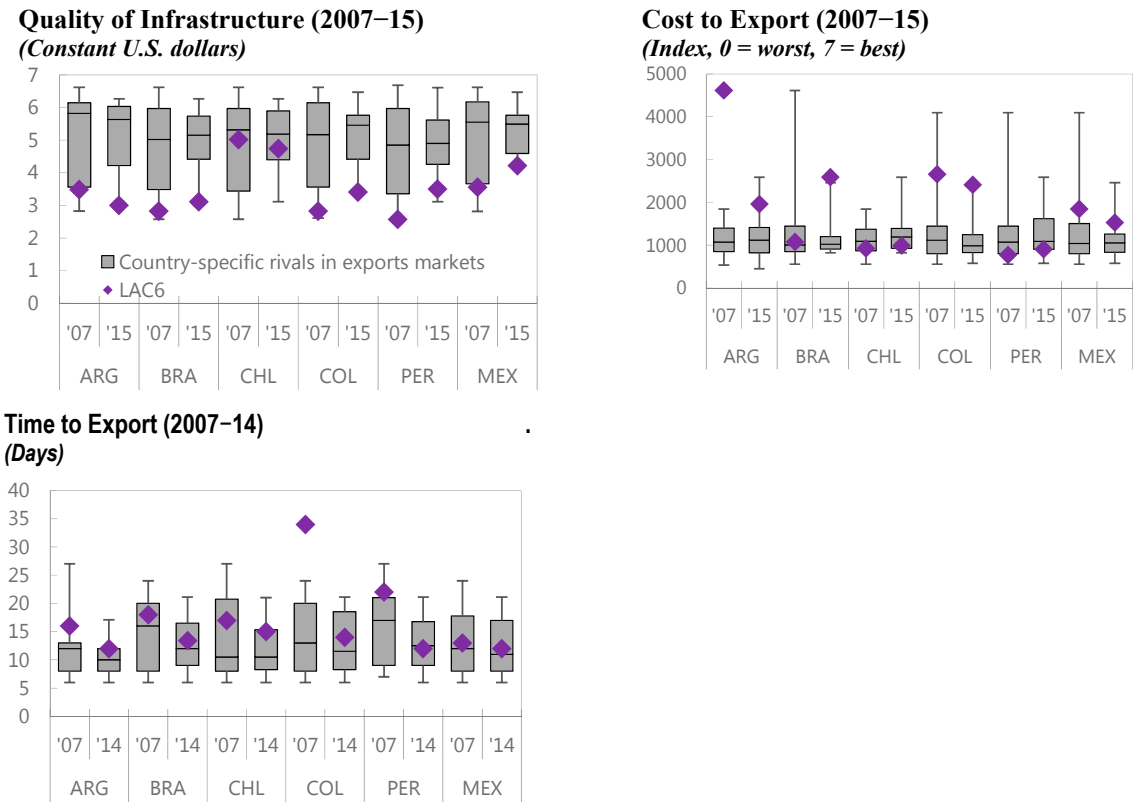


Sources: World Economic Forum; and IMF staff calculations.

Comparing Infrastructure to Competitors

Infrastructure is an important determinant of external competitiveness. Producers will be more reluctant to invest in a project in a country lacking the transport or logistical infrastructure required to take the product to the point of shipment, for example. To explore this angle, country-specific benchmarks were created for the region's six largest economies by identifying each country's top five competitors in each of its top five export products. The benchmark is the range of each indicator of infrastructure and competitiveness in the rival group (Figure 5). On this metric, Chile stands out as the only country with similar infrastructure to its trading rivals, though its position has declined vis-à-vis its rivals.

Figure 5 – LAC6 and Trade Rivals Comparison



Sources: IMF Staff estimates; based on WEF and UNCOMTRADE. 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.

While these comparisons broadly coincide with time- and cost-to-export comparisons, they do not account fully for export competitiveness. Mexico, with many export-oriented firms located near its border with the U.S., does better on time-to-export comparisons than it does on infrastructure quality. Peru is another counter-example, with relatively low cost of exporting. In this, as in other cases where exports include mining products, the existence of large rents may allow companies to build proprietary infrastructure, and after such investments are sunk, their export costs fall.

III. Selected Determinants of Infrastructure Investment

A. Econometric Analysis

To help identify some of the factors explaining differences in the levels and quality of infrastructure across countries, a model based on Agénor and Neanidis (2015) and Calderon and Serven (2010) is estimated using a variety of estimation techniques. The model is:

$$(1) \qquad Infra_{it}^{n} = \beta_0^n GDP_{it-1} + \sum_{j=1}^{3} \beta_{1j}^n Infra_{it}^{j} + \sum_{k=1}^{K-1} \beta_{2k}^n Fisc_{it}^{k} + \sum_{l=1}^{m} \beta_{3l}^n X_{it}^{l} + \beta_4^n DEBT_{it} + u_{it}$$

where *i* and *t* are the country and time indices, respectively; GDP_{it} is the log of GDP per capita (PPP, constant terms); $Infra_{it}^{j}$ is the log of infrastructure of type j (telecommunication, power, and transport, measured by fixed telephone lines per 100 people, electricity generation capacity, and road density in km of roads per km^2, respectively). This specification accounts for (i) the heterogeneity of infrastructure assets; (ii) their interconnectedness in stock accumulation and growth processes; (iii) their different dynamics depending on policy priorities.

As in Agénor and Neanidis (2015), the model imposes the government budget identity $\sum_{k=1}^{K} Fisc_{it}^{k} = 0$ (tax revenue, non-tax revenue, current expenditure, capital expenditure, primary balance, as a percent of GDP) excluding one fiscal variable (non-tax revenue) to avoid linear dependence. X_{it}^{l} are standard control variables for growth and infrastructure (private sector credit, inflation, trade openness, fertility rate, urbanization rate,

population density, rule of law, private sector investment). ε_{it} and u_{it} are the error terms for country- and time-specific effects.

The empirical analysis reveals a dispersion of regression estimates. Nevertheless, in general, results suggest that, in addition to the dynamism of each economy (represented by its GDP growth), the following factors tend to matter for infrastructure investment (Appendix, Tables 2 and 3).[3]

- ***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 as discussed below. A higher debt burden appears to deter increases in electricity generation capacity.
- ***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 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***. Infrastructure investment in LAC generally appears responsive to controls that measure aspects of economic or social development, such as the level of income, the degree of urbanization, population density, fertility, rising financial depth, and rule of law.

[3] For robustness, we estimated parsimonious specifications of the equations with fixed country and time effects, using a general to specific regression approach (results not shown, but available upon request).

