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Trends and Challenges in Infrastructure Investment in Low-Income Developing Countries

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Abstract

This paper examines trends in infrastructure investment and its financing in low-income developing countries (LIDCs). Following an acceleration of public investment over the last 15 years, the stock of infrastructure assets increased in LIDCs, even though large gaps remain compared to emerging markets. Infrastructure in LIDCs is largely provided by the public sector; private participation is mostly channeled through Public-Private Partnerships. Grants and concessional loans are an essential source of infrastructure funding in LIDCs, while the complementary role of bank lending is still limited to a few countries. Bridging infrastructure gaps would require a broad set of actions to improve the efficiency of public spending, mobilize domestic resources and support from development partners, and crowd in the private sector.

JEL Classification: E22, H4, O18.

Keywords: Infrastructure; Public Investment; Public-Private Partnerships; Developing Countries.

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I. INTRODUCTION

Since infrastructure investment is widely recognized as a crucial driver of economic development, while the quality, quantity and accessibility of economic infrastructure in developing countries lag considerably behind those in advanced economies, scaling up infrastructure investment is widely seen as a key pillar in national development strategies in low-income developing countries (LIDCs).[2] In fact, in recent years, many developing countries have been scaling up infrastructure investment, mostly through public spending, but also with a growing participation of the private sector. The growth dividend and the distributional effect of this investment push cannot be taken for granted, as past experiences suggest (see Section II), and many challenges lie ahead: infrastructure gaps are still large and bridging those gaps will require tackling several problems, in terms of additional financing and project selection and implementation.

This paper reviews infrastructure investment in LIDCs, focusing on the last 15 years. Our main objective is providing a multi-faceted picture of infrastructure development in LIDCs, covering the evolution of several physical indicators of infrastructure, the role of public and private sectors in delivering infrastructure, and its financing, including traditional and new sources.[3]

In the absence of consistent and comparable data on infrastructure investment, and since infrastructure in LIDCs is typically provided by the public sector and accounts for a large part of its capital spending, we start by analyzing trends in public investment. Then we look at the concurrent evolution of public saving and debt, tracing the main sources of financing for public investment. Beyond that, the paper takes stock of infrastructure investment via Public-Private Partnerships (PPPs), as well as official development financing and syndicated bank lending. Limited data availability prevents us from presenting a comprehensive quantitative picture of the modes of delivery and financing of infrastructure in LIDCs. To partially overcome this constraint, we introduce a unique dataset on infrastructure investment in LIDCs—based on the results of a survey of IMF country teams—which collects novel information on public investment in infrastructure (including its sectoral distribution), obstacles to investment scaling-up, reliance on PPPs, sources and terms of financing for

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[2] One can distinguish between economic and social infrastructure. Recent evidence suggests heterogeneous growth effects, with possible benefits in low-income countries from re-allocating investment from economic to social infrastructure (Acosta-Ormaechea and Morozumi, 2017). Our analysis focuses exclusively on economic infrastructure: power, transportation, water and sanitation, and telecommunications facilities. For a discussion about the potential trade-offs between investing in economic and social infrastructure, see Atolia et al. (2017). We zoom in on the experience of low-income developing countries; see IMF (2014a) for the definition of LIDCs and IMF (2017) and Annex Table A1for the current list of LIDCs as well as their breakdown into analytical categories used in this paper, such as (i) frontier markets, fragile states, and developing markets; and (ii) commodity exporters and diversified exporters.

[3] This analysis complements and extends previous regional studies, such as IMF (2014b) and IMF (2016b). Because of limited data availability, the short time period under consideration, and the difficulty in having a credible identification strategy we refrain from any new analysis. Section II provides a selective review of the empirical literature on the economic impact of infrastructure development in low-income countries.

major projects, and other aspects of infrastructure investment for a subset of LIDCs. We believe that the use of several complementary datasets allows us to shed new light on some key issues related to delivery and financing of infrastructure investment. In addition, selected case studies illustrate experiences with public infrastructure provision (Ethiopia), private provision (solar micro-grids in Kenya), and PPPs (hydropower in Lao PDR).

The paper is organized as follows. The next section sets the stage by selectively reviewing the empirical literature on the economic effects of infrastructure, pointing out potential downside risks in terms of growth dividend and distributional effects. Section III provides an overview of the evolution of various measures of quantity and quality of infrastructure in LIDCs since 2000, making clear that infrastructure in LIDCs lags behind that in emerging markets on a number of dimensions. Section IV explores trends in infrastructure investment and financing over the last 15 years. It starts by looking at public investment and saving, taking advantage of broad availability of these indicators. It then zeros in on public investment in economic infrastructure using survey data. The rest of the section covers private participation in infrastructure provision, the role of official development finance, and cross-border syndicated bank lending for LIDC infrastructure. Section V considers challenges to improving infrastructure further—as would be required to attain Sustainable Development Goals (SDGs). The last section concludes.

II. INFRASTRUCTURE AND ECONOMIC DEVELOPMENT

Infrastructure investment is a key component of the 2030 Development Agenda.[4] However, the interest around infrastructure is not new (Rosenstein-Rodan 1943). Since the 1990s there has been a wide body of literature looking at the possible development gains from investing in infrastructure (World Bank 1994). The macro literature shows that improvements in infrastructure could raise productivity, stimulate private investment (Cavallo and Duade 2011), and facilitate domestic and international trade (Bougheas et al. 1999), thereby promoting sustainable growth (Esfahani and Ramirez 2003; Agenor 2010; Calderon and Serven 2010). In a recent contribution, Calderon et al. (2015) estimate that a 10 percent increase in infrastructure provision increases output per worker by about 1 percent in the long run.

Some recent analyses use detailed data on transportation networks to look at their impact on economic activity and they generally find consistent results. Focusing on transportation investments in Africa since 1960, Jedwab and Storeygard (2016) show that increased market access has a positive effect on city growth, favoring urbanization. An interesting strand of literature looks at the historical experience of colonial Africa and India to shed light on how

[4] Enhancing infrastructure is a key component of the 2030 Development Agenda, mentioned explicitly in three of the seventeen Sustainable Development Goals (SDGs 6, "Ensure availability and sustainable management of water and sanitation for all;" SDG 7, "Ensure access to affordable, reliable, sustainable and modern energy for all;" and SDG 9, "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation") and essential for achieving many others.

infrastructure investment shapes economic activity. The analysis of railroads in Ghana and Kenya shows that infrastructure investment can produce long-term economic gains by reducing trade costs and integrating markets, potentially transforming the economic landscape in poor, remote regions with high trade costs (Jedwab and Moradi 2016; Jedwab et al. 2017). Similar findings have been shown for colonial India, where railroads decreased trade costs and interregional price gaps and increased interregional and international trade as well as real income level (Donaldson 2017). The historical impact of railroads on the American economy is also consistent with a positive impact of infrastructure investment on market integration and economic development (Donaldson and Hornbeck 2016).

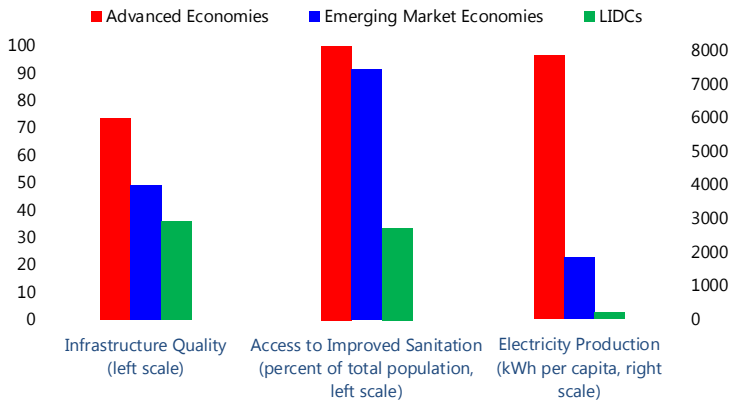
Increased access to essential services could reduce inequality, foster inclusion and support poverty reduction efforts (Calderon and Chong 2004; Calderon and Serven 2010). Micro-level evidence shows that the distributional effect of infrastructure investment could vary. For instance, Khandker et al. (2009) look at road improvement projects in Bangladesh and find overall positive effects on output and poverty reduction; they also show that the poorest households are those benefiting the most. Similarly, Jedwab and Storeygard (2016) point to the importance of taking the local context into consideration, given the evidence of heterogeneous effects of transportation investments in Africa—which seem to favor small and remote cities. The evaluation of programs of infrastructure rehabilitation in Georgia and Vietnam also shows positive average effects, with some evidence of a stronger effect on the poor (Lokshin and Yemtsov 2005; Mu and van de Walle 2011). Duflo and Pande (2007) look at large public infrastructure investments—specifically, dams in India—and find a bleaker picture as poverty, in the aggregate, rises. Moreover, they point out significant distributional implications, as agricultural productivity increases in downstream districts but not in those where dams are built, where poverty increases. Similarly, the extensive highway network built in China since the 1990s has complicated spatial effect on economic activity, with winners and losers. Large cities in the center of a dense regional highway network grow faster and specialize in business services and manufacturing, while the hinterlands grow more slowly, and become relatively more specialized in agriculture (Baum-Snow et al. 2017). This points to the importance of anticipating distributional effects of infrastructure projects and planning offsetting measures if such effects are expected to be negative.

Even though the empirical literature indicates that infrastructure investment could deliver long-term gains, some historical experiences suggest caution. For example, in the 1980s, a wave of public-financed infrastructure investment delivered poor results in terms of short and long-run economic growth, mostly because of cost overruns, corruption and poor maintenance (Arezki et al. 2017; Warner 2014). After this negative experience, and following market liberalization policies, the private sector started playing a more prominent role in financing infrastructure investment, partly through PPPs (see Hammami et al. 2006). However, in many developing countries this resulted in high construction and maintenance costs (Estache and Fay 2007). Thus, public investment effectiveness and efficiency are not always assured and need to be achieved through appropriate institutions and policies.