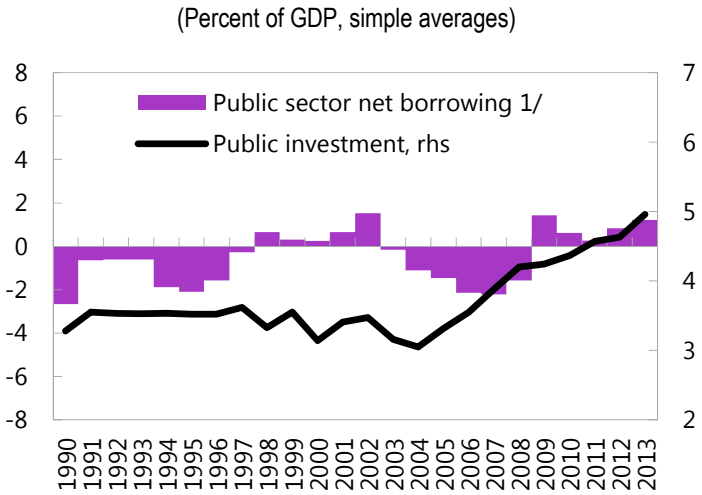
B. Fiscal Policy

Public finances have influenced the evolution and composition of infrastructure investment across the region. The fiscal adjustment programs in the 1980s featured large cuts in public investment (Calderon and Serven, 2010, and Fay and Morrison, 2006). Many governments in LAC (Argentina, Brazil, Mexico, and Peru) implemented partial adjustment programs accompanied by monetization of deficits in the absence of foreign financing.[4] 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 but a shift in its composition toward more private investment, helped by a wave of privatizations in the 1990s. Country experiences have, however, varied significantly. While Mexico and Chile 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 (Frischtak and Davies, 2014; Garcia-Escribano and others, 2015).

The commodity super-cycle has enabled investment in some resource-based countries in the LAC region. Although fiscal consolidation often tends to fall disproportionately on investment, the variation in public investment since the 1990s does not show a clear-cut link to government deficits, measured by public sector borrowing (Figure 6). Notably, in the early-to-mid 2000s in LAC, public investment rose despite strengthening public finances. During the Great Recession, LAC countries were typically able to accommodate the drop in revenues without cutting public investment. However, fiscal buffers were eroded in many countries since then (Celasun and others, 2015), and the sensitivity of public investment to revenue may increase going forward. Meanwhile, infrastructure (and overall) investment by the private sector has also been steadily rising since the mid-2000's with similar trends among other emerging and developing countries, as we discuss next.

[4] The strategy resulted in several countries (e.g., Argentina, Brazil, and Peru) experiencing high inflation episodes in the 1980s and early1990s that later had to undertake strong fiscal adjustment programs to bring inflation under control.

Figure 6 – Fiscal Performance and Public Investment in LAC (1990–2013)



Sources: World Economic Outlook; and IMF staff calculations.

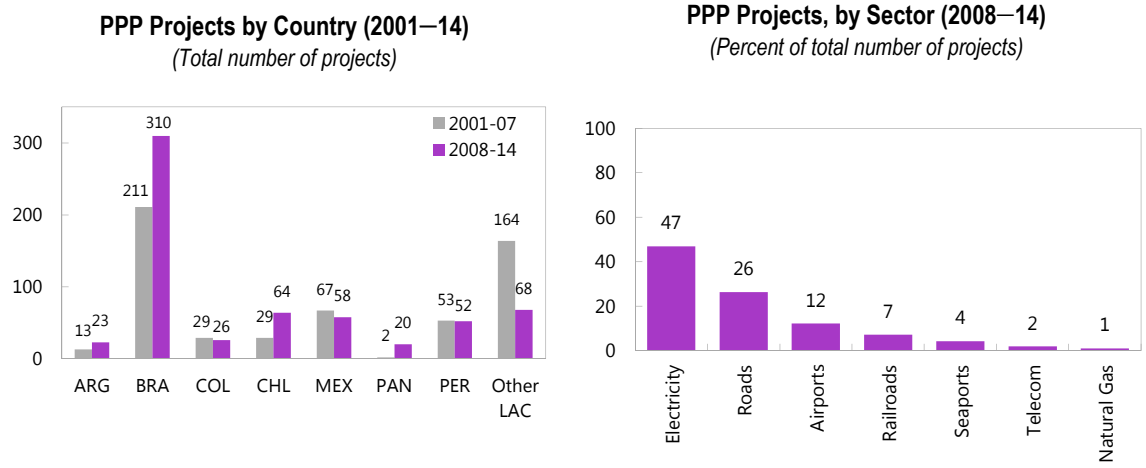
C. Private Participation

The history of private sector participation in infrastructure through public-private partnerships (PPPs) in Latin America is recent. The first arrangements between the public and private sector in the form of concessions or greenfield projects date back to the early 1990s in Mexico and Colombia, and fall in the area of road transport infrastructure. The initiative in Mexico was spurred by the need to improve linkages under the North American Free Trade Agreement signed in 1992. Colombia followed with an investment program in the port sector, while Chile and Brazil also introduced PPPs in the transport sector (port and roads) together with Peru (roads and airports) and Panama (port that connects the canal). Costa Rica started towards end-1990s, using PPPs to construct ports and roads. Uruguay, Guatemala, Honduras, Jamaica, El Salvador and Paraguay are relatively new players and have recently formed PPP agencies or approved framework laws and contracted out projects. Brazil, Chile, Colombia, Peru and Uruguay, however, account today for 70 percent of projects and total investment in LAC.

The use of PPPs in Latin America as a vehicle for building infrastructure has grown rapidly, including through the global financial crisis period. Between 2008 and 2014, Latin America closed 620 investment projects with private participation in financing and

construction, totaling over 230 million U.S. dollars, of which 2/3 were in operational phase.[5] The vast number of projects are located in the largest countries of Latin America, led by Brazil, where energy sector projects were most numerous. Compared to the period 2001−07, larger LACs dominate the PPP landscape today even more decisively (Figure 7).

Figure 7 – LAC: Public-Private Partnerships



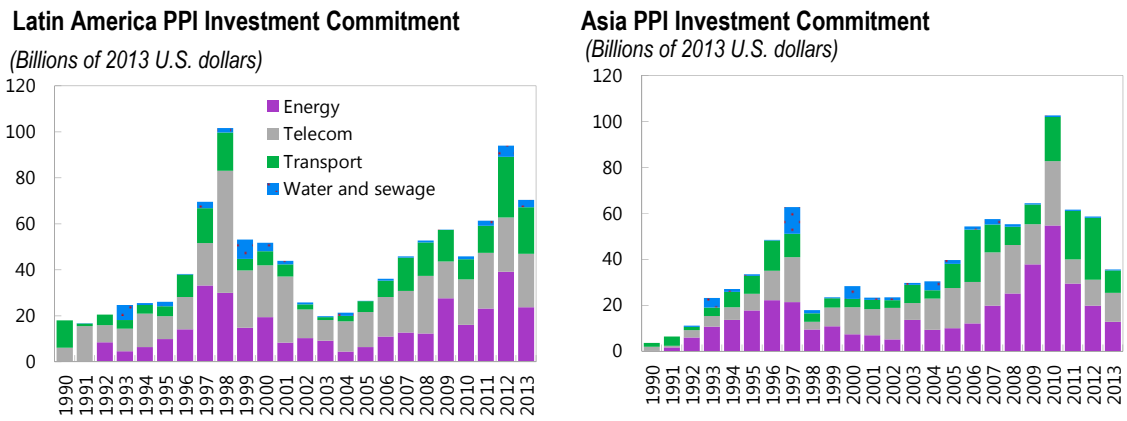
Sources: IMF Staff estimates; based on PPIF (World Bank).

Primary sectors of interest were energy and transport, present in equal shares of nominal investment, and a small part was dedicated to telecoms. Investments in electricity, totaling 420 projects across Latin America, outpaced by far all other subsectors, followed by road construction (105 projects).[6] Concentration of PPPs in sectors in which collecting user fees is both technically feasible and is viewed as politically acceptable is common both in LAC and emerging Asia (Figure 8).

[5] Based on the World Bank PPI database, 2015.

[6] Funding refers to the ultimate source of the funds that will pay for creating and operating a piece of infrastructure, with the basic funding decision being the fraction of the cost borne by the tax-payer as opposed to the direct user of infrastructure.

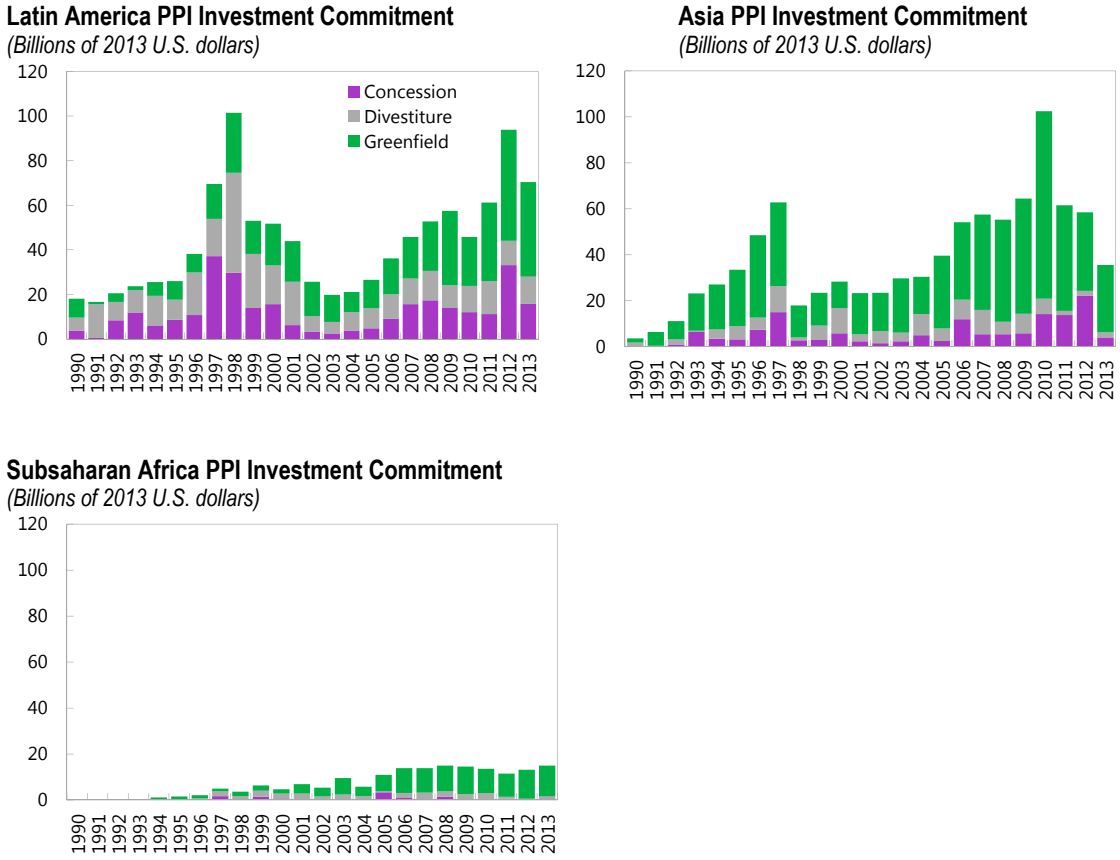
Figure 8 – Private Participation in Infrastructure Investment Commitment (1990−2013)



Sources: IMF Staff estimates; based on PPIF (World Bank).

An important contrast between LAC and Asia is the extent to which privatizations and concessions have played a role. Although privatizations were 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 9). In recent years, however, greenfield projects have gained ground even in LAC.

Figure 9 – Private Participation in Infrastructure Investment Commitment, by Region and Type of Contract (1990−2013)



Sources: World Bank's PPI database; and IMF staff calculations.

D. Financing Options

Accessing the funds necessary to meet the growing infrastructure needs represents a key challenge for LAC. At the heart of the problem is matching investible projects that have satisfactory risk/reward tradeoffs over the long term to the supply of financing from the private sector. Countries have aimed to meet this challenge by promoting infrastructure investment through a variety of mechanisms, including investment funds (private, hybrid and pension funds), guarantee funds, subsidy funds, as well as innovative financial products, such as infrastructure bonds (World Bank, 2011). Nevertheless, financing gaps remain.

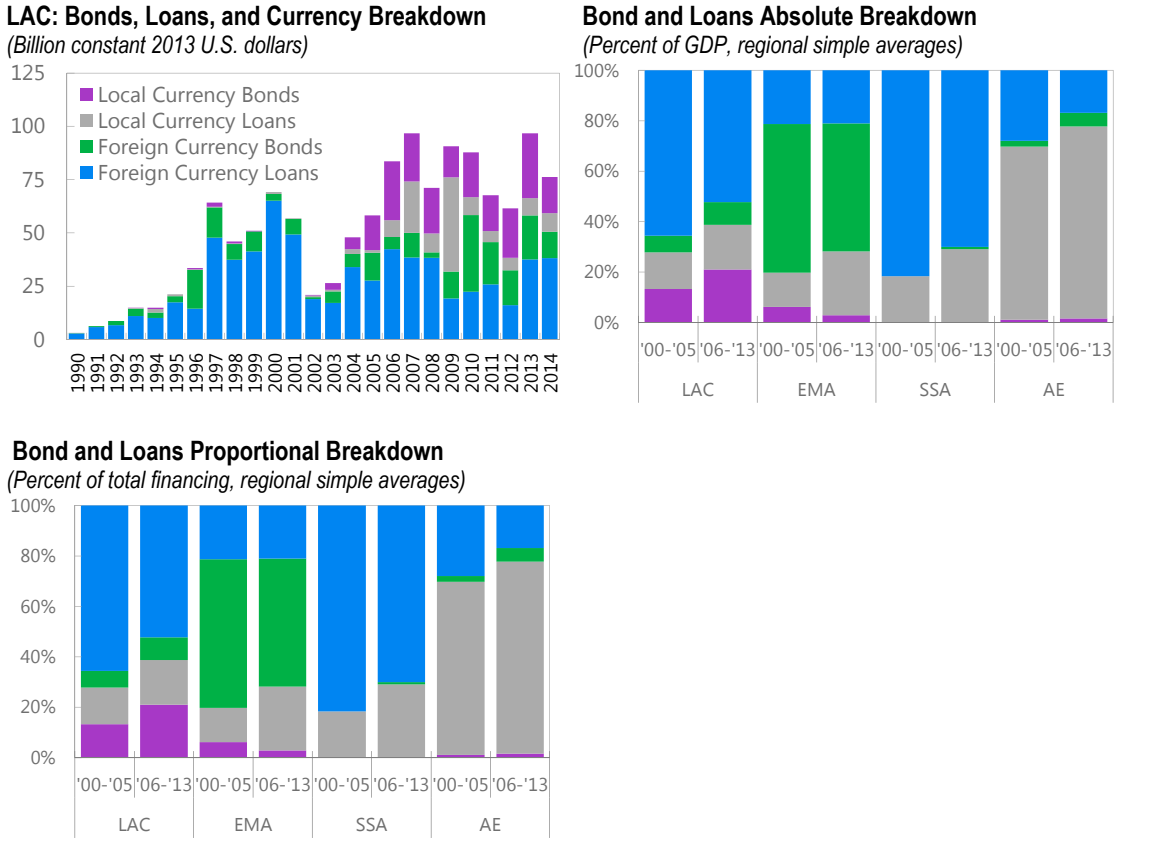
Private sector finance has come in many different forms. In addition to "direct" investment routes—such as infrastructure stocks, private participation, corporate or project bonds, and direct loans—"indirect" investment in infrastructure can occur through various

types of funds. By far the largest source of private financing for infrastructure is debt financing through bond issuance and bank loans (Ehlers, 2014).