III. INFRASTRUCTURE DEVELOPMENT

The quality, quantity and accessibility of economic infrastructure in LIDCs lag considerably behind those in advanced and emerging market economies, with the gap particularly large in the power sector (Figure 1). Firm-level data compiled by the World Bank as part of the Enterprise Surveys confirm the presence of large gaps in access to electricity, water and transportation infrastructure, and indicate that such gaps are an actual constraint on real economic activity (Table 1, top panel). The percentage of firms in LIDCs that identify access to electricity and transportation as a major constraint to their business activity is, respectively, 43 and 24 percent. By contrast, the same percentages are 32 and 18 percent, respectively, in emerging markets (EMs). Focusing on access to electricity, it is interesting to observe that 74 percent of firms in LIDCs experience power outages—compared to 53 percent in EMs. Furthermore, the average firm in LIDCs experiences 11 power outages per month, which implies a cost of 7.1 percent of annual sales; in contrast, in EMs firms have to deal with 4.3 power outages per month, which cost 3.4 percent of annual sales.

Figure 1. Selected Infrastructure Indicators
(Median, latest available year during 2013-2015)



Note: Infrastructure quality (index: 1-7) was rescaled to range 0-100 (100= maximum quality).
Sources: The World Bank; World Economic Forum; United Nations; and IMF staff estimates.

Data on physical infrastructure show that there has been a sharp improvement in most LIDCs over the past fifteen years. This change has been broad-based across country groups, although frontier economies have shown faster accelerations and, on the contrary, changes in fragile states have been less perceptible. A few countries—particularly Vietnam—stand out with impressive performance across a range of indicators.

Progress has not been uniform across sectors. Information and communication technology (ICT) has expanded dramatically, with the number of internet servers growing from near zero in 2005 to the average of 6 servers per million people in 2015. Electricity generation per capita has increased by 57 percent on average, with very large increases in a few countries, such as Bhutan and Vietnam.[5] Access to improved water and sanitation facilities rose on average by around 20 percent from 2000 to 2014. On the other hand, improvements in transport infrastructure have been relatively minor, even though transportation is typically the

[5] Consistent with the aggregate evidence, firm level data show that the share of firms that indicate electricity as a major constraint to economic activity almost halved in Vietnam between 2009 and 2015.

largest item in LIDC capital budgets. Firm-level data from the World Bank Enterprise Survey confirm these trends, as the share of firms identifying electricity and water insufficiencies as major constraints to their business activity sharply decreased over the last decade, while almost no progress is observable on transportation infrastructure (Table 1, bottom panel).

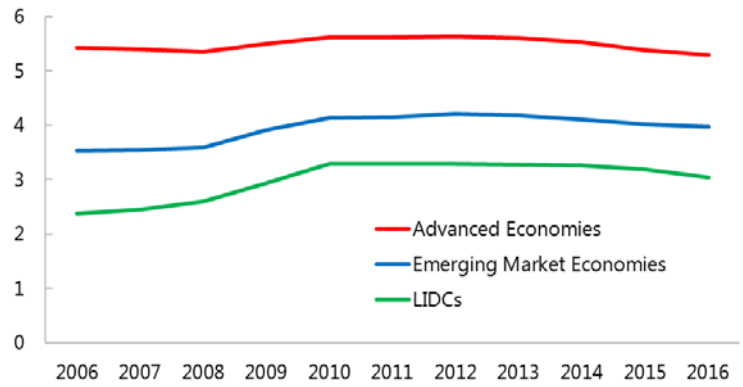
Table 1: Infrastructures and Economic Activity

Countries:	AEs	EMs	LIDCs
Percent of firms:			
identifying electricity as a major constraint	14.6	26.3	39.3
experiencing water insufficiencies	4.6	12.8	22.1
identifying transportation as a major constraint	9.2	15.0	22.1
number of surveys	33	165	114
Change in the percent of firms:			
identifying electricity as a major constraint	-7.2	-10.5	-9.4
experiencing water insufficiencies	-2.7	-2.3	-5.4
identifying transportation as a major constraint	-6.7	-2.5	-0.1
number of survey pairs	6	48	41

Note: The top panel reports simple averages of all available country-representative surveys, over the period 2006-2016, by country groupings. The bottom panel reports changes between the most recent survey and the first one, starting in 2006. Then, the initial and final year changes because of data availability. Only countries with at least two surveys since 2006 are considered.
Source: World Bank Enterprise Survey.

Progress notwithstanding, the quantity and quality of infrastructure in LIDCs continue to lag. Despite significantly faster growth, electricity generation capacity in LIDCs—even in frontier markets—remains considerably lower than in emerging markets. Furthermore, electricity supply is also less reliable. Road density also lags behind, although the gap is smaller. Mobile phone penetration made huge strides from near zero in 2000 to 72 per 100 people in 2014, but was still significantly lower than 118 per 100 people in EMs. Survey-based measures about the quality of national infrastructure compiled by the World Economic Forum (Schwab 2016) show a noticeable improvement in perceived infrastructure quality in LIDCs in the second half of the 2000, but no progress for the median LIDCs since 2010, leaving a large gap with advanced and emerging market economies (Figure 2).

Figure 2. Perceptions of Infrastructure Quality
(Index, 1-7)



Source: World Economic Forum Global Competitiveness Index Database.

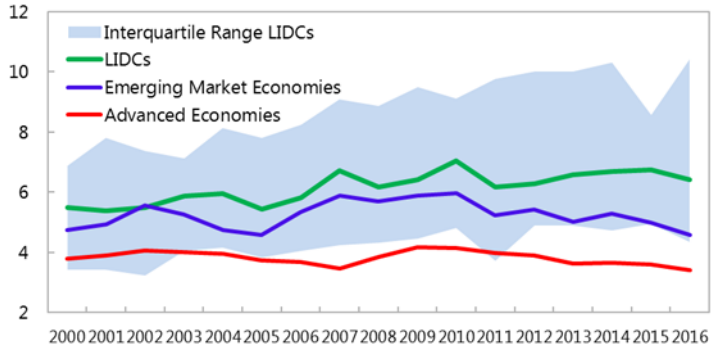
IV. INFRASTRUCTURE INVESTMENT—DELIVERY AND FINANCING

3.1 Public Investment and Saving

Analyzing infrastructure investment in developing countries is a difficult task because of the lack of systematic and comparable data. It is generally recognized, however, that the public sector provides the bulk of infrastructure in these countries. In addition, as we show below for a limited sample of countries, investment in economic infrastructure constitutes a large share of total public investment so that the latter can serve as a reasonable proxy for the former. Thus, we start our analysis by examining trends in public investment.

Public investment in LIDCs is higher as a percent of GDP than in emerging and advanced economies and has followed a general upward trend since 2000, first surging before the Global Financial Crisis (GFC) and then picking up again until 2015.[6] By contrast, trends in emerging markets and advanced economies had been downward sloping in the 2010s. Median public investment in LIDCs rose significantly from 5.5 percent of GDP in 2000 to a peak of 7.1 percent of GDP in 2010. Following a temporary slowdown in 2011, public investment picked up again and stood at 6.7 percent of GDP in 2015, before declining to 6.4 percent in 2016 (Figure 3).[7] As documented in the previous section, this scaling-up has resulted in a broad enhancement of economic infrastructure in LIDCs, although this relationship is far from tight and exhibits significant variation across countries and sectors. Moreover, a large gap still remains compared to emerging and advanced economies.

Figure 3. Public Investment: 2000-2016
(Median and interquartile range, percent of GDP)

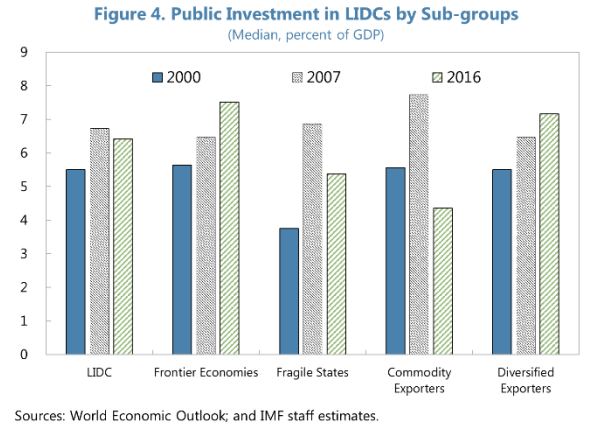


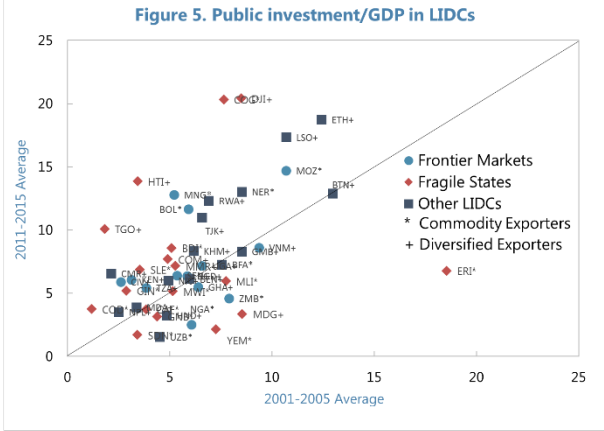
Sources: World Economic Outlook; and IMF staff estimates.

The wide variability in the public investment-to-GDP ratio across countries indicates a variety of experiences. Public investment trajectories differed somewhat across LIDC groups, particularly after the GFC. In the pre-crisis period the scaling-up of public investment was common to most countries, which benefited from a favorable global environment, rising commodity prices, and debt relief under the HIPC and MDRI initiatives, among other factors. In particular, commodity exporters expanded public investment more than other countries as

[6] The analysis in this section is based on 47 LIDCs for which the IMF's World Economic Outlook database contains information on public investment and public saving.

[7] The current median level of public investment in LIDCs is similar to that observed in the present-day EMs in the 1980s and is higher than the 1990s EM median of 6 percent of GDP.





they benefited from a large terms-of-trade improvement. These trends diverged in recent years, with public investment falling in commodity exporters as a decline in commodity prices led to fiscal pressures, while diversified exporters recorded a further small increase from the pre-GFC peak (Figure 4).