Bonds versus Bank Loans

Infrastructure firms across LAC are currently financing more investment by issuing bonds than in the past (Figure 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 reflects economic development and greater integration into global financial markets. Brazil is leveraging the long-term finance available from its state-owned development bank (BNDES), long the main provider of infrastructure financing, with tax-exempt infrastructure bonds (Frischtak and Davies, 2014). But the role of other national development banks in LAC is relatively limited.

Figure 10 – Total Capital Raised by Infrastructure-Focused Companies (1990–2013)



Sources: IMF staff calculations with Dealogic data. LAC = Latin America and Caribbean; EMA = Emerging Asia; SSA = Subsaharan Africa; AE = Advanced Economies. Includes all bonds and syndicated loans to infrastructure-focused companies, defined as those falling in the following categories: (a) Tranportation; (b) Construction/Building; (c) Telecommunications; (d) Utilities; (e) Water & Sewage.

Domestic versus Foreign-Currency Financing

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

While the trend toward local currency financing is evident globally, the mix of bond versus loan financing differs across regions. Emerging Asia stands out with a larger share of infrastructure financing coming from FX bonds. In contrast, debt financing in advanced economies occurs mainly through local currency loans, rather than bonds, possibly a consequence of larger and more sophisticated banking systems, where risks are more easily diversified and collateralized.

Determinants of Domestic Financing of Infrastructure

To evaluate the importance of financial market depth and openness in determining the degree of domestic financing for infrastructure investment, we estimate the model:

$$(2) \quad domestic_{i,t} = \gamma\ depth_{i,t} + \theta\ financial\ openness_{i,t} + \phi\ trade\ openness_{i,t} + f_i + \delta_t t + e_{i,t}$$

where $depth_{i,t}$ is the credit-to-GDP ratio, which is taken as a proxy for domestic financial depth; $finanical\ openness_{i,t}$ is the FDI-to-GDP ratio, which proxies for financial openness; $trade\ openness_{i,t}$ is trade openness (the sum of the absolute values of imports and exports); f_i is a vector of country-specific time-invariant intercepts; δ_t are the coefficients for time fixed effects; and $e_{i,t}$ is a vector of residuals. Two different proxies for domestic infrastructure financing ($domestic_{i,t}$) are used: the share of domestic financing in total infrastructure financing and total domestic infrastructure financing as a share of GDP. Parameters of interest (γ, θ, and ϕ) are assumed to be homogeneous across panel members.

Not surprisingly, the estimation results show that financial market depth and the degree of openness (both trade and financial) lead to higher levels of domestic infrastructure financing across countries (Appendix, Table 4). The preferred specification, which incorporates country- and time-fixed effects, suggests that a 1 percent increase in credit-to-GDP, FDI-to-GDP, or trade-to-GDP increases the share of domestic financing in total infrastructure financing by 0.40 percent, 0.48 percent, and 0.34 percent, respectively. Likewise, when using total domestic infrastructure financing as a share of GDP as the proxy for domestic financing, the results suggest that a 1 percent increase in credit-to-GDP, FDI-to-GDP, or trade-to-GDP increase domestic infrastructure financing by 0.016 percent, 0.015 percent, and 0.021 percent of GDP, respectively.

Development Financing

For many LAC countries, infrastructure financing has relied on development banks and quasi-fiscal entities, official lenders, nontraditional sources and new initiatives. The World Bank and the Inter-American Development Bank (IDB) have historically provided budget and project support to the public sector. In recent years, the IDB has also increased its role in non-sovereign guaranteed activities. Energy cooperation agreements in Central America and the Caribbean have included subsidized financing for oil imports that supported energy-related infrastructure; Guyana, Nicaragua, Haiti, and Belize were top recipients of PetroCaribe funds in 2014.

IV. INFRASTRUCTURE INVESTMENT EFFICIENCY

Putting strong systems in place to manage public investment is key for efficient allocation of public funds. Legal, institutional, and procedural arrangements, including risk management, for public investment management play a key role in determining the level, composition, and the impact of public investment on the economy.

The Public Investment Efficiency indicator (PIE-X) proposed in IMF (2015) estimates the relationship between the public capital stock and per capita income, on the one hand, and indicators of access to (and the quality of) infrastructure assets on the other hand for over 100 countries. Countries with the highest infrastructure coverage and quality for given levels of public capital stock and per capita income form the basis of an efficiency frontier. The slope of the frontier in Figure 11 decreases as the level of capital stock rises, illustrating the decreasing marginal returns to additional investment. Countries are assigned a PIE-X score of between 0 and 1 based on how close they are to the frontier (countries attaining the frontier have a score of 1, not to be confused with the value of the indicators for infrastructure quality, measured in index points). According to the Public Investment Efficiency Indicator (PIE-X), the efficiency of public investment generally increases with income per capita although there are efficient countries across all income levels. The PIE-X estimate for LAC confirms that there is substantial scope for improving public investment efficiency. The LAC average (a sample of 16 countries) for the hybrid indicator is about 52 index points, with Barbados, Chile and Panama scoring above 70 points; on average, for LAC countries this translates into a PIE-X score of 0.73 (Figure 12).

With respect to survey-based indicators, LAC compares well with EMs and the total sample. Yet, averages hide important differences between advanced and low income countries (not shown, with gap of 40 percent), advanced economies (not shown, with a gap of 13 percent) and even between EMs (Figure 12).

Figure 11 – Efficiency Frontier: Infrastructure Hybrid Indicator (2013)

(X-axis: Public Capital Stock, in U.S. dollars; Y-axis: Infrastructure Indicator, higher = better)

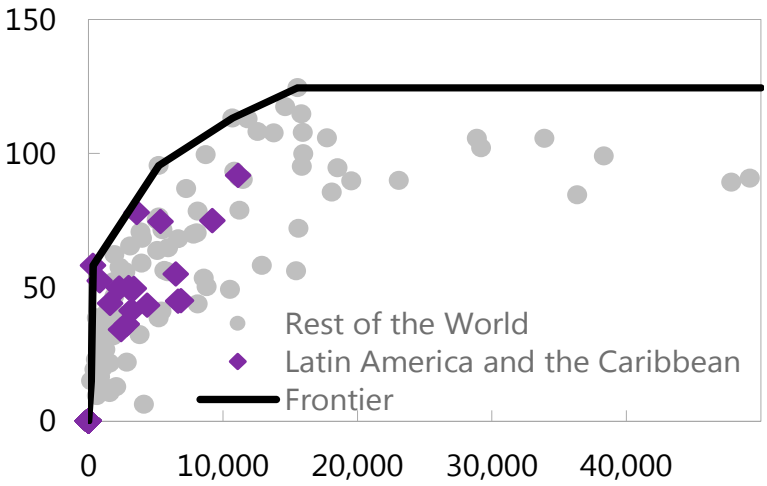
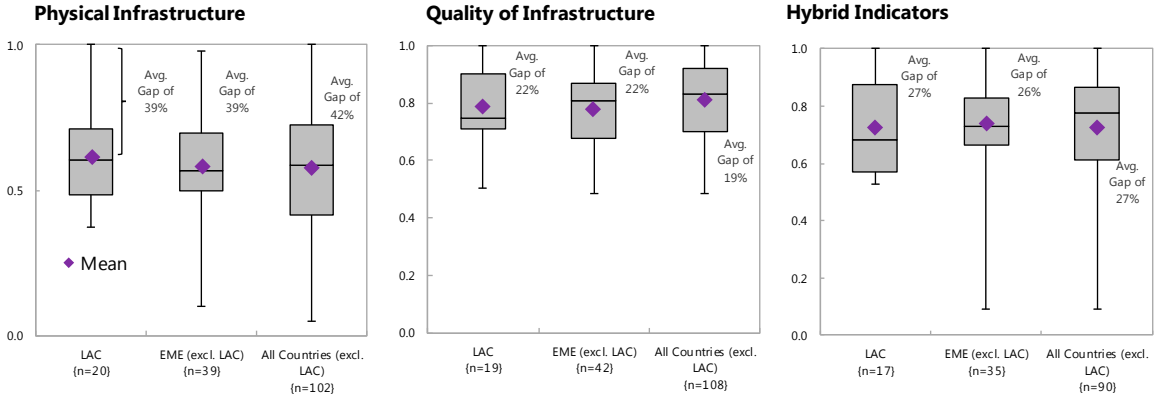


Figure 12 – Public Investment Efficiency



Source: IMF Staff estimates.

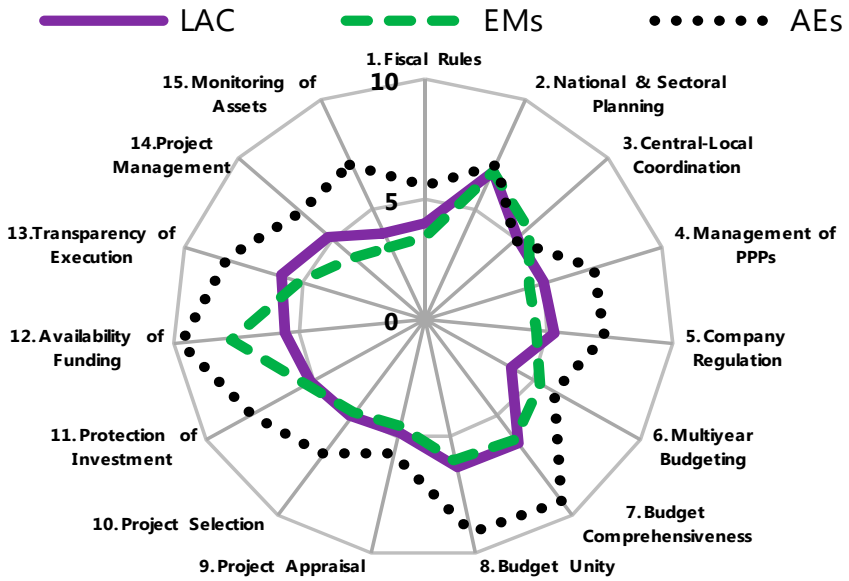
Public Investment Management

Efficient investment planning requires an overarching infrastructure strategy. This includes institutions that ensure public investment is fiscally sustainable and effectively coordinated across sectors, levels of government, and between public and private sectors.

The first step is thus to have an overall macro-consistent investment strategy followed by the analysis of how much fiscal space does the government has, how the local level coordination can be ensured, and what role can the private sector play.

The Public Investment Management Assessment (PIMA), developed by IMF (2015), provides a comprehensive assessment of the public investment decision-making process through evaluating 15 key institutions for planning, allocation, and implementing public investment, with scores of 0 (non-existent) to 10 (fully implemented). LAC compares well to other EMs but the performance is subpar in both groups when it comes to management of project implementation and monitoring of public assets (Figure 13). LAC appears weaker than the EMs in the categories of availability of funding and multi-year budgeting (Table 2).

Figure 13 – Public Investment Management: LAC, EMs, and AEs[1]



Sources: IMF Staff calculations based on a survey.

[1] Index, (*0=worst, 10=best).* Includes 25 advanced economies, 12 emerging market countries, and selected LAC (Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Grenada, Guatemala, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, and St. Lucia).

Table 2. Public Investment Management in LAC

	Ensuring Sustainble 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	Multi-Year 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															
Bahamas, The															
Belize															
Bolivia															
Brazil															
Chile															
Colombia															
Costa Rica															
Dom. Rep.															
Ecuador															
Grenada															
Guatemala															
Honduras															
Jamaica															
Mexico															
Panama															
Paraguay															
Peru															
St. Lucia															

Scoring Rubric:	
	= To no or a lesser extent
	= To some extent
	= To a greater extent

Sources: IMF Staff calculations with inputs from country authorities.

Based on the results of the survey, the progress towards implementing best practices in public investment management is uneven across LAC. Many countries in LAC, especially in the Caribbean,[7] do not have well-structured approaches to public investment, leading to low levels of investment and poor quality of the projects. For this reason, strengthening frameworks for public investment management is essential, including by making sure that cost-benefit analysis is used consistently in project selection and that budget planning extends for the duration of the project.

V. Institutional and Regulatory Frameworks for PPPs

Although PPPs can increase the efficiency of service provision, they often give rise to fiscal risks. PPPs investments can benefit from private sector expertise in project preparation; service delivery can be timely and overall quality of services superior; and with appropriate allocation of risk in the contract, efficient outcomes can be expected. But PPPs can sometimes be considered chiefly to circumvent short-run budget restrictions, without due regard for value-for-money. In addition, if incorrectly conceived, they can result in

[7] Several countries in the Caribbean were not included in the project due to their nascent nature of the PIM systems.

(continued…)

large transfers of risk to the state.[8] Fiscal risks are potentially large and can contribute to the buildup of contingent liabilities or lead to the assumption of one-off and ongoing liabilities, which can threaten the integrity of the budget and planning processes and complicate fiscal governance.

Experience has shown that mistakes could be costly. From about 1989 to 1994, the government of Mexico undertook an ambitious program of private toll road concessions. By 1995, it had awarded more than 50 concessions for about 5,500 kilometers of roads. However, most concessionaires soon ran into financial difficulties. Various solutions were tried and in 1997, the government announced a restructuring plan under which it offered to take over the private concessions, assuming all their debt and all their liabilities to third parties (Bloomgarden and Blumenfeld, 2013). Evidence from Chile, Peru and Colombia has shown that renegotiation of contracts can be substantial, and may end up in higher spending for the government and lower value-for-money (VfM) when done outside of a competitive tender process (Engel and others, 2014).

The experience with PPPs in the region shows that two main challenges tend to raise the costs of PPPs for governments– the recognition of contingent liabilities and the renegotiation of contracts.

- **Contingent liabilities.** The case of the Mexican toll roads mentioned above is well known in the literature as an example of poor contract design and excessive company leverage that have created financial difficulties, later exacerbated by the macroeconomic crisis that affected the traffic demand and increased interest rates. Another unfortunate example is the divestiture of the electricity company of Sao Paulo (Brazil) in 1998 which left the privatized entity with a substantial regulatory and exchange rate risk following the reform of the sector. Company leverage grew over time for a variety of reasons, including the depreciation of the currency and the government rationing program in response to rainfall shortages in 2001. The losses eventually led to debt restructuring and the swap of debt to the national development bank (BNDES) for equity in the company (Ehrhardt and Irwin, 2004). Calls on demand guarantees on PPPs

[8] In some countries budgetary and fiscal rules treat PPPs as not creating any government liability in the short term. See Funke and others (2013) for a detailed treatment of budgeting and reporting of PPPs.

in power, telecom, and roads resulted in government payments of 2 percent of GDP in Colombia during the 1990s (Cebotari and others, 2008).