Diversity is notable not only between but also within groups. In every category, one can find examples of countries that achieved or maintained high public investment levels and examples of those that failed to do so. A large majority increased the public investment-to-GDP ratio in the 2011-2015 period compared to 2000-05 (Figure 5).[8] Some countries stand out with substantial scaling-up, with highest levels reached in Djibouti, Congo (Alter et al (2017) discuss Congo's experience) and Ethiopia (see Appendix I), which have been pursuing national development agendas centered on improving infrastructure. Public investment rose steadily in several commodity exporters, including Bolivia, Mongolia, Mozambique, Niger, and Tajikistan, until a drop in 2014-15 following a negative commodity price shock. However, in some other countries, the ratio of public investment to GDP has declined significantly over time, reflecting, for example, intensified fragility in Eritrea and Yemen, and fiscal pressures in Nigeria and Uzbekistan. A few countries have not experienced a pronounced scaling-up, but have maintained fairly high levels of public investment throughout the past 15 years. For example, Bhutan and Vietnam averaged 13 and 9 percent of GDP, respectively, since 2000. On the other hand, in several countries, public investment has been quite low over the whole period (e.g., never exceeding 5 percent of GDP in Nepal, primarily because of implementation capacity constraints and frequent government turnover).

Public saving has generally not been scaled up commensurately with the increase in public investment. Over the last decade and a half, there has been a clear correlation between changes in public investment and in public saving (Figure 6). However, the former was greater than the latter in most countries, especially in most recent years.[9] As a result, the gap

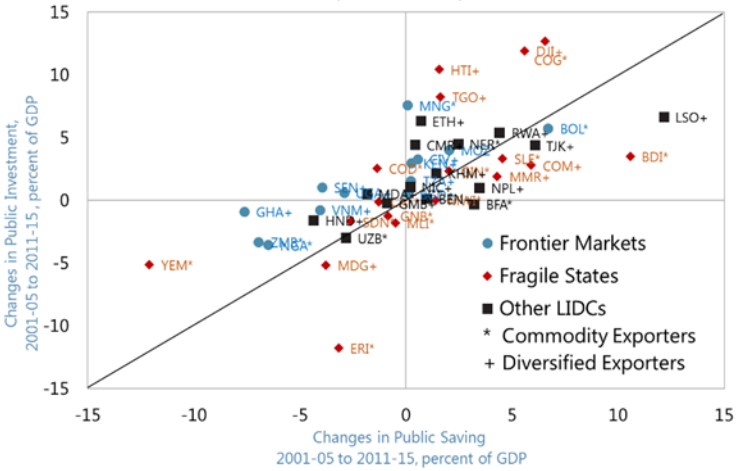
[8] Five-year averages are used to smooth over yearly fluctuations.

[9] Among the 33 countries where the public investment/GDP ratio increased between 2001-05 and 2011-15, public saving rose in 27, but only in 10 of them it rose enough to cover the increase in public investment. As

(continued…)

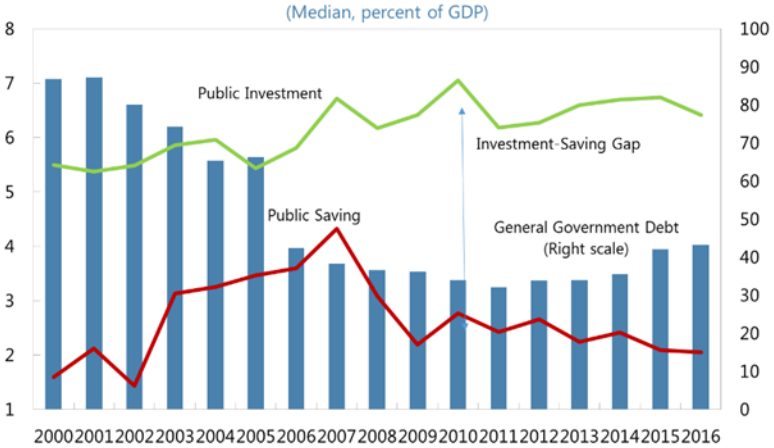
between public investment and saving—which narrowed before the GFC—started widening in subsequent years, indicating increasing recourse to debt financing (Figure 7). Median public saving as a share of GDP rose 2.9 percentage points between 2000 and 2007—twice as much as public investment. Median public saving declined sharply during the GFC, and, after a brief rebound, started slipping again, with the latest slide reflecting lower commodity prices. As a result, median public saving has dropped 2.4 percentage points of GDP since its 2007 peak, returning to the early 2000s' levels, even as median public investment eked out a small increase. In 2015, public investment exceeded public saving in 42 out of 46 LIDCs and the gap between median public investment and median public saving reached 4.8 percent—the widest it has been since 2000.

Figure 6. Changes in Public Saving and Investment in LIDCs
(Percent of GDP)



Sources: World Economic Outlook; and IMF staff estimates.

Figure 7. Public Investment, Public Saving and General Government Debt in LIDCs
(Median, percent of GDP)



Sources: World Economic Outlook; and IMF staff estimates.

In the most recent years, the negative public saving-investment balances have contributed to higher government debt-to-GDP ratios, following a notable drop in debt ratios in most LIDCs over the course of the 2000s, mostly driven by multilateral and bilateral debt relief initiatives (Figure 9). Fiscal vulnerabilities have increased recently, particularly among commodity exporters. Budget deficits have gone up, interest rates have risen, and local currency depreciation has increased the burden of external debt. As a result, the median general government debt ratio went up from 34 percent in 2013 to 43 percent in 2016.[10] In some

with investment, fragile states exhibit the widest variety of changes in public saving and the extent to which those match changes in public investment.

[10] According to the latest debt sustainability analyses conducted by IMF and World Bank country teams, two LIDCs are currently experiencing external debt distress, 11 are at a high risk of debt distress, and 27 are at a moderate risk (IMF 2017).

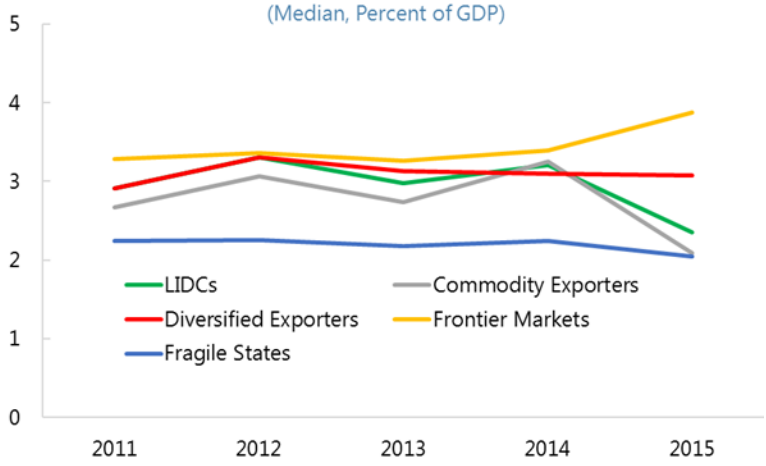
frontier markets, rising debts are also the result of access to international capital markets: since 2010 LIDCs issued more than USD 22 billion in sovereign bonds, in many cases with the aim of using part of the proceeds to finance new infrastructures (Presbitero et al. 2016). For instance, in 2014 Ethiopia issued a USD one billion Eurobond to finance imports related to export-oriented projects such as investment in the power transmission infrastructure, sugar factories, and the development of industrial parks (IMF 2015a). More recently, in May 2017 Senegal issued its third Eurobond (USD 1.1 billion) with the intent to finance a series of infrastructure and power production projects.

3.2 Public Infrastructure Investment

As noted above, internationally comparable data on infrastructure investment for a broad set of LIDCs is lacking. To fill that gap, we have conducted a survey of the IMF's LIDC country desks. Thirty-two teams were able to provide information on public investment in economic infrastructure over the last five years, typically in consultation with the authorities.[11] Twenty-three of them had data by sector. This information offers valuable insights, even though the results should be taken with a grain of salt as quality and comparability of data cannot be assured.

For a median LIDC in the sample, investment in economic infrastructure accounted for about half of total public investment.[12] The median investment level stood around 3 percent of GDP in 2011–14, but dropped below 2½ percent in 2015 as commodity exporters were hit by falling export prices (Figure 8). Looking across country groupings, frontier market economies had somewhat higher levels of investment, facilitated by easier access to financing and stronger economic prospects. Investment levels in fragile states were typically lower than average, likely reflecting limited fiscal space and weak institutional capacity.

Figure 8. Public Investment in Infrastructure
(Median, Percent of GDP)



Sources: Country Desk Survey; and IMF staff estimates.

[11] See Annex table A1 for details. For some countries, coverage included only budgetary central government.

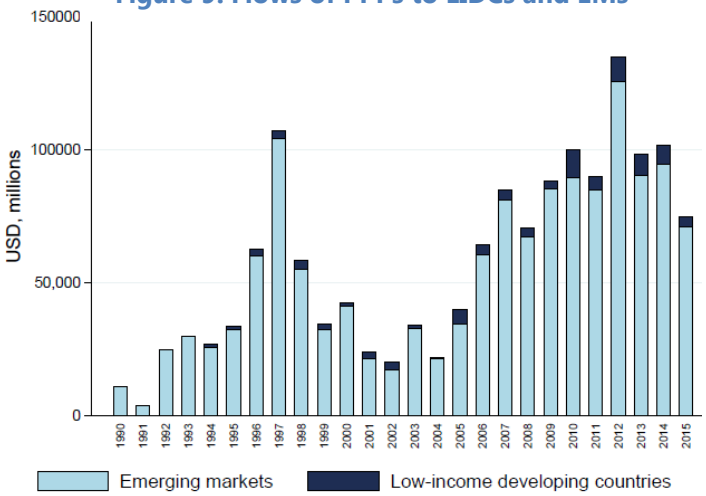
[12] The correlation between public infrastructure investment and total public investment is 0.8 in this sample, providing justification for looking at cross-country differences and time evolution in the latter as a reasonable proxy for the behavior of the former.