- **Renegotiation of contracts.** In a long-run contract, it is often necessary to introduce modifications to reflect changes in demand, quality standards and other evolving circumstances. If carried out transparently these renegotiations can bring about mutual welfare gains for the public and private sector. However, because the recognition of liability on the side of the public sector is deferred to the future, PPP contracts may be subject to renegotiations that are not justified by objective circumstances that undermine the budget process, and generate unforeseen additional obligations for future governments. Chile, Colombia, Peru are countries which underwent numerous renegotiation of PPPs, in particular in the transport sector.[9] Contrary to expectations, renegotiations started early in these countries, mostly during the operational and construction phase of the project. Colombia's case is emblematic: between 1993 and 2010 there were on average 20 renegotiations per single contract, the fiscal cost of which increased the expenditure threefold compared to the initial value of the project, and extended the length of the project. Renegotiations in Chile and Peru have had less dramatic results although Peru's history of PPPs is more recent and the very strong framework has benefitted from the mistakes of other countries (Bitran and others, 2013). The experience has taught that governments must set limits on contracts renegotiation to avoid overturning efficiency gains from PPPs and undermining VfM principle.[10]

Countries have learned from past failures, and recognized the importance of sound institutions in preventing undesired outcomes of PPPs. Some of the key elements of a sound institutional framework for PPPs include: consistent PPP legislation, incentive-neutral

[9] Bitran and others (2013) and Engel and others (2014) study the renegotiation of contracts in these countries, in a theoretical and empirical setting, focusing mostly on PPPs in the area of transport infrastructure. The incidence of renegotiations in transport has been close to 80 percent of all contracts during 1980–2000, has increased more recently but has also decreased in countries that have strengthened their PPP frameworks (Guash and others, 2014).

[10] Chile introduced limits on renegotiation in 2010 when it reformed the PPP framework. Another possible solution to reduce incentives for renegotiation is to include all obligations associated with PPPs in the balance sheet of the government and apply the same oversight as for other budgetary expenses (Engel, 2009). Putting in place platforms for renegotiation at the ministry of finance (Chile and Peru) and the use of expert panels has proven successful.

(continued…)

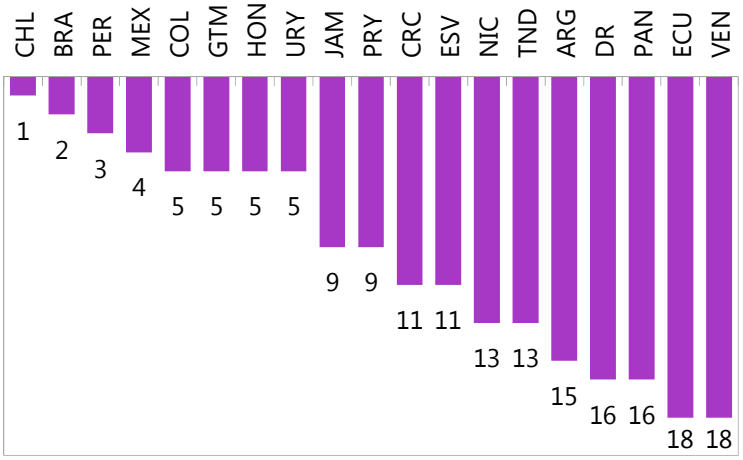
regulation, integration of projects into the budget cycle, clarity on roles and responsibilities across institutions responsible for PPPs, strong oversight framework, VfM and fiscal affordability, transparent disclosure, and sound accounting.

Brazil, Chile, Colombia, Mexico and Peru (the LA5) have the most attractive overall environment for PPPs in the region (Figure 14).[11] While the LAC region ranks below Asia in the institutional and regulatory frameworks for PPPs, the LA5 are very highly placed in the worldwide context. Among the LAC countries, the LA5 have consistently ranked in the top 5 on the overall environment for enabling PPPs since 2009, and were the best also across most subcategories: the institutional framework, the regulatory framework, the operational maturity, the financial facilities available for PPPs and the use of PPPs at subnational level. Some differences in strength across different areas are visible in this group. Chile and Brazil, for instance, score highest across all categories, while Peru excels in particular for a strong regulatory and institutional framework. Brazil is the country with the most active subnational governments in the area of PPPs, followed by Mexico, and the one with the longest and most prominent project experience, a dimension necessary to build operational maturity. However, relative to other LA5, Brazil has a less favorable investment climate and regulatory framework. Uruguay, which ranks at the 8th place among the LAC countries for the overall framework, enjoys a particularly friendly investment climate and also displays operational maturity comparable to that of Colombia. Most other LACs, while lagging behind the LA5, have made notable progress over time in creating conditions suitable for scaling up PPPs learning from the LA-5's experience.

[11] Data based on Infrascope (Economic Intelligence Unit, 2014). Institutional environment refers mainly to the quality of the institutional design. Regulatory framework reflects characteristics in the area of PPP legislation, project selection and decision making, bidding process, and dispute resolution.

Figure 14 – LAC: Overall PPP Environment

Ranking of PPP Favorability, by Country[1] (Rank, lower = better)



Sources: EIU Infrascope, 2014.

The region can also claim several success stories. Colombia has effectively used PPPs to reform procurement and public service delivery with the concession of four public ports in 1990. Under 20-year contract concessionaires were responsible for managing each port and for contracting with port operators for the use of the port facilities. New laws abolished restrictive labor laws and allowed free competition between ports and of stevedoring within the ports, which lead to a strong increase in productivity and attractive returns to the concessionaires (Farquharson and others, 2011). There is much hope for a successful implementation of Colombia's biggest infrastructure project to date, "*Ruta del Sol*" road infrastructure concession, a more recent enterprise, designed with the help of multilateral institutions. The concession was structured in three segments, the second of which will be completed in 2016. Government subsidies would be allocated to concessionaries only upon completion of contractually defined construction milestones. Brazil's "Sao Paulo - Metro Line 4" initiated in 2008 included a complex financial agreement, structured with the help of the Inter-American Development Bank, aimed at sheltering the private partner from the risk of delays in governments commitments. The contract included detailed provisions for monitoring private operator's performance and determining compensation (Farquharson and others, 2011).[12] In response to past experience,

[12] Farquharson and others (2011) includes a case study on the construction of a hospital in Mexico in 2005.

large countries' frameworks for the scrutiny, selection, and oversight of PPPs have become more transparent.

Overall, the LAC is better placed today to make increasing gains from PPPs and narrow the infrastructure gap, thanks to stronger institutional frameworks and lessons learned over the last quarter century. However, the institutional maturity, the technical capacity and the political support for the projects are unequal in the region, with some countries emerging as new players on the market along the LA5s, and others lagging behind. Nevertheless, institutional frameworks can be improved swiftly in the lagging countries by studying the experiences of those that have been working with PPPs longest and most successfully. Operational maturity needed to scale up investment will come only over time, with more on-the-job skills development and training. Planning and executions will continue to pose challenges until technical capabilities and know how are fully developed across lower government levels, including in countries where subnational PPPs enjoy an already strong legal framework and presence (Brazil and Mexico).

VI. Environmental Sustainability of Infrastructure

Infrastructure is a physical asset that provides a service to the economy which must be cost-effective, but also be equitable and environmentally viable. The need for infrastructure in developing countries is increasing due to population and income growth, and economic concentration in urban areas. Scaling up infrastructure to address these needs could lead to severe implications for the ecosystem balance and climate change.

Latin America has its own particular environmental challenges related to transport infrastructure. Urbanization rates are very high, and motorization rates are the fastest growing in the world, at 4.5 percent per year with the demand for vehicle ownership far from saturation (OECD, 2015).[13] Freight shipping distances are also increasing due to changing transport patterns from trade liberalization and integration of economies into global markets and, with them, greenhouse emission levels and local air pollution are set to

[13] Vehicle ownership per 1000 population is projected to increase fourfold by 2050 while CO2 emissions will be between 2 and 4 times higher than in 2010 (OECD, 2015).

increase. Moreover, reliance on tracks and road transport (diesel) is excessive relative to railway transportation.

Environmental challenges are expected to magnify as transport infrastructure is scaled up. Fragmentation of the ecosystem and loss of biodiversity due to deforestation during infrastructure construction is common and could be expected to continue. As infrastructure investment is scaled up, pollution from traffic is almost certain to increase, especially in the absence of mitigating policies. The pressing question is thus how to shrink the ecological footprint of new infrastructure while expanding capacity to meet the rising mobility needs?

Latin America has adopted innovative practices to address its transport challenge over the last two decades, improving the quality of public transport and its inclusiveness through “bus rapid transit” systems (BRTs). These systems have streamlined mass transit by offering high capacity and low-cost service, and have improved safety. In the process, BRTs have also brought environmental benefits.

Going forward, infrastructure development needs will have to be aligned with environmental protection through public policies at national, regional, and sectoral levels that take into account all modes of transport, involving all stakeholders and those responsible for environmental impact control. Investment should pay close consideration to protecting natural habitats and preserving ecosystem functions, effectively internalizing climate and health objectives into a holistic framework of project design and user control.

Stringent and progressively tighter rules on vehicle emissions and fuel standards, as in place in many developed countries (Europe and the U.S.) can substantially curb local air pollutants from engines (Chambliss and others, 2013). At the local level, a shift to public transport-oriented urbanization, walking, and cycling could lower congestion and emission levels; high-occupancy vehicle incentive schemes, parking restrictions and charges on vehicle ownership and use also have a virtuous effect on demand management. All these must accompany any efforts to scale up transport infrastructure.

Tax policies should encourage green investment and consumption of fuels, by controlling atmospheric accumulations of greenhouse gases including through greater use of carbon taxes and emissions trading systems which are not only effective instruments for

mitigating climate change but can also generate government revenue. Surcharges on fuel can be effective and in most of LAC countries, as the basic mechanisms to impose them are already in place. Revenues from “green” taxes can be further used to promote development and use of environmentally friendly materials for infrastructure construction. Investment in Carbon pricing schemes, or "feed-in-tariffs," which require use of green energy, have been found to have a positive and significant impact on green investment (Eyraud and others, 2011).

Efforts should be made to minimize energy subsidies which are shown to be costly, inefficient and inequitable and to aggravate fiscal imbalances, crowd out priority public spending, and depress private investment, including in the energy sector. Other policies to improve the fuel economy and make infrastructure environmentally friendly could include:

- regulation on the use of clean technologies for construction and climate-resistant materials, improve isolation and cooling system;
- greater share of low carbon electricity generation;
- regulatory policies and incentive programs to facilitate investment in alternative fuel and power sources used for ships (biofuel, wind and nuclear);
- soft measures for trade facilitation, such as measures to improve border and transport efficiency (by minimize time, cost and number of documents necessary for export and import procedures);
- compensatory policies to reverse the loss of habitat during construction, such as improvements of the remaining sources of natural habitat or replanting an area of vegetation that was cleared to allow construction access, (as in Colombia and Brazil) and tax incentives and land use restrictions in the early stages of projects (Quintero, 2012).

VII. CONCLUSIONS

Infrastructure indicators in the region compare, on average, reasonably well with those in the group of emerging markets at large, and 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. 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 potential.

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 accumulations. Strengthening public investment management processes and practices is important for ensuring that the money mobilized is put to effective use. But closing infrastructure "gaps" is not just a matter of public money. Public policy should also set appropriate conditions to crowd in private investment in infrastructure. These are especially important given the current outlook, characterized by reduced prospects for growth compared to those envisioned a few years ago. Private sector participation should be maximized in sectors that have the most potential interest, especially by improving the regulatory framework to enable user fees and protect contracts. Environmental concerns should be internalized into infrastructure design and policies tailored to manage demand and protect the environment.

Preserving political support and building popular trust will be no less important for fostering private investment. Given the track record of past failures in some LAC countries, supporting private sector investment may be complex; deepening financial markets and developing alternative instruments for involving long-term investors is, thus, becoming increasingly important.

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 coming decades.

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APPENDIX

Table 1. Data

Variable	Scale	Source	Notes
1. Infrastructure Quantitative and Qualitative Indicators			
Road Network	Kilometers of road	International Road Federation.	
Road Density	Kilometers of road per square kilometers of land area	IMF Staff estimates from IRF and World Bank data.	Calculated from Road Network and Landmass.
Road Rural Access Index	Road access in percent of total population	World Bank.	
Roads Paved	Percent of total	World Bank, World Development Indicators.	
Mobile Phone Lines	Per 100 persons	World Bank, World Development Indicators.	
Fixed Telephone Lines	Per 100 persons	International Telecommunication Union.	
Fixed Telephone Access	Percent of total population.	International Telecommunication Union.	
Fixed Telephone Faults.	Faults reported over a year per 100 fixed-telephone lines	International Telecommunication Union.	
Electricity Generation Capacity	Million Kilowatts	Energy Information Agency.	
Access to Electricity	Percent of total population.	World Bank.	
Electricity Distribution Losses.	Percent of total electricity.	World Bank.	
Infrastructure Quality, Overall	Index (0 to 7)	World Economic Forum, Global Competitiveness Report.	
Infrastructure Quality, Electricity	Index (0 to 7)	World Economic Forum, Global Competitiveness Report.	
Infrastructure Quality, Roads	Index (0 to 7)	World Economic Forum, Global Competitiveness Report.	
2. Infrastructure Financing Indicators			
Infrastructure Financing, Bonds	Current U.S. Dollars	IMF Staff estimates from Dealogic data.	Includes all bonds and syndicated loans to infrastructure-focused companies, defined as those falling in the following categories: (a) Transportation; (b) Construction/Building; (c) Telecommunications; (d) Utilities; (e) Water & Sewage.
Infrastructure Financing, Loans	Current U.S. Dollars	IMF Staff estimates from Dealogic data.	
Infrastructure Financing, Local Currency, Bonds	Current U.S. Dollars	IMF Staff estimates from Dealogic data.	
Infrastructure Financing, Local Currency, Loans	Current U.S. Dollars	IMF Staff estimates from Dealogic data.	
Infrastructure Financing, Foreign Currency, Bonds	Current U.S. Dollars	IMF Staff estimates from Dealogic data.	
Infrastructure Financing, Foreign Currency, Loans	Current U.S. Dollars	IMF Staff estimates from Dealogic data.	
3. Real and Monetary Indicators			
Per Capita Gross Domestic Product	Constant PPP U.S. dollars, per person	World Bank, World Development Indicators.	
Public Investment	Billion Constant PPP U.S. dollars	IMF, Fiscal Affairs Department.	
Public Capital Stock	Billion Constant PPP U.S. dollars	IMF, Fiscal Affairs Department.	
Private Investment	Billion Constant PPP U.S. dollars	IMF, Fiscal Affairs Department.	
Private Capital Stock	Billion Constant PPP U.S. dollars	IMF, Fiscal Affairs Department.	
Private Participation in Infrastructure	Constant U.S. Dollars	IMF Staff estimates from World Bank data.	
Credit to Private Sector	Share of GDP	IMF, International Finance Statistics.	Labelled in the IFS as "Claims on the Private Sector".
Consumer Price Inflation	Year over year percent change	IMF, World Economic Outlook.	
4. Fiscal Indicators			
Government Total Revenues	Share of GDP	IMF, Government Finance Statistics.	
Tax Revenues	Share of GDP	IMF, Government Finance Statistics.	
Government Total Expenditures	Share of GDP	IMF, Government Finance Statistics.	
Public Capital Expenditures	Share of GDP	IMF, Government Finance Statistics.	
Public Current Expenditures	Share of GDP	IMF, Government Finance Statistics.	
Government Interest Expenditures	Share of GDP	IMF, Government Finance Statistics.	
Public Debt	Share of GDP	IMF, World Economic Outlook.	
Primary Balance	Share of GDP	IMF, Government Finance Statistics.	
5. External indicators			
Trade Openness	Share of GDP	IMF Staff estimates from World Economic Outlook data.	Calculated as the sum of Exports and Imports to GDP.
Terms of Trade	Index	IMF, World Economic Outlook.	
Foreign Direct Investment (net)	Billion Current U.S. dollars	IMF, World Economic Outlook.	
6. Institutional Quality and Social Indicators			
Rule of Law Governance Indicator	Index, (-2.5 to +2.5)	Worldwide Governance Indicators.	
Fertility Rate	Births per woman	World Bank, World Development Indicators.	
Urbanization Rate	Percent of total population	World Bank, World Development Indicators.	
Population	In million persons	World Bank, World Development Indicators.	
Landmass	In square kilometers	World Bank, World Development Indicators.	