The transportation sector accounted for about half of total investment in economic infrastructure, consistent with what found in other analyses (e.g., UNCTAD, 2014), although the reported share is usually below 50 percent. Water and sanition account for 22 percent, the energy sector for 19 percent and ICT for the residual 6 percent. The relatively low share of energy is somewhat troubling, since access to electricity is frequently identified as a key constraint to development in LIDCs (see Payne (2010) for a review of the literature, and Di Bella and Grigoli (2016) for an application to Haiti and Nicaragua). Fairly broad private provision of ICT services has allowed governments to spend relatively little in that area.

3.3 Private Participation in Infrastructure

Private participation in infrastructure investment is quite limited in LIDCs. Since 2000, LIDCs accounted for 6.5 percent of the value and 10.5 percent of the number of Public-Private Partnership (PPP) projects in all emerging market and developing economies (Figure 9).[13] In the last five years PPP volume amounted on average to about 0.4 percent of LIDC GDP—a ratio similar to EMs. After a sharp acceleration in the early 2010s, PPP flows have declined in the most recent years. Of the $43 billion in LIDC PPP projects since 2010, more than half has been invested in Asia and one third in Sub-Saharan Africa. Vietnam and Bangladesh have the largest number of projects (Table 2), while Lao PDR is an undisputed leader in terms of volume (Appendix II). Public-private partnerships have also been used to finance regional projects. Across Africa there are several examples of regional infrastructure projects, especially in the energy and transport sectors (UNCTAD, 2016). For instance, the Central Corridor is an integrated transport program across five countries (Burundi, DR Congo, Rwanda, Tanzania, and Uganda) with an investment of about $18 billion involving local and international actors from the public and private sectors (WEF, 2015).

Figure 9: Flows of PPPs to LIDCs and EMs



Source: World Bank's PPI database

[13] The World Bank's PPI database (World Bank, 2016) records total investment in infrastructure projects with private participation (but not purely private investment). Investment commitments include expenditures on facility expansion, divestiture revenues, and license or concession fees. Infrastructure refers to telecommunications, energy, transport, and water projects serving the public, including natural gas transmission and distribution, but excluding oil and gas extraction. Coverage of the telecom sector currently includes only the ICT "backbone" (e.g., fiber optic networks), but was broader in the past.

Private participation varies greatly across sectors (Figure 10). The telecom sector attracted considerable private participation in the 1990s, following liberalization and technological advances, and has ultimately moved toward mostly purely private provision (particularly for mobile services), with the government's role limited to regulation and licensing.[14] There is very little purely private provision of infrastructure services outside the telecom sector, although some small-scale successful models can be found (Appendix III), and private sector involvement is channeled predominantly via PPPs. Currently, the energy sector attracts the bulk of PPPs, with transportation a distant second, and a small share allocated to water and sanitation.[15] This likely reflects the fact that it might be easier—both technically and politically—to charge end users for electricity than for roads or water. The vast majority of projects are greenfield projects (87 percent since 2000) and brownfields (8 percent) and almost all the contracts (97 percent) have been have been with the central government. There is considerable variation in the size of PPP projects, and some of them are very large, such as a coal plant in Laos with an investment of $3.7 billion, the expansion of the Onne port complex in Nigeria ($2.9 billion), and a thermal power generation project in Vietnam ($2 billion). Nine projects started since 2010 are valued over $1 billion.

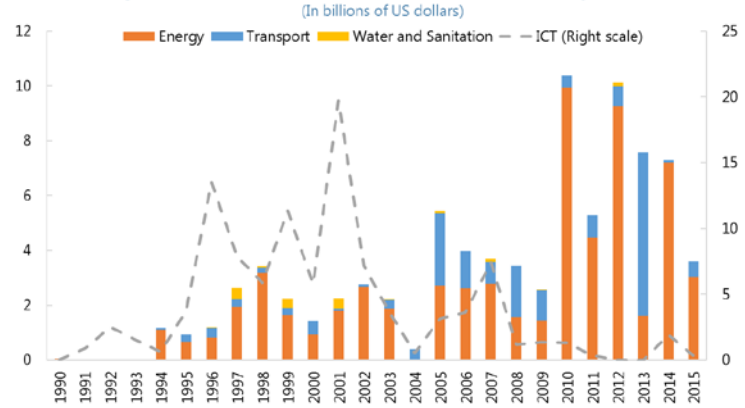
Table 2. Countries with Most PPPs, 2011–15

Ranking	Country	# PPPs	Value US$ (in millions)	% of GDP
1	Lao PDR	18	8,075	15.3
2	Nigeria	5	5,812	0.2
3	Vietnam	31	5,430	0.6
4	Bangladesh	22	2,688	0.3
5	Honduras	18	2,636	2.8
6	Ghana	3	1,466	0.7
7	Kenya	7	1,358	0.5
8	Nepal	12	1,173	1.2
9	Zambia	3	1,170	0.9
10	Senegal	6	717	1.0

Sources: World Bank; and IMF staff estimates.

Figure 10. Flows of PPPs Commitments in LIDCs, by Sector

(In billions of US dollars)



Sources: World Bank; and IMF staff estimates.

Multilateral development banks (MDBs) are involved in a significant share of PPPs to provide operational assistance, financial support and risk mitigation (World Bank, 2016). More than a quarter of the projects in LIDCs involve MDB support in the form of direct loans, syndication, equity investment, partial credit guarantees, and political risk coverage.

[14] Changes in methodology amplify the rise and fall in telecom PPPs in Figure 13.

[15] At the regional level, in Asia the vast majority of PPI are in the energy sector, while in Sub-Saharan Africa private participation in transport infrastructure is also common.

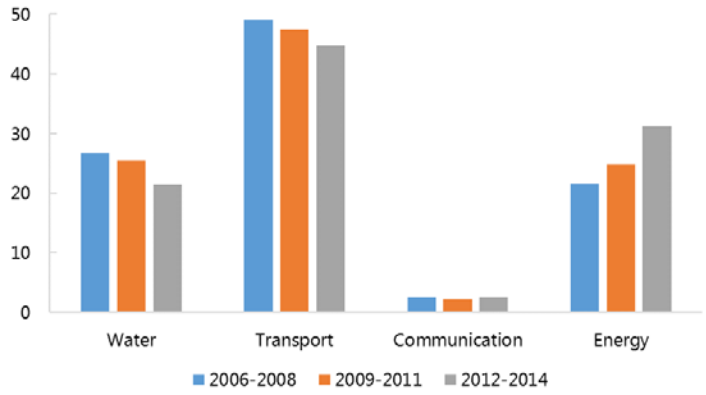
(continued…)

The presence of MDBs is associated with a lower probability that a project comes under distress or is canceled, even after controlling for a set of project-specific variables and for year and country fixed effects.[16] This likely reflects a combination of careful project selection by MDBs and the impact that MDB involvement—through a thorough preparation and a strengthened oversight—has on the quality of the project (Jandhyala, 2016).

3.4 Financing for Infrastructure: Official Development Finance and Cross Border Lending

Official development finance (ODF) is a major source of infrastructure financing in LIDCs. Detailed data obtained from OECD show that LIDCs received nearly $17 billion in project finance from MDBs and OECD members in 2014.[17] While the total value of infrastructure investment in LIDCs is not known, ODF certainly covers a much larger share of investment in LIDCs than in other developing countries.[18] Moreover, 87 percent of ODF for LIDCs consisted of grants and concessional loans, in contrast to only 56 percent for all developing countries. The bulk of the money went to public projects, with direct support to the private sector amounting to $0.9 billion. The share of projects in water and transportation sectors in total infrastructure ODF declined steadily since 2006, while the share of energy increased to about 30 percent in 2014 (Figure 11).

Figure 11. Selectoral Allocation of Infrastructure ODF to LIDCs, 2006–2014
(Percent of total)



Sources: OECD; and IMF staff estimates.

There is considerable dispersion across countries in the amounts of ODF received. In 2014, for all LIDCs, the median ratio of ODF to GDP equaled 1.3 percent, the simple average 2.0 percent, and the GDP-weighted average 0.9 percent. As expected, grants accounted for the bulk of financing in fragile states, while frontier markets and commodity exporters received less ODF (relative to their GDP) than other country groups as they have a higher

[16] On average, about 5 percent of the projects recorded in the PPI database are canceled or under distress. Regression results are available upon request.

[17] Multilateral support accounted for 57 percent of ODF, bilateral for 43 percent. The World Bank is the largest multilateral donor, and Japan is the largest bilateral one. ODF *commitments* amounted to around $24 billion in 2014, exceeding disbursements by a wide margin.

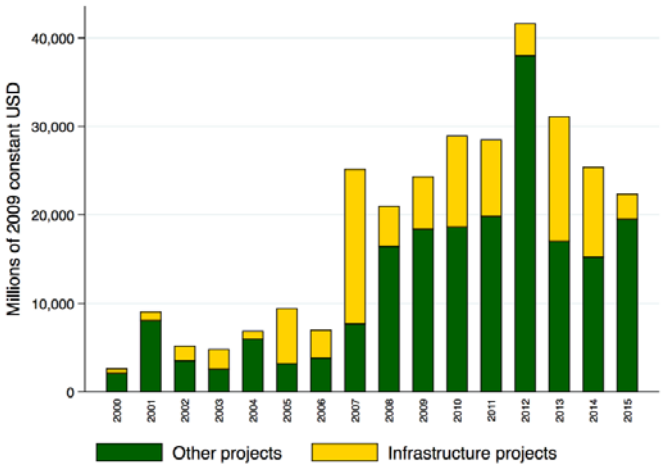
[18] According to OECD (2016), ODF covers 6-7 percent of infrastructure investment in developing countries.

domestic revenue base and greater access to commercial borrowing.

Some emerging donors, notably China and India, have also become important providers of infrastructure financing to LIDCs. These countries direct a considerable share of their development financing to infrastructure. China, in particular, committed billions of dollars of infrastructure investment under the "Belt and Road" initiative, an ambitious plan to boost trade and global development, strengthening the links between Asia, Europe, and Africa. According to the data on Chinese development assistance published by AidData, between 2000 and 2013 almost 60 percent of Chinese-funded projects were infrastructure ones.[19] Gutman et al. (2015) calculate that China contributes about 20 percent of external finance for infrastructure projects in Sub-Saharan Africa, with most of that financing provided by China's EXIM Bank.[20] India's development financing for infrastructure is estimated at $1.3 billion in 2014, with most of it going to neighboring countries, primarily for energy and transportation. The role of non-traditional donors has also widened with the entry of new multilateral institutions, notably, the Asian Infrastructure Investment Bank (AIIB) and the New Development Bank (NDB). The AIIB focuses on supporting Asia's infrastructure needs while the NDB has a broader development mandate for BRICS and other emerging market and developing economies.

Infrastructure projects in LIDCs are also increasingly financed by cross-border bank lending, which generally represents a complementary source of external financing with respect to ODF. Vietnam, Uzbekistan, Nigeria, Lao PDR, Ethiopia and Kenya are the largest recipients of international syndicated loans, with MDBs participating in about one fourth of these cross-border loans. Total cross-border bank lending rose steadily in the late 2000s, peaking in 2012—when it amounted to about USD 40 billion—before falling significantly alongside the drop in commodity prices in 2014–15. A significant share of these flows is financing infrastructure projects, especially since 2007, when almost

Figure 12. Cross-Border Bank Lending to LIDCs



Source: World Bank's PPI database

[19] See AidData (Strange et al, 2017) for the original data that include realized and committed flows. We exclude pledges from the figure cited in the text.

[20] Figures based on *realized* foreign direct investment of China, show that China only accounted for around 5 percent of global FDI into Africa in 2015 (Brautigam et al, 2017). The same authors show that Chinese FDI in Africa is starting to diversify in terms of sector and location.

30 percent of cross border bank lending in LIDC financed infrastructure projects, while the share in EMs is about 22 percent (Figure 12; see also Gurara et al. (2017) for a detailed discussion of syndicated lending to LIDCs). In terms of sector distribution, 52 percent of infrastructure loans go to energy and utilities, 19 percent to telecommunications, 17 percent to transportation. This allocation points to complementarity between commercial cross-border lending and ODF, with the latter focused more on the transportation sector.

V. CHALLENGES AND WAY FORWARD

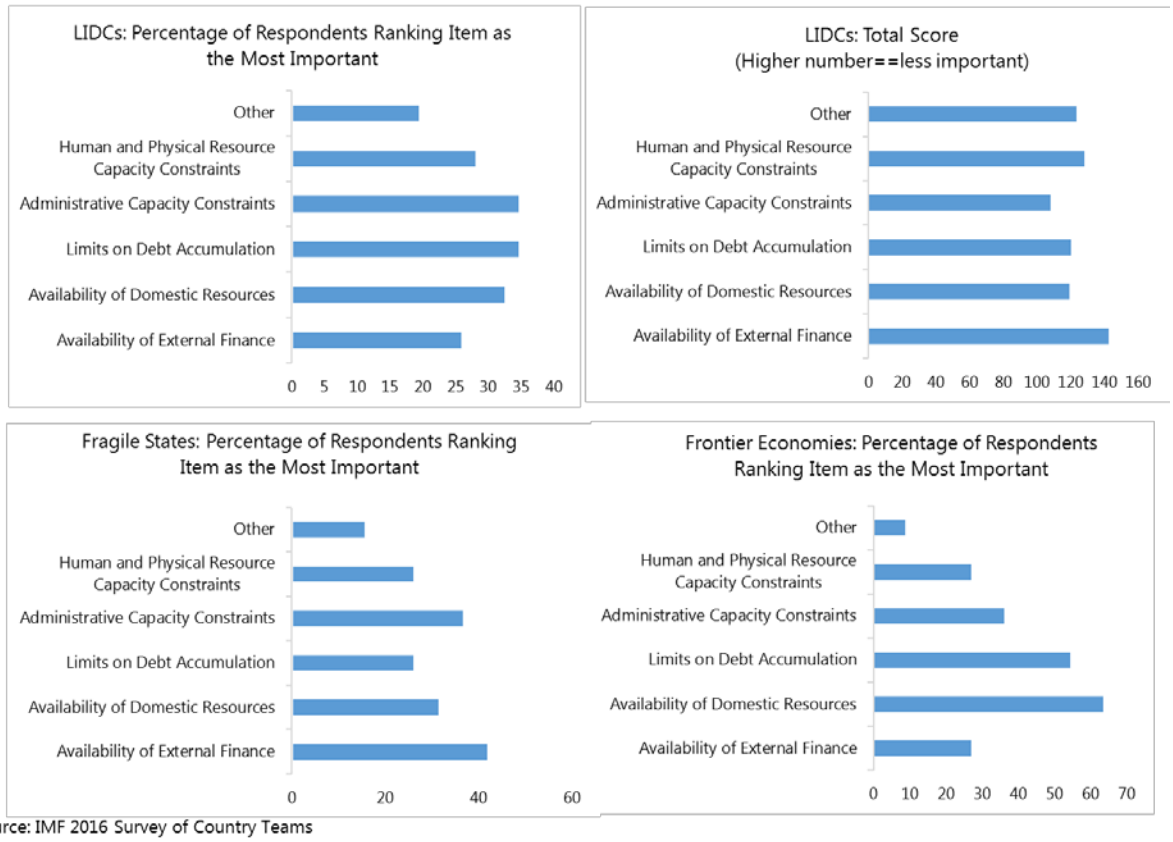
UNCTAD (2014) estimates that attaining the SDGs would require increasing spending on economic infrastructure by USD 0.8 to 1.7 trillion a year from current levels, although these numbers cover all developing countries, not just LIDCs. Various other analyses (e.g., Foster and Briceño-Garmendia (2010) for Sub-Saharan Africa) also find large gaps between infrastructure investment needs and actual spending. Thus, despite the broad increase in infrastructure investment documented in the previous section, a strong case exists for further expansion in light of potentially high social and economic returns, even though policy makers should keep in mind the lessons from past experiences and the possible heterogeneous effects of infrastructure investment (see Section II).

The path forward is not easy and the scope for increasing public investment in LIDCs is rather limited, even though the wide range of investment ratios shows that many countries may have some room for scaling up. Over the last two years, public debt levels have risen, external financing conditions have tightened, and growth prospects have weakened for the LIDCs. These trends create a challenging environment for infrastructure investment. Countries with fiscal space should seek financing on the most concessional terms possible, with the support from the international community. Especially for countries where fiscal space is limited (but also for the others) there is a need to increase the efficiency of public investment—and considerable scope for it exists. The link between the amount of public investment (the input) and the quantity and quality of infrastructure in a country (the outputs and the outcomes) is not very tight and, although many factors may contribute to this variance, differences in investment efficiency are likely one of them. Several studies (Dabla-Norris et al, 2012) show that low-income countries have relatively weak public investment management institutions, and that improving those institutions could increase considerably the efficiency (i.e., the "value for money") of public investment.[21] In addition, mobilizing domestic revenues and prioritizing expenditures could provide more sustainable and reliable sources of development funding.

Even in the absence of financing constraints, absorptive capacity constraints could weaken

[21] A related issue is a frequent failure to allocate adequate funds to maintenance (Adam and Bevan, 2014). In the IMF survey, only 40 percent of LIDC country teams indicated that new projects included a budget for maintenance.

Figure 13. Key Obstacles to Scaling Up Public Investment in Economic Infrastructure



Source: IMF 2016 Survey of Country Teams
1/ Scores ranges from 1-6 in decreasing order of importance. Based on 46 responses.

the growth impact of infrastructure spending, as countries could not have the capacity to reap the benefit of additional investment, given that a simultaneous implementation of several investment projects would require a varied set of technical and managerial resources which cannot be expanded in the short-run (Horvat 1958, Rosenstein-Rodan 1961). In a seminal paper, Isham and Kaufmann (1999) show that once the ratio between public investment over GDP is too high (above 10 percent), the increase in public investment is associated with a declining productivity of investment projects. More recently, Presbitero (2016) uses a large dataset of investment projects financed by the World Bank since the 1970s in 100 developing countries and shows that infrastructure projects undertaken in periods when public investment accelerates compared to its historical patterns are less likely to be successful, indicating the presence of absorptive capacity constraints. This suggests that it might be advantageous to scale up infrastructure investment gradually, while building capacity and strengthening institutions.

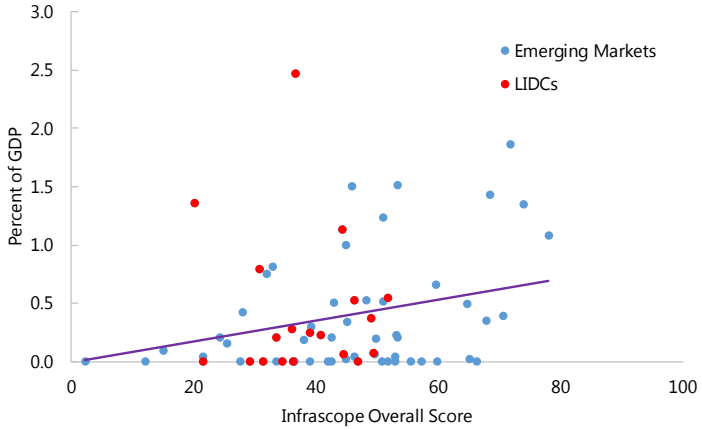
The IMF team survey shows that indeed countries face multiple obstacles to scaling up public investment in economic infrastructure. Interestingly, no single constraint emerged as dominant in the full sample (Figure 13). Sharper results were obtained for subgroups, with fragile state desks emphasizing availability of external finance and administrative capacity as

key challenges, while availability of domestic resources and limits on debt accumulation were most important for frontier economies.

Even under optimistic assumptions about future improvements in public investment efficiency, domestic resource mobilization, and concessional financing, the scale of the infrastructure challenge is such that tackling it is inconceivable without a significant increase in private sector participation. While over the longer run purely private provision can be expected to spread more widely beyond the telecom sector, in the near future private participation is likely to occur primarily through PPPs.

The balance between public and private financing depends to a large extent on the country context and, in particular, on the institutional weaknesses that are felt most acutely, as government could be affected by limited commitment, limited accountability, limited capacity, and limited fiscal efficiency (Estache et al. 2015). Macro-fiscal implications of PPP projects could be large and expose countries to fiscal risks. Thus,a strong regulatory environment and a robust institutional framework[22] are essential to implement PPP infrastructure projects in a sustainable and efficient way, especially in developing countries, where public sector capacity constraints may be more severe (Romero, 2015). PPP use is correlated with domestic institutions, such as the rule of law and levels of corruption (Moszoro et al, 2014). In a broad sample of emerging market and developing economies, there is a positive association between PPP investment as a percentage of GDP and the Infrascope index developed by the Economist Intelligence Unit (EIU, 2010) to evaluate countries' capacity to deliver efficient and sustainable infrastructure projects (Figure 16).The average Infrascope index for LIDCs is significantly lower than the one of EMs, and the gap is particularly strong for the legal regulatory framework and for the presence of financial facilities. A heavy reliance on external financing and lags in the implementation of the PPP legal framework have been identified as key constraints for the growth of PPPs in sub-Saharan Africa (EIU, 2015). In that perspective, there is scope to improve the collaboration between local governments and MDBs in the preparation, structuring and financing of infrastructure project, to facilitate the

Figure 14. PPP Amount vs. Institutional Framework



Sources: The World Bank; and IMF staff estimates.

[22] These include sound planning and project selection; strong fiscal institutions; strong legal frameworks; strong budgeting, accounting and reporting practices; and appropriate fiscal risk analysis at the project level (see IMF, 2017 Box 9).

participation of private long-term investors—the World Bank *Global Infrastructure Facility* and the EBRD *Equity Participation Fund* are infrastructure platforms that go in that direction (Arezki et al. 2017).

More broadly improving infrastructure in LIDCs is subject to numerous challenges and requires a coordinated set of measures that include:

- Mobilizing domestic resources for public investment by increasing tax revenue and streamlining and prioritizing expenditures;[23]
- Increasing access to concessional external financing;
- Developing local capital markets;
- Strengthening the institutional and regulatory framework to expand private sector involvement in the provision and financing of infrastructure investment, supported by multilateral development banks and development finance institutions;
- Improving "value for money" in public and PPP investment projects.

VI. CONCLUSIONS

Public investment, including in infrastructure, has broadly increased in LIDCs over the last 15 years. Despite the scaling-up, the quantity, quality and accessibility of infrastructure in LIDCs remain considerably lower than in emerging market economies. Outside the telecom sector, infrastructure services in LIDCs are primarily provided by the public sector. Private participation is largely channeled through Public-Private Partnerships, which are mostly concentrated in the energy sector and whose volume has declined recently after a sharp spike in the early 2000s. Grants and concessional loans from development partners are an essential source of infrastructure funding in LIDCs. International syndicated loans play an important complementary role in a few countries, even though lending volumes have fallen in the last two years. Data collected through a survey of IMF country teams confirm that funding constraints are a common impediment to scaling up infrastructure investment.

Improving LIDC infrastructure to levels consistent with attaining Sustainable Development Goals—and at the same time being able to reap the benefits in terms of growth and inclusion—requires action on multiple fronts, to avoid to repeat the negative experiences of past scaling-up episodes. Governments need to strike a careful balance between supporting development outlays and maintaining debt sustainability, and financing schemes should be adapted to the institutional context. As fiscal risks limit room for debt financing, additional resources for public investment need to be sought through domestic resource mobilization and concessional financing. Given the scarcity of resources, improving administrative

[23] The potential to mobilize domestic resources in developing countries and the steps needed to realize that potential are discussed in detail in IMF (2015a).

capacity and investment efficiency is paramount. In addition, a major increase in private sector involvement is essential and requires concerted efforts to improve the regulatory and macroeconomic environment as well as complementary actions by multilateral development banks to provide risk mitigation and technical assistance.

REFERENCES

Acosta-Ormaechea, Santiago, and Atsuyoshi Morozumi, 2017, "Public Spending Reallocations and Economic Growth Across Different Income Levels," *Economic Inquiry*, 55(1): 98–114.

Adam, Christopher, and David Bevan, 2014, "Public Investment, Public Finance, and Growth: The Impact of Distortionary Taxation, Recurrent Costs, and Incomplete Appropriability," IMF Working Paper, No. 14/73.

Agenor, Pierre-Richard, 2010, "A Theory of Infrastructure-led Growth," *Journal of Economic Dynamics and Control*, 34: 932–950.

Alter, Adrian, Matteo Ghilardi, and Dalia Hakura, 2017, "Public Investment in a Developing Country Facing Resource Depletion," *Journal of African Economies*, 26(3): 295–321.

Arezki, Rabah, Patrick Bolton, Sanjay Peters, Frederic Sanama, and Joseph Stiglitz, 2017, "From Global Savings Glut to Financing Infrastructure," *Economic Policy*, 32: 221–261.

Atolia, Manoj, Bin Grace Li, Ricardo Marto, and Giovanni Melina, 2017, "Investing in Infrastructure: Roads or Schools?," IMF Working Paper, No. 17/105.

Baum-Snow, Nathaniel, J. Vernon Henderson, Matthew A. Turner, Qinghua Zhang, and Loren Brandt, 2017, "Highways, Market Access, and Urban Growth in China," mimeo.

Bougheas, Spiros, Panicos O. Demetriades, and Edgar L.W. Morgenroth, 1999, "Infrastructure, Transport Costs and Trade," *Journal of International Economics*, 47: 169–89.

Brautigam, Deborah, Xinshen Diao, and Margaret McMillan, 2017, "Chinese Investment in Africa: How Much Do We Know?," IFPRI Working Paper, forthcoming.

Calderon, Cesar, and Alberto Chong, 2004, "Volume and Quality of Infrastructure and the Distribution of Income: An Empirical Investigation," *Review of Income and Wealth*, 50: 87–105.

Calderon, Cesar, and Luis Serven, 2010, "Infrastructure and Economic Development in Sub-Saharan Africa," *Journal of African Economies*, 19(s1): i13–i87.

Calderon, Cesar, Enrique Moral-Benito, and Luis Serven, 2015, "Is Infrastructure Capital Productive? A Dynamic Heterogeneous Approach," *Journal of Applied Econometrics*, 30: 177–198.

Cavallo, Eduardo, and Christian Duade, 2011, "Public Investment in Developing Countries: A Blessing or a Curse?", *Journal of Economic Dynamics and Control*, 39: 65–81.

Di Bella, Gabriel, and Francesco Grigoli, 2016, "Power It Up: Strenghtening the Electricity Sector to Improve Efficiency and Support Economic Activity," IMF Working Paper, No. 16/85.

Donaldson, Dave, and Richard Hornbeck, 2016, "Railroad and American Economic Growth," *Quarterly Journal of Economics*, 131(2): 799–858.

Donaldson, Dave, 2017, "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure," *American Economic Review*, forthcoming.

Duflo, Esther, and Rohini Pande, 2007, "Dams," *The Quarterly Journal of Economics*, 122(2): 601–46.

Economist Intelligence Unit, 2010, "Evaluating the Environment for Public-Private Partnerships in Latin America and the Caribbean: The 2010 Infrascope. A Guide to the Index and Methodology."

Economist Intelligence Unit, 2015, "Evaluating the Environment for Public–Private Partnerships in Africa: The 2015 Infrascope," EIU, London.

Estache, Antonio, and Marianne Fay, 2007, "Current Debates on Infrastructure Policy," Policy Research Working Paper, No. 4410, The World Bank.

Estache, Antonio, Tomas Serebrisky, and Liam Wern-Lewis, 2015, "Financing Infrastructure in Developing Countries," *Oxford Review of Economic Policy*, 31(3–4): 279–304.

Dabla-Norris, Era, Jim Brumby, Annette Kyobe, Zac Mills, and Chris Papageorgiou, 2012, "Investing in Public Investment: An Index of Public Investment Management Efficiency," *Journal of Economic Growth*, Vol. 17, Issue 3, Pages 235–266, September 2012.

Esfahani, Hadi Salehi, and Maria Teresa Ramirez, 2003, "Institutions, Infrastructure, and Economic Growth," *Journal of Economic Development*, 70: 443–477.

Foster, Vivien, and Cecilia Briceño-Garmendia (editors), 2010, "Africa's Infrastructure: A Time for Transformation," co-publication of the Agence Française de Développement and the World Bank.

Gurara, Daniel, Miguel Sarmiento, and Andrea F. Presbitero, 2017, "Borrowing Costs in Developing Countries and the Role of Multilateral Development Banks: Evidence from Syndicated Bank Lending," mimeo.

Gutman, Jeffrey, Amadou Sy, and Soumya Chattopadhyay, 2015, "Financing African Infrastructure: Can the World Deliver?", Global Economy and Development at Brookings Institution.

Hammami, Mona, Jean Francois Ruhashyankiko, and Etienne B. Yehoue, 2006, "Determinants of Public–Private Partnerships in Infrastructure," IMF Working Paper, No. 06/99.

Horvat, Branko, 1958, "The Optimum Rate of Investment," *Economic Journal*, 68: 747–67.

IMF, 2014a, "Proposed New Grouping in WEO Country Classifications: Low-Income Developing Countries," IMF Policy Paper, June 2014.

IMF, 2014b, “Regional Economic Outlook: Sub-Saharan Africa. Staying the Course,” October 2014.

IMF, 2014c, “Macroeconomic Developments in Low-Income Developing Countries.”

IMF, 2015a, “Macroeconomic Developments and Prospects in Low-Income Developing Countries – 2015,” Washington DC.

IMF, 2015b, “Making Public Investment More Efficient,” Washington DC

IMF, 2016, “Regional Economic Outlook: Western Hemisphere. Managing Transitions and Risks,” April 2016.

IMF, 2017, “Macroeconomic Developments and Prospects in Low-Income Developing Countries – 2016,” Washington DC.

Isham, Jonathan, and Daniel Kaufmann, 1999, “The Forgotten Rational for Public Reform: The Productivity of Investment Projects,” *The Quarterly Journal of Economics*, 114(1): 149–84.

Jandhyala, Srividya, 2016, “International Organizations and Political Risk – The Case of Multilateral Development Banks in Infrastructure Projects.”, mimeo

Jedwab, Remi, and Alexander Moradi, 2016, “The Permanent Effects of Transportation Revolutions in Poor Countries: Evidence from Africa,” *Review of Economics and Statistics*, 98(2): 268–84.

Jedwab, Remi, and Adam Storeygard, 2016, “The Heterogeneous Effects of Transportation Investments: Evidence from Sub-Saharan Africa,” *mimeo*, George Washington University.

Jedwab, Remi, Edward Kerby, and Alexander Moradi, 2017, “History, Path Dependence, and Development: Evidence from Colonial Railroads, Settlers, and Cities in Kenya,” *Economic Journal*, forthcoming.

Khandker, Shahidur R., Zaid Bakht, and Gayatri B. Koolwal, 2009, The Poverty Impact of Rural Roads: Evidence from Bangladesh,” *Economic Development and Cultural Change*, 57(4): 685–722.

Lokshin, Michael, and Ruslan Yemtsov, 2005, “Has Rural Infrastructure Rehabilitation in Georgia Helped the Poor?”, *World Bank Economic Review*, 19: 311–33.

Moszoro, Marian W., Spiller, Pablo T., and Stolorz, Sebastian, 2014, “Rigidity of Public Contracts,” GMU School of Public Policy Research Paper No. 2013–13; IESE Business School Working Paper No. 07/2013.

Mu, Ren, and Dominique van de Walle, 2011, “Rural Roads and Local Market Development in Vietnam,” *Journal of Development Studies*, 47(5): 709–34.

OECD, 2016, “Official Development Finance for Infrastructure in 2014: Draft Report.”

Payne, James, 2010, "Survey of the International Evidence on the Causal Relationship Between Energy Consumption and Growth," *Journal of Economic Studies*, 37(1): 53–95.

Presbitero, Andrea F., 2016, "Too Much and Too Fast? Public Investment Scaling-Up and Absorptive Capacity," *Journal of Development Economics*, 120: 17–31.

Presbitero, Andrea F., Dhaneshwar Ghura, Olumujiwa Adedeji, and Lamin Njie, 2016, "Sovereign Bonds in Developing Countries: Drivers of Issuance and Spreads," *Review of Development Finance*, 6: 1–15.

Romero María, José, 2015, "What Lies Beneath? A Critical Assessment of PPPs and Their Impact on Sustainable Development."

Rosenstein-Rodan, Paul N., 1943, "Problems of Industrialization of Eastern and South-Eastern Europe," *Economic Journal*, 53: 202–211.

Rosenstein-Rodan, Paul N., 1961, "International Aid for Underdeveloped Countries," *The Review of Economics and Statistics*, 43(2): 107–38.

Schwab, Klaus, 2016, *The Global Competitiveness Report 2016–2017*, World Economic Forum, Geneva.

Strange, Austin M., Axel Dreher, Andreas Fuchs, Bradley Parks, and Michael J. Tierney, 2017, "Tracking Underreported Financial Flows: China's Development Finance and the Aid–Conflict Nexus Revisited," *Journal of Conflict Resolution*, 61(5): 935–63.

UNCTAD, 2014, "World Investment Report 2014, Investing in the SDGs: An Action Plan," UN, New York and Geneva.

UNCTAD, 2016, "Economic Development in Africa Report 2016: Debt Dynamics and Development Finance in Africa."

Warner, Andrew, 2014, "Public Investment as an Engine of Growth," IMF Working Paper No. 14/148.

World Bank, 1994, *World Development Report 1994 – Infrastructure for Development*, The World Bank, Washington DC.

World Bank, 2016, "The State of PPPs. Infrastructure Public-Private Partnerships in Emerging Markets & Developing Economies 1991–2015," The World Bank, Washington DC.

World Economic Forum, 2015, "Africa Strategic Infrastructure Initiative Project Overview: Accelerating Project Infrastructure in Africa," World Economic Forum, Geneva.

Appendix Table A1. LIDCs classification

		Frontier Markets (14)	Fragile States (28)	Developing Markets (19)
Commodity Exporters (27)	**Fuel Exporters (6)**	Bolivia[#] Nigeria (2)	Chad Congo, Rep.[2#] South Sudan Yemen, Rep. (4)	
	Non-fuel Commodity Exporters (21)	Mongolia[#] Mozambique[#] Papua New Guinea[#] Zambia[#] (4)	Afghanistan[2#] Burundi[2#] Central African Rep.[2] Congo, Dem. Rep.[2] Eritrea Guinea[2#] Guinea-Bissau[2#] Malawi[#] Mali[#] Sierra Leone[#] Solomon Islands Sudan Zimbabwe (13)	Burkina Faso Mauritania Niger[#] Uzbekistan[#] (4)
Diversified Exporters (33)		Bangladesh[#] Cote d'Ivoire[1,2#] Ghana Kenya Senegal[#] Tanzania[#] Uganda[#] Vietnam (8)	Comoros[2] Cote d'Ivoire[1,2#] Djibouti Haiti[2#] Kiribati Liberia[2#] Madagascar[#] Myanmar Sao Tome and Principe[2] Somalia Togo[2] (11)	Benin[#] Bhutan[#] Cambodia Cameroon[#] Ethiopia[#] Gambia, The[2] Honduras Kyrgyz Republic[#] Lao PDR Lesotho Moldova[#] Nepal[#] Nicaragua[#] Rwanda Tajikistan[#] (15)

Note: See IMF, 2014a, for the details of the classification. The number of countries is shown in the parentheses.

[1] Cote d'Ivoire is included in both the "frontier market" and "fragile state" groups.

[2] Late HIPC: completion point in or after 2007.

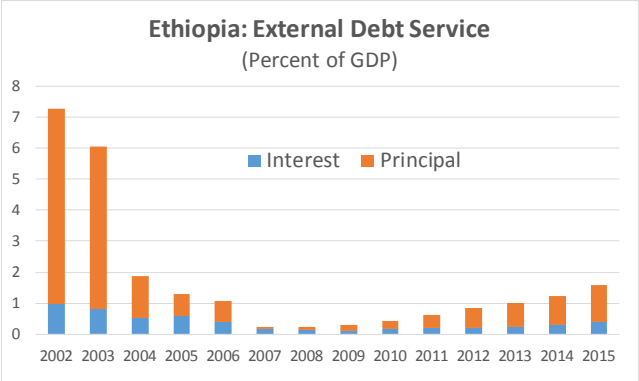
[#] Country with survey data on infrastructure investment.

Appendix I. Public Investment Scaling-up in Ethiopia

High public investment in Ethiopia reflects the government's national development agenda with a focus on infrastructure. Since 2010, public investment has been guided by 5-year Growth and Transformation Plans (GTPs). With this concerted effort, public investment went up from 12 percent of GDP in 2009 to 22 percent in 2015—among the highest levels in the world—and private investment also rose.

As a result, the stock of infrastructure has increased significantly, although the impact has not been uniform. From 2010 to 2015, power generating capacity more than doubled, the number of telecom users quadrupled, and the stock of asphalt roads rose by 30 percent. At the same time, the growth of power transmission and distribution networks was not commensurate with that of generation, and the quality of the old lines has deteriorated. Consequently, the number of electric outages doubled between 2011 and 2015, as did the reliance of manufacturing firms on own electricity generators. More broadly, the benefits of the scaling-up have not reached some of the households and SMEs.

Financing for capital spending came from several sources. While tax revenue is low in Ethiopia even by LIDC standards, a major compression in current expenditure compared to the 2000s freed up space for public investment.[24] Debt cancellation under HIPC in the mid-2000s reduced the debt service dramatically and made room for external borrowing, which averaged 5.7 percent of GDP per year over the period 2010-15.[25] SOEs—which carry out a large share of infrastructure investment—have easy access to credit from state-owned banks. Private banks are also forced to buy government bonds equivalent to 27 percent of their annual loans to fund long term investments.



The scaling-up has benefited the economy, but concerns about debt sustainability are emerging. Despite the growth dividend of high investment (real GDP increased at an average rate of 10 percent per year between 2010 and 2015), the ratio of public debt to GDP is on the rise. Both domestic and external public debt stood close to 30 percent of GDP in 2015 and are expected to increase further with the implementation of the second GTP. The 2015 debt sustainability analysis elevated the risk of debt distress from low to medium.

[24] On occasions, an overvalued exchange rate has reduced the cost of imported investment goods.

[25] Foreign loans come on both concessional and non-concessional terms. China has become an important creditor recently, accounting for 29 percent of total external borrowing during 2012-2015

Appendix II. Hydropower PPPs in Lao PDR

Lao PDR stands out as a LIDC in which there has been substantial private sector participation in infrastructure projects. Lao PDR is relatively poor and landlocked, but it has abundant hydrological and mineral resources, and has used private investment to implement its strategy to become "the battery of ASEAN" by investing in hydropower generation and exporting electricity to its neighbors. Given the limited ability of the government to make necessary investments directly, and the lack of availability of local finance as well as expertise, the government has turned to foreign private and public sector firms, as well as multilateral financial agencies, to help develop energy infrastructure.

Aside from energy, the government has pursued only two other PPPs, in the transportation sector. The first is a small ($3 million) management and lease contract for the Vientiane Airport Terminal, that has worked well and is still active. The second was a PPP for the Ngone Bridge Project, initiated in 1993. The bridge opened in 1995 and was operated under a concession to an Australian company. However, the concession contract was subsequently cancelled and operations were taken over by the government as the effects of the Asian Financial Crisis in 1997 made the project financially unviable.

The paucity of projects outside of the energy sector stems from the largely non-existent legal and institutional framework in Lao PDR for PPPs. In the energy sector, contracts have been developed with private energy firms as Independent Power Producers (IPP) in a typical structure that gets around the constraints of not having a PPP legal and institutional infrastructure. In this structure, the construction and operation of energy generators is performed by a limited liability company, where the government or a designated state company holds a voting equity interest as a shareholder.

The basic structure of an IPP contract includes a long term concession agreement to exploit a natural resource for the generation of energy, a power purchase agreement (PPA), an engineering, procurement and construction contract (EPC) contract, and project financing facilities. In Lao PDR, the contract is typically given to a locally incorporated company that has international and local equity financing, with a contribution from the government of the Lao PDR through a state-owned holding company called the Lao State Holding Enterprise (LSHE). LSHE manages the concession agreement and receives income from the projects in the form of concession fees, royalties and dividends.

An example of the structure of an IPP contract is the Nam Theun 2 project (NT2) in Lao PDR. NT2 is a $1.45 billion hydroelectric project that began operation in 2010. From a financing perspective, NT2 represents the largest foreign investment in Lao PDR, the world's largest cross-border financing project and the largest hydroelectric power project in South East Asia.

Concession arrangement. The concession agreement was signed in 2002 between the government of Lao PDR and the Nam Theun Power Company Limited (NTPC) under which

NTPC would build, own and operate NT2 for 25 years, after which it is to be transferred to the government. Shareholders in NTPC are Electricite de France (EDF – 35 percent, contracted to carry out construction), Lao State Holding Enterprise (25 percent), Electricity Generating Public Company Ltd. (a Thai company – 25 percent), and Italian-Thai Development Public Company Limited (a Thai entity - 15 percent).

Power purchasing agreement. The Electricity Generating Authority of Thailand (EGAT) agreed to acquire 95 percent of the power produced by NT2 for the first 13 years of operation, with an agreed pricing formula indexed to the exchange rate and the cost of alternative generating technologies. After the 13-year period the energy can be sold on the spot market if there is alternative demand, but most likely any energy not taken by EGAT would be bought by EDF.

Financing. Equity financing amounted to $450 million with remainder being debt finance. Debt finance was provided by a broad base of lenders, including two bilateral lenders, five multilateral lenders, four export credit agencies, and 10 commercial banks. Notable contributions, with a view to aiding economic development in Lao, came from the Asian Development Bank, the World Bank (IDA) and the Multilateral Investment Guarantee Agency (MIGA).

To date NT2 has provided close to $1 billion of export revenue to Laos and close to $180 million in royalties and dividends to the government.

Appendix III. Solar Micro-Grids in Kenya

Micro-grids are an example of private production and distribution of electricity. Micro-grids deliver electricity produced locally through low-voltage distribution lines. In Kenya, micro-grids under a platform pioneered by Steama.co are rapidly expanding, currently serving about a thousand households and businesses. They have attracted global players such as E.ON.

Private sector involvement is enabled by synergy between technical advances in electricity generation and in mobile telephony. With Kenya's GSM network covering even remote locations, customers prepay electricity through SMS. Their consumption is measured remotely. Payments are managed through cloud-based software. This has reduced administrative costs, making micro-grids attractive as business ventures.

Micro-grids occupy an important niche in the market. They charge about 10 times as much for electricity as the national network, but that cost is significantly lower than that of other off-grid alternatives such as diesel generators, kerosene lanterns, or home solar systems. Moreover, their connection fees are much lower than those for the national grid, even for customers close enough to existing lines. The technology has a large potential for scaling up. According to Bloomberg New Energy Finance and Lighting Global (2016) forecast, local solar power will reach one in three off-grid households (currently around 90 million people in Sub-Saharan Africa and Asia) by 2020.

Micro-grids are some of the few examples of the private sectors participation in producing and distributing electricity for the off-grid community. Micro-grids deliver electricity produced locally from solar energy to households and businesses through low-voltage distribution lines. In Kenya, innovative metering and billing technologies have made micro-grids attractive for the private sector. Consumers prepay for electricity through SMS and their electric consumption and payments are managed remotely through a cloud based software. This has reduced administrative cost and burdens, making micro-grids attractive as business ventures.

The micro-grid operator, Steama.co, is the pioneer in providing the technological solution for the billing and management problems in Kenya. The company started its operation as a micro-grid operator in 2013 with its innovative remote management of metering, control and payments system. The focus of the business is now more on providing the management platform to other micro-grid operators. Currently, it operates three of its own solar micro-grids and provides its technological solutions to more than 28 solar micro-grids owned by five other investors, including E.ON, the world's largest investor-owned electric utility service provider.

At the initial stage, the company was funded by its founders and early investors including the Vulcan Capital, set up by Microsoft co-founder Paul Allen. In March 2016, Steama.co

completed a US $1m seed investment round with "angel investors" led by GReeN,[26] and the Ashden Trust. The data collected through the smart meters is the key factor in convincing the private investors to invest on in micro-grids. The data reduces the information barriers to private investment in electricity in rural villages, which has long been uncharted territory.

The total installed capacity managed under the Stema.co platform is around 200kW, serving 1000 households and businesses with close to 10,000 total end-beneficiaries[27]. Subscription increased rapidly from around 100 connections in 2014 to 1000 in 2015, and it is projected to reach 5000 by end-2016. This growth has mainly come from an increasing number of micro-grid operators entering the market to deploy pilot portfolios using the Steama.co platform. The number of service providers has roughly doubled from 3 in 2014 to 6 in 2016, and the number of solar sites has tripled to 31. The proposed sites for future expansion are larger in terms of the number of people they hope to connect to power. Generation capacity has increased by a factor of 50 between 2014 to 2016.

The cost of electricity from the solar micro-grid is not cheap. The price per kWh is around US$1.5[28] as compared to the national grid tariff of about US$ 0.15 per kWh. Yet, it is much lower than the other alternative energy sources. The levelized cost of electricity (LCOE)[29] in Kenya from an individual diesel generators is about US$ 2 per kWh; kerosene lanterns costs between US$ 5 to 10 per kWh; and home solar systems costs anywhere between US$ 2.5 to 8 per kWh. Getting connected to the micro-grid is however much cheaper. Connection fee to the micro-grids is about US$10 as compared to the often subsidized[30] national grid connection fees of US$ 150 to $350, which could be much higher for customers who are far from existing grid lines. Anecdotal evidence shows that the high up-front investment to get connected to the national grid is a barrier to access to electricity[31].

The micro-grid model thrives in remote rural villages partly because of the almost universal coverage of GSM network, Kenya's buoyant mobile banking service, as well as government incentives. The widely available GSM network enables service providers to manage their grids through SMS even in the remotest places. Mobile banking has made possible accepting micro-payments from mobile phones through SMS, reducing the administrative burden, exorbitant

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[26] An angel investor group formed by Peter Gutman (Board of Director at Solar Universe and Seven Energy), Ian Nolan (former CIO at the Green Investment Bank) and Andrew Reicher (investment committee of Berkeley Energy's Asia and Africa renewable energy funds and Energy Access Venture Fund's impact fund),

[27] All figures regarding Steama.co's operations and are provided by Steama.co upon request.

[28] Some estimates show that large scale production cost of solar electricity per kWh in Kenya is between $0.163-$0.271 in constant 2010 USD (see Hauff et al., 2011; Schmidt et al., 2012)

[29] LCOE provides cost per kilowatt hour of an electricity source considering the cost of capital, operation and maintenance, and fuel over a one-year period. The LCOE estimates for rural Kenya are provided by Steama.co.

[30] The real cost of a single-phase connection is about US$1000. http://www.businessdailyafrica.com/Corporate-News/Kenya-Power-ends-connection-subsidies/539550-3119076-10pr58uz/index.html

[31] http://www.poverty-action.org/study/rural-electric-power-evaluation-household-electricity-connections-kenya

costs and risks associated with manual cash collection in remote locations. This helps investors to overcome a major risk inherent in operating in electricity market in developing countries. In addition, the removal of VAT and tariffs for solar imports has reduced the cost of capital.

Micro-grid solar has great potential to fill the acute power deficit in developing countries. According to Bloomberg New Energy Finance and Lighting Global (2016) forecast, off-grid solar (both micro-grid and home solar systems) will improve access to electricity to 89 million people in sub-Saharan Africa and Asia and about one in three off-grid households globally will use off-grid solar by 2020. Investment in off-grid solar in sub-Saharan Africa increased by 15 fold from $18.4 million in 2012 to $276 million in 2015. The market size of the off-grid population is also significant. The off-grid population in sub-Saharan Africa and Asia spent over $20.6 billion on lighting in 2014, which is between $45 to $186 on per household (Bloomberg New Energy Finance and Lighting Global, 2016). The average annual lighting spending per household in Kenya is $157 (Bloomberg New Energy Finance and Lighting Global, 2016) as compared to a typical micro-grid customer annual spending of $120 for lighting, powering television and phone charging. Given micro-grid solar is relatively cheaper than the alternatives, it may come as a dominant off-grid solar alternatives.

References

Bloomberg New Energy Finance and Lighting Global (2016). Off-Grid Solar Market Trends Report 2016. Bloomberg New Energy Finance and Lighting Global in cooperation with Global Off-Grid Lighting Association.

Hauff, J., Verdonck, M., Derveaux, H., Dumarest, L., Alberich, J., Malherbe, J.-C., Gammal, A.E., Llamas, P., Masson, G., Macías, E., 2011. Unlocking the Sunbelt Potential of Photovoltaics (No. 3rd edition). European Photovoltaic Industry Association, Brussels.

Schmidt, T.S., Born, R., Schneider, M., 2012. Assessing the costs of photovoltaic and wind power in six developing countries. Nature Climate Change 2, 548–553.