Table 2. Determinants of Infrastructure—Latin America and 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 **	-0.030	-0.055 **	0.025 ***
LN Electricity Generation Capacity (t-1)	0.154 **	0.127 *	0.180 **	0.000	0.442 ***	0.526 ***	0.430 ***	0.998 ***	0.033	0.030	0.020	0.002
Road Density (km of roads per square km) (t-1)	-0.193	-0.060	-0.307 **	-0.010 ***	-0.047	-0.050	-0.055	-0.001	0.720 ***	0.839 ***	0.696 ***	1.003 ***
Fiscal												
Tax Revenues, Share of GDP	0.517	0.303	0.187	0.105	-0.640	-0.651 *	-0.649	-0.059	-0.238	-0.231	-0.280	-0.001
Current Expenditures, Share of GDP	0.438	0.430	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	-0.060	-0.056	-0.064	-0.074 ***	-0.001	0.005	-0.001	0.009
Macro												
Private Participation in Investment, constant USD	-0.309 ***	-0.305 ***	-0.298 ***	-0.002	0.123 *	0.094	0.130 **	0.006	0.022	0.023	0.040	0.005 **
Consumer Price Inflation, yearly average	-0.004	0.009	0.139	-0.028	0.013	0.018	0.010	0.116	-0.062	-0.061	-0.047	-0.079 **
Trade Openness, Share of GDP	0.069	0.032	0.079	0.010	-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-sq			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

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimates.
Note: LSDV = Least Square Dummy Variable; LSDVC = Least Square Bias-Corrected Dummy Variable, following Bruno (2004); Diff. GMM = Difference 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 with the following variables which are not reported in the table: Fertility Rate; Urbanization Rate; Population Density; Rule of Law Governance Indicator.

Table 3. 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 **	-0.110	0.035 *	0.006	0.001	0.009	-0.005 **
LN fixed telephone lines per 100 people (t-1)	0.937 ***	1.043 ***	0.670 ***	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 ***	0.610 ***	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 ***	1.000 ***
Fiscal												
Tax Revenues, share of GDP	0.008	-0.113	0.602 *	-0.088	0.015	-0.058	0.801 **	-0.202	-0.011	-0.000	0.000	-0.008
Current Expenditures, share of GDP	-0.134	-0.189	0.077	0.110	-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	-0.090	-0.137	0.438 **	0.423 **	0.322	0.223	0.038	0.049	-0.023 **	0.043 *
Primary balance, share of GDP	0.080	0.095	0.000	-0.047	0.166 *	0.189 **	0.296 ***	0.064	-0.011	-0.009	-0.030 ***	-0.038 *
Debt to GDP ratio	0.010	0.027	-0.002	-0.028 **	-0.056 **	-0.047 ***	-0.063 ***	-0.021 *	-0.000	-0.003	-0.003 *	-0.002
Macro												
Private participation in investment, constant USD	0.017	0.012	-0.103 ***	0.002	0.073 ***	0.051 **	0.268 ***	-0.005	0.005	0.001	0.010 ***	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	-0.000	0.009 ***	0.003
Credit to private sector, share of GDP	-0.010	0.007	-0.159	-0.025	0.009	0.007	-0.196 **	0.009	0.005	0.000	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-sq			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

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimates.
Note: LSDV = Least Square Dummy Variable; LSDVC = Least Square Bias-Corrected Dummy Variable, following Bruno (2004); Diff. GMM = Difference 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 with the following variables which are not reported in the table: Fertility Rate; Urbanization Rate; Population Density; Rule of Law Governance Indicator.

Table 4. Determinants of Infrastructure—Domestic Financing

	Dependent Variable: Change in Share of Domestic Financing in Total Infrastructure Financing						Dependent Variable: Change in Domestic Infrastructure Financing as a Share of GDP					
	(1) OLS Random Effects		(2) OLS Fixed Effects		(3) OLS Fixed Effects and Time Effects		(1) OLS Random Effects		(2) OLS Fixed Effects		(3) OLS Fixed Effects and Time Effects	
Change in Credit to GDP	0.361	**	0.38	**	0.402	**	0.016	**	0.018	**	0.016	*
	(0.182)		(0.194)		(0.196)		(0.007)		(0.008)		(0.008)	
Change in FDI to GDP	0.505	***	0.501	***	0.477	***	0.015	**	0.015	**	0.015	**
	(0.151)		(0.157)		(0.156)		(0.006)		(0.007)		(0.007)	
Change in Trade to GDP	0.267	*	0.251		0.343	*	0.015	**	0.017	**	0.021	***
	(0.148)		(0.161)		(0.185)		(0.006)		(0.007)		(0.008)	
Constant PPP GDP per Capita Growth	-0.535	*	-0.449		-0.469		-0.014		-0.016		-0.017	
	(0.323)		(0.361)		(0.419)		(0.012)		(0.015)		(0.018)	
Constant	0.001		0.005		-0.093	*	0.000		0.000		-0.001	
	(0.020)		(0.015)		(0.056)		(0.001)		(0.001)		(0.002)	
Country Fixed-Effects	No		Yes		Yes		No		Yes		Yes	
Time Dummies	No		No		Yes		No		No		Yes	
Observations	878		878		878		879		879		879	
Number of countries	91		91		91		91		91		91	
R-squared Within	0.0201		0.0202		0.0706		0.0178		0.0178		0.0402	
R-squared Between	0.0459		0.0378		0.0119		0.0765		0.0764		0.0532	

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimates.