Metropolitan Infrastructure and Capital Finance

13

GREGORY K. INGRAM, ZHI LIU, AND KARIN L. BRANDT

Perceptions of the role of infrastructure in economic development and of the desired modes for providing infrastructure have evolved in the last two centuries at both the national and metropolitan levels. In the nineteenth and early twentieth century, much metropolitan infrastructure was privately provided. By the mid-twentieth century, infrastructure was viewed as the commanding heights of the economy, important for economic development but also subject to endemic market failures. Accordingly, public-sector involvement in infrastructure, advocated by both governments and development agencies, became the norm. Then in the 1980s and 1990s, concerns about government failure, poor performance of public infrastructure agencies, and large investment requirements heightened interest in the private provision and financing of infrastructure. Private participation in infrastructure (PPI) has since greatly expanded, doing well while falling short of the most optimistic expectations, with a more sector-focused and country-tailored approach evolving in recent years (Ingram and Fay 2008).

Infrastructure is not precisely defined, and it originally encompassed most social overhead capital. This chapter defines infrastructure to include energy (electricity and natural gas); telecommunications (fixed telephone lines, mobile phone service, and Internet connections); transportation (airports, railways, roads, and seaports); and water supply and sanitation (piped water and sewage collection and treatment). Many of these activities share technical features that require governmental regulation to improve outcomes, such as integrated networks and economies of

The authors acknowledge counsel and assistance from Wanli Fang, Om Prakash Agarwal, Arturo Ardila-Gomez, and Jorge Rebelo and helpful comments from Robert Buckley, Jeff Gutman, Anthony Pellegrini, and the volume editors.

scale that encourage natural monopolies, and economic features, such as externalities and attributes of public goods.[1]

Unfortunately, reliable data on infrastructure capital stocks are seldom available for urban versus rural areas or for metropolitan areas (Estache 2004), while national data are now reasonably ubiquitous. The analysis of infrastructure physical capital stocks reported here is based on country-level data available from the World Development Indicators database (World Bank 2011), including kilowatts of electricity-generating capacity, kilometers of paved roads, number of fixed telephone lines, number of mobile phone subscriptions, and share of households with access to safe water and adequate sanitation. Additional service quality data for roads and telecommunications are from the World Road Statistics (International Road Federation 2010) and the World Telecommunications Development Report (International Telecommunications Union 2010). The data for physical stocks across all sectors are for 2006, and complete data are available for 83 countries.

Urbanization and Infrastructure Stocks

To explore the effect of urbanization and income on infrastructure, the relations across countries among infrastructure levels, urbanization levels, and income were examined by estimating the elasticities of national infrastructure stocks per capita with respect to the share of urban population and income per capita. In regressions of log infrastructure physical stocks per capita by sector on log purchasing power parity (PPP) gross domestic product (GDP) per capita, and urban population percentage, the coefficients are elasticities. The elasticities of infrastructure stocks with respect to urbanization are 0.01 or smaller, and only two of the six elasticity measures are statistically significant (table 13.1). This means that a doubling of urban population share would increase national infrastructure stocks by 1 percent or less. These findings indicate that a country's urbanization level has little relation with its amount of physical infrastructure stock.

The lack of relation between national infrastructure stocks and share of urban population at first seems surprising, but note that the estimated model holds income constant. Of course, income and urbanization are correlated (simple correlation of 0.60 in the sample used here), but urbanization varies widely in low-income countries (Fay and Opal 1999). In addition, two countervailing relations are likely to be at work. First, infrastructure's technical economies of scale mean that less physical stock per person is needed to provide infrastructure services as population density increases. Urban densities are much higher than rural densities, thus lowering urban infrastructure stock per capita. Second, in developing countries average urban incomes are typically higher than average rural incomes, and this would increase the demand for infrastructure services and for related urban infrastructure capital stock. These two effects may offset each other in the aggregate at the country level.

[1]This definition omits hospitals, schools, and government facilities, which do not utilize integrated networks and/or exhibit many economies of scale. It also excludes soft infrastructure such as governance, financial, social, and cultural assets and institutions that rely more on knowledge than on physical capital.

TABLE 13.1

Regressions of log per capita infrastructure measures on log PPP, income, and percentage of population urban

	Log electricity generation	Phone lines	Paved roads*	Mobile subscriptions	Access to sanitation	Access to water
Intercept	−5.11 (−8.37)	−5.38 (−8.68)	−7.9 (−10.07)	0.092** (0.17)	0.74** (1.87)	3.24 (19.35)
Log PPP income/ capital	1.17 (13.02)	1.10 (12.04)	0.97 (8.44)	0.58 (7.08)	0.38 (6.50)	0.12 (4.88)
Percent urban	0.0096 (2.15)	0.004** (0.88)	−0.0038** (−0.66)	0.014 (3.49)	0.0016** (0.55)	0.0022** (1.80)
N	83	83	83	83	83	83
R^2	0.85	0.81	0.63	0.73	0.56	0.52

Parentheses indicate *t*-ratios. Coefficients of PPP, income, and urban percentages are elasticities.

*The road length measure includes both intercity and urban roads.

**$p < 0.05$.

Similarly, Canning (1998) found that the impact of urbanization on infrastructure varies by sector: electricity and telephones increased with urbanization, while transport was not strongly related to urbanization. Other studies found that while population, per capita income, and population density are significant determinants of road length, urbanization is insignificant (Ingram and Liu 1999). Accordingly, this chapter develops investment projections at the national level. Metropolitan-level investment projections can be scaled from those, using metropolitan GDP or other appropriate measures.

Of course, even if detailed urban data were available, addressing infrastructure needs at the metropolitan level raises difficulties of definition in some sectors because infrastructure located outside of metropolitan boundaries can be integral to urban infrastructure services. In the power sector, metropolitan areas normally draw from a national or regional grid, and electricity-generating and distribution capacity are often located outside of urbanized areas. Metropolitan areas also have much transport capacity within their borders but benefit greatly from intercity transport located outside city boundaries. The same is true for telecommunications, where intercity capacity is an important component of urban telephone service. In these sectors, some attribution of the costs of infrastructure assets located outside of metropolitan areas would need to be made based on population or regional product, similar to the approach proposed here. Some other infrastructure sectors face less difficult metropolitan boundary issues. For example, mass rail transit, water supply, and sanitation networks are often essentially contained within metropolitan boundaries, and in many developing countries, reported national water and sanitation infrastructure levels include only urban data.

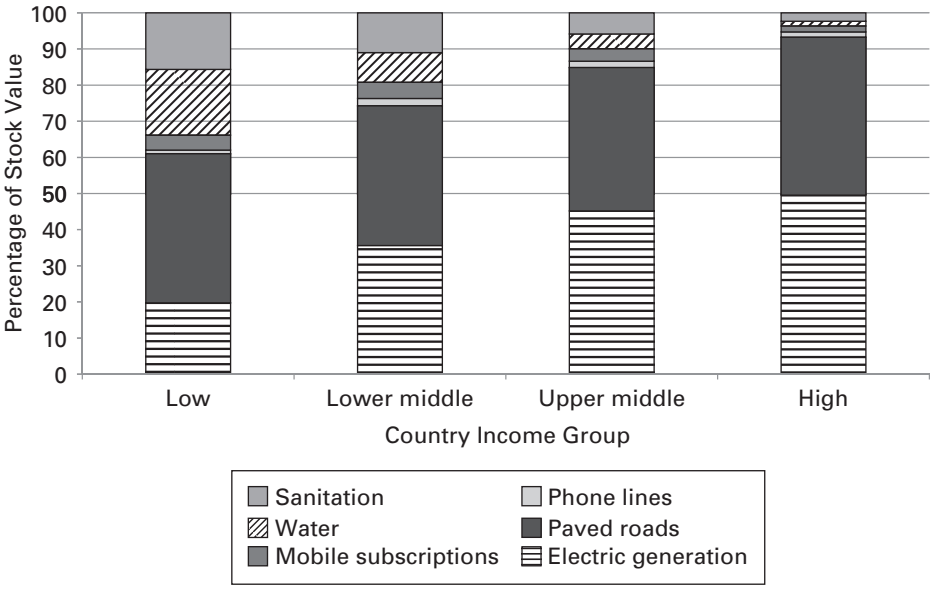
Turning to the relation between quantities of infrastructure facilities and income, the coefficients of table 13.1 for per capita income (elasticities of infrastructure with respect to PPP income) indicate that physical stocks of infrastructure and

percentages of households served increase across countries at very different rates as PPP income grows. For example, when per capita PPP income doubles, electricity-generating capacity and phone lines more than double, road length almost doubles, and access to sanitation and water much less than doubles.

Because the quantity of infrastructure stocks by sector increases at different rates with income, the sectoral composition of infrastructure stock varies systematically across country income levels. Figure 13.1 shows the average composition of infrastructure stocks by value across country income groups (using World Bank [2011] country income categories). These shares by value are obtained by weighting the physical stocks by their unit costs (see table 13.2).

FIGURE 13.1

The sectoral mix of infrastructure varies with country income group



SOURCES: International Telecommunications Union (2010); World Bank (2011).

TABLE 13.2

Unit costs of infrastructure investment in 2010 and thereafter

Sector	Cost (US$)
Electricity generation	$1,900 per kilowatt of generating capacity, including network cost
Paved roads	$410,000 per kilometer of paved two-lane road
Phone lines	$261 per fixed line
Mobile subscriptions	$127 per subscriber
Water access	$400 per connected household
Sanitation access	$700 per connected household

SOURCE: Derived from Chatterton and Puerto (2005, table A1).

Figure 13.1 reveals that paved roads constitute a large share of the value of infrastructure stocks at all income levels and that electricity generation's share is large and grows rapidly, eventually exceeding the share of paved roads in upper-middle- and high-income countries. While the share of phone lines grows in middle-income countries, its base value is small relative to other sectors. Water and sanitation grow less rapidly than income, and their share of total infrastructure value decreases even as coverage expands. The surprise in figure 13.1 is mobile phone service. Fifteen years ago, this sector was virtually nonexistent in developing countries, and it has expanded dramatically, with coverage now much greater than for fixed telephone lines. While the elasticity for mobile subscriptions is less than 1 in table 13.1, it is the one infrastructure sector where the elasticity of expansion with income varies across income groups and where expansion of coverage has been driven more by cost reductions than by income growth. Since 2000, the investment required per mobile phone subscription has fallen more than 80 percent (Chatterton and Puerto 2005).

Investment Projections

Based on countries' existing physical infrastructure stocks and the elasticity of stocks' growth with respect to national income, the magnitude of investment required is projected so that current infrastructure amounts in each sector increase in accordance with the estimated sectoral income elasticities. The results from one set of projections of annual investments, based on assumed economic growth rates of 5 percent in developing countries and 3 percent in high-income countries, are shown in table 13.3. This global projection is based on the sample of 83 countries (30 low-, 22 lower-middle-, and 21 upper-middle-income developing countries and 10 high-income countries) that have data for all infrastructure sectors. These projections are

TABLE 13.3

Investment and maintenance in infrastructure and national income

Country income group	Aggregate GDP, 2008 US$ (billion)	Assumed growth rate (%)	Infrastructure share					
			As percentage of national GDP			In 2008 US$ (billions)		
			Investment	Maintenance	Total	Investment	Maintenance	Total
Low	509.60	5	2.8	1.7	4.5	14.00	8.80	22.80
Lower middle	7,691.90	5	3.5	2.4	5.9	270.80	183.80	454.60
Upper middle	7,471.90	5	2.2	1.5	3.7	165.20	113.20	278.40
Developing total	15,673.40		2.8	2.0	4.8	450.00	305.80	755.80
High	42,041.40	3	0.8	0.9	1.7	332.80	363.70	696.40
Total	57, 714.80		1.4	1.2	2.5	782.80	669.50	1452.20

SOURCE: GDP data from World Bank (2011).

what would be invested if past relations hold in the future; they are not normative projections from an optimization model showing what should be invested. Results have not been corrected for outliers or for countries with infrastructure deficits or surpluses.

The investment required as a percentage of GDP for the sampled countries in each income group to increase their infrastructure in line with estimated income elasticities was calculated, and this percentage was then applied to the total GDP of all countries in each income group. For example, the investment required for low-income countries in the sample to increase their infrastructure stocks as their incomes rise is calculated based on country physical stocks, the income elasticities in table 13.1, the unit costs in table 13.2, and the assumed growth rate. This amount was then transformed to a share of GDP for the 30 sampled low-income countries, and that GDP share was applied to the GDP total for all countries in the low-income group. The projections for new investment average 2.8 percent of GDP across all developing countries.

Maintenance, which averages 2.0 percent of GDP for developing countries, was calculated in a similar way based on annual maintenance costs that are: 2 percent of the replacement cost of electric power and paved roads, 3 percent for water and sanitation, and 8 percent for mobile and fixed-line telephone stocks (Fay and Yepes 2003). Projections for maintenance are also shown in table 13.3 using these general rules.

Reasonably growing lower-middle-income countries need about 5.9 percent of GDP per year for total infrastructure investment and maintenance, and upper-middle-income countries, 3.7 percent, with more required for investment than maintenance in all but high-income countries. The highest dollar amounts for investment and maintenance are projected for high-income countries ($696 billion), followed by lower-middle-income countries ($454 billion). Relative to high-income countries, developing countries taken together will require more annual investment and somewhat less maintenance. Financing will likely be needed for new investment in developing countries, while maintenance should be covered as an operating expense on an ongoing basis.

The projected shares and amounts provide an order-of-magnitude estimate of needed expenditures. These shares are generally similar to those formulated from 2000 to 2010 using a more disaggregated approach (Fay and Yepes 2003). These investment shares vary linearly with the assumed rate of economic growth and would be higher for faster-growing countries and lower for slower-growing ones. Given the lack of relation between the size of infrastructure stocks at the national level and urbanization, metropolitan estimates can be obtained by applying these GDP shares to the output of metropolitan areas.

Annual investment shares of metropolitan GDP are available for two special metropolitan areas, Hong Kong and Singapore, that had average economic growth rates from 2000 to 2010 of 4.4 percent and 5.9 percent, respectively. From 2007 to 2010, Hong Kong's infrastructure expenditure averaged 2.56 percent of its GDP, and Singapore's was 6.44 percent, indicating that higher growth rates are associated with higher infrastructure expenditures.

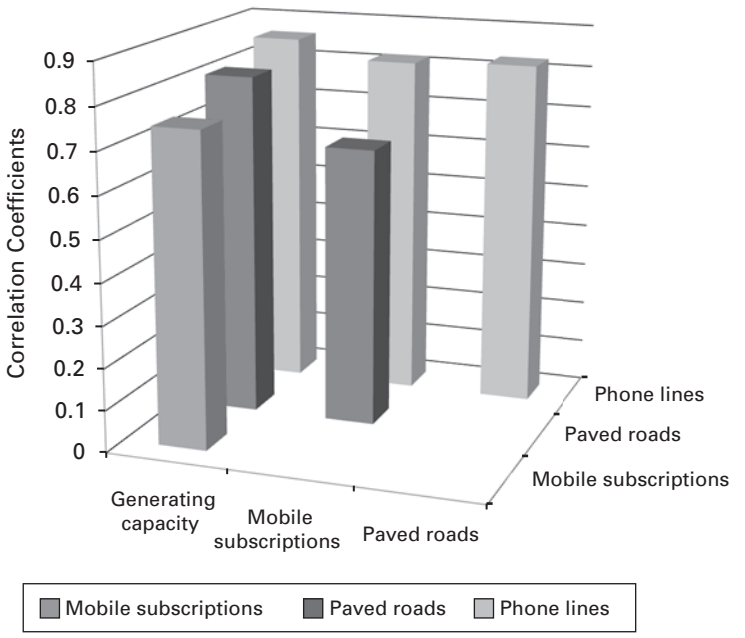
Infrastructure Service Delivery

The foregoing analysis of infrastructure capital stocks and investment assumes that economic growth increases the demand for infrastructure services and thereby the demand for additions to infrastructure capital. However, increasing the efficiency of use of existing infrastructure facilities may be an alternative means of increasing infrastructure services in many countries. The performance of infrastructure stocks in terms of delivering services efficiently varies widely across countries. Electricity losses range from 5 to 25 percent, faults per 100 phone lines range from 1 to 70, and unpaved roads range from 0 to 80 percent of all roads.

Because sectoral infrastructure stocks are highly correlated with income, it is not surprising that they are also highly correlated with one another within countries. For example, countries with ample paved roads also have large electricity-generating capacity. This high correlation of infrastructure stocks within countries is summarized in figure 13.2. However, infrastructure performance is not highly correlated with income, and the performance of infrastructure stocks (the quality of the services produced and the efficiency of production) has a much lower correlation within countries (figure 13.3). Moreover, both good and poor performance is observed across all country income levels. Inefficiency matters because increased efficiency reduces the need for investment in additional stocks.

FIGURE 13.2

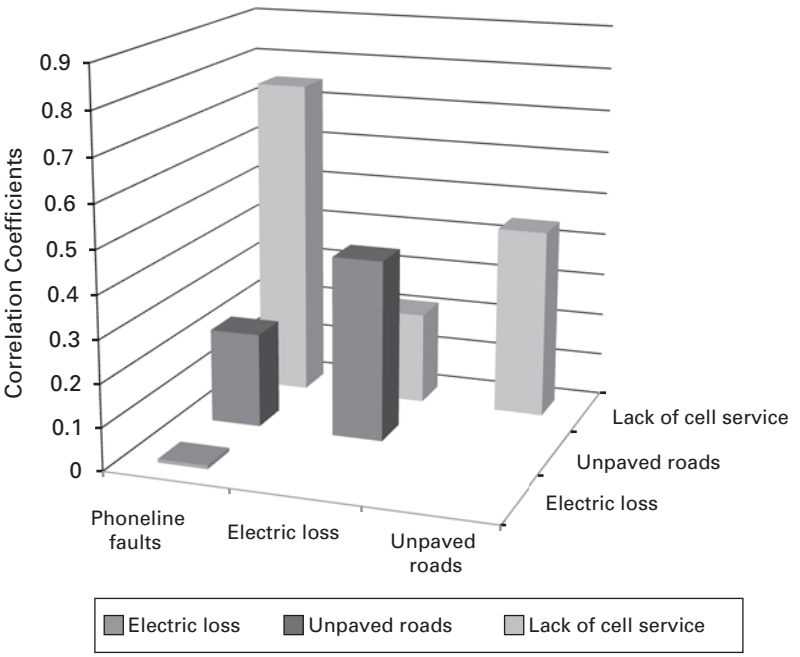
Infrastructure stocks across sectors are highly correlated within countries



SOURCES: International Road Federation 2010; International Telecommunications Union (2010); World Bank (2011).

FIGURE 13.3

Infrastructure sector performance varies within countries



SOURCES: International Road Federation (2010); International Telecommunications Union (2010); World Bank (2011).

Many inefficiencies in infrastructure service provision have their roots in poor incentive frameworks, including soft budget constraints, large government subsidies, inadequate maintenance, and bureaucratic inefficiencies. Moreover, offering services below cost promotes overuse of services, a particular problem in electric power and water, where subsidized rates undermine end-user efficiency, stimulating demand for services and hence for investment. Latin America's electricity tariffs are about 75 percent of Organisation for Economic Co-operation and Development (OECD) tariff levels and do not cover full costs, while in other regions power tariffs range from one-third to half of OECD levels (Ingram and Fay 2008). Governments in sub-Saharan Africa already spend $4.1 billion a year (0.7 percent of GDP) on power and water subsidies that benefit mainly a small group of affluent customers (Foster and Briceño-Garmendia 2010). Obtaining sufficient infrastructure services involves not only investment in additional stocks but also improved management and service delivery from existing facilities.

Limited evidence from developing countries also shows that PPI has led to improved performance and efficiency. A comparison of performance by Gassner, Popov, and Pushak (2008) between utilities with private-sector participation and state-owned enterprises in the electricity and water distribution sectors in a number of countries found that private-sector participation resulted in improved quality of services, increased outputs, increased labor productivity, and an ex-

panded capital base. Another study of electricity distribution companies in Latin America also found that privatization of ownership resulted in improved labor productivity, operating efficiency, and service quality (Andres, Foster, and Guasch 2006). Privatization of infrastructure service provision and competition among providers have improved service quality in telecommunications in many countries. Even in urban and suburban transport in some countries, privatization and competition have also improved public transit services and ridership (box 13.1).

Changing International Sources of Investment Funds

While improving efficiency will help, most developing cities will require large new investments as their populations and economies grow. While some cities have been successful in financing urban infrastructure from traditional sources of local revenues (i.e., local tax revenues, user charges, and intergovernmental transfers), the revenue has often been modest and used mainly for local recurrent expenditures. Many developing cities not only have a small revenue base but also assume few responsibilities for the provision of municipal infrastructure.

Decentralization has enabled many cities to seek other sources of financing and modalities of infrastructure provision. Developing cities increasingly are successful in financing urban infrastructure through borrowing from commercial banks, issuing municipal bonds, imposing land development-related charges such as land concessions, and adopting public-private partnership financing. Development assistance and PPI grew dramatically in the last 20 years, providing metropolitan areas with much needed infrastructure finance.

BOX 13.1

Privatization and competition can improve efficiency: The case of Rio's subway and suburban rail

In 1997 the Rio de Janeiro state government privatized the city's subway and suburban rail systems that had been heavily subsidized to compensate for high deficits, insufficient management, and inadequate infrastructure. Concessions were awarded through a competitive bidding process to two private operators for subway operations and maintenance of the two systems, respectively, without operating subsidies. This move was part of a government effort to address the budgetary crisis of the mid-1990s. The two concessionaires significantly improved services, ridership, and financial performance with their improved management, cost control measures, and implementation of tariff integration agreements. One subway concessionaire, MetroRio, helped to expand the subway network by 62 percent in length, from 25.3 km to 40.9 km, and increased ridership by 71 percent, from 380,000 to 650,000 trips a day. In 2007 the government awarded MetroRio a 20-year concession renewable for an additional 20 years. The system is now sufficiently profitable, with a 1.6 cost recovery ratio. Prior to privatization of the suburban rail system, ridership had declined from 1.2 million trips a day in 1985 to 145,000 in 1998. After the privatization, ridership increased steadily to 530,000 trips per workday in 2010. Most remarkable, these subway and suburban rail performance and efficiency improvements were achieved without government operating subsidies during a period of slow metropolitan population growth, less than 1 percent a year.

sources: Rebelo (1999); Gevert (2004); Briginshaw (2011).

Official Development Assistance and World Bank Trends

In recent decades, official development assistance (ODA) and lending from the World Bank's International Bank for Reconstruction and Development (IBRD), and International Development Association (IDA) commitments have continued to be an important source of infrastructure investment funds in developing countries.[2] ODA commitments for infrastructure recently reached $20 billion per year, an amount that is similar to the current infrastructure investment forecast for low-income countries in table 13.3. However, low-income countries receive only about 25 percent of total ODA, meaning that lower-middle- and upper-middle-income countries receive a majority of ODA. IBRD/IDA commitments for infrastructure trended down in the 1990s and then grew in the 2000s (see figures 13.4 and 13.5). The recent growth reflects the World Bank's increasing awareness of the impact of infrastructure service delivery on poverty reduction and economic development, embodied in the World Bank's Infrastructure Action Plan initiated in 2004. This engaged the International Finance Corporation (IFC) and the Multilateral Investments Guarantee Agency (MIGA). The subsequent Sustainable Infrastructure Action Plan aimed to scale up public-private partnership programs, including joint planning initiatives with IFC/IDA and MIGA/IDA projects in the Africa region from 2009 to 2011.

Figure 13.4 also shows that ODA and IBRD/IDA shares of lending commitments to infrastructure have followed different patterns. ODA's infrastructure share was fairly constant, around 15 percent, from 1980 to 1999, and then decreased to about 10 percent as commitments for infrastructure grew less rapidly than total ODA. The IBRD/IDA share declined from around 45 percent in 1980 to 16 percent in 1999 and then rebounded to above 40 percent in recent years.

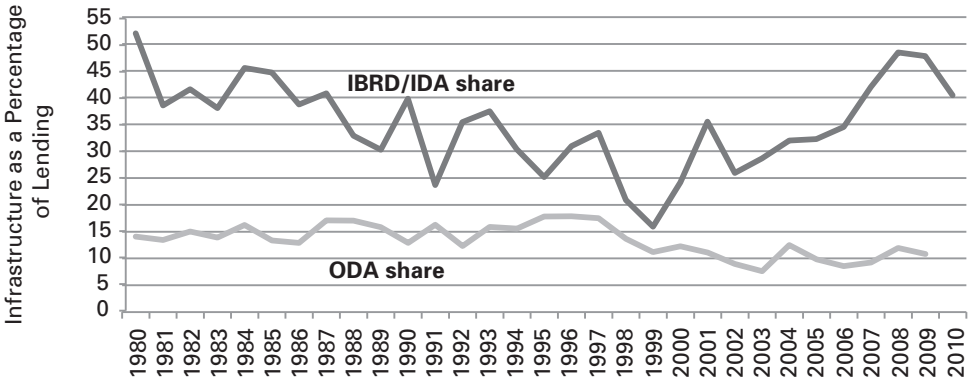
PPI Trends

PPI in the form of direct investments, leases, and operating contracts revived in the late 1980s, grew dramatically in the 1990s, and became less regionally concentrated in the early 2000s. Figure 13.5 shows that the dollar value of PPI has been as volatile as ODA in relative terms (both varying by a factor of 2 in the past 15 years) while changing much more in absolute terms. PPI grew rapidly in the 1990s until the East Asian crisis of 1997, decreased, and then rebounded until the 2008 financial crisis. ODA commitments are not countercyclical but follow a pattern similar to that of PPI, with both peaking in the mid-1990s, bottoming in 2002, and rising again through 2008. The striking fact from figure 13.5 is that PPI commitments are nearly 10 times larger than ODA in 2007 for infrastructure and are now a major element of infrastructure finance. Its peak value of $160 billion is about 36 percent of the $436 billion new infrastructure investment forecast in table 13.3 for its primary recipients, lower-middle- and upper-middle-income countries. PPI and

[2] ODA encompasses concessional aid, so it includes IDA lending but not IBRD lending. IDA accounts for about 6–10 percent of total ODA. IBRD, IDA, IFC, and MIGA (mentioned later) are four of the five institutions that compose the World Bank Group.

FIGURE 13.4

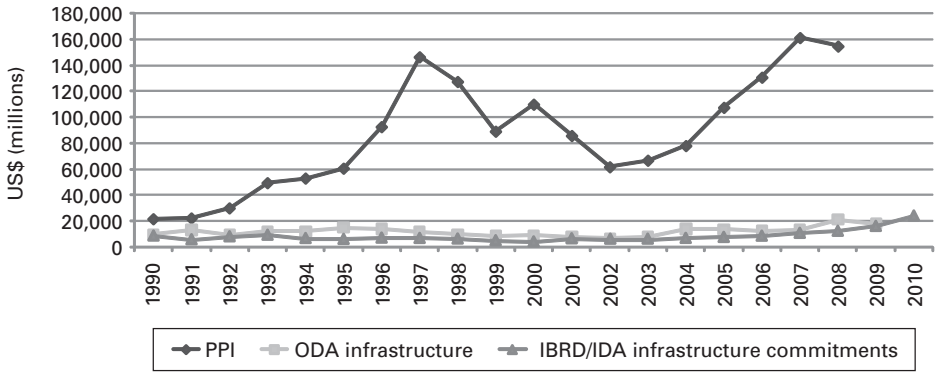
Infrastructure share of ODA and IBRD/IDA commitments



SOURCES: OECD (2011); World Bank (2011).

FIGURE 13.5

PPI is much larger than development assistance



SOURCES: OECD (2011); World Bank (2011); World Bank and Public-Private Infrastructure Advisory Facility (2011).

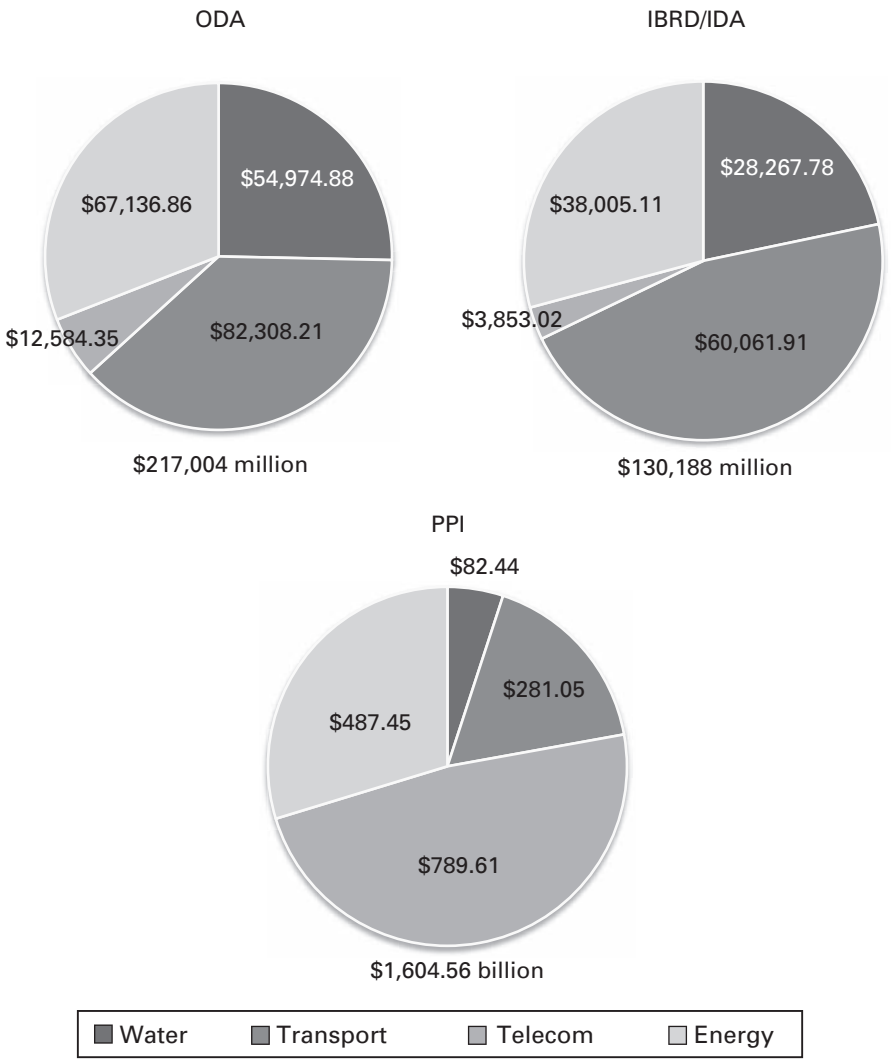
development assistance to infrastructure together are now about 42 percent of the total new infrastructure investment forecast for all developing countries.

Although it follows a similar cyclical path over time as development assistance, the distribution of PPI across infrastructure sectors is very different from that of ODA and IBRD/IDA (figure 13.6). ODA and IBRD/IDA commitment shares are similar: both provide their largest support to transport and energy, substantial support to water and sanitation, and the least to telecom. In contrast, telecom is the largest recipient of PPI commitments, while water and sanitation receive the smallest share of total PPI. PPI in telecom is occurring across all country income groups, including low-income countries in Africa and elsewhere, with the bulk of PPI activity in mobile service.

Telecom has made the most progress toward privatization, and the number of state-owned telecom firms nearly halved from 150 in 1991 to 79 in 2003 (World Bank 2004). Many developing countries are passing up fixed telephone infrastructure for

FIGURE 13.6

International infrastructure investment varies by sectors and source, 1990–2008



sources: World Bank (2011); World Bank and Public-Private Infrastructure Advisory Facility (2011).

wireless service to reduce initial investment costs. The private sector's concentration in telecom and mobile service provision is attributed to the ease of cost recovery through direct user charges. Cost recovery is more difficult in other sectors, with water and sanitation the most challenging. As a result, there is little private investment in water and sanitation, and leasing with operating contracts is the common mode of private participation in those sectors.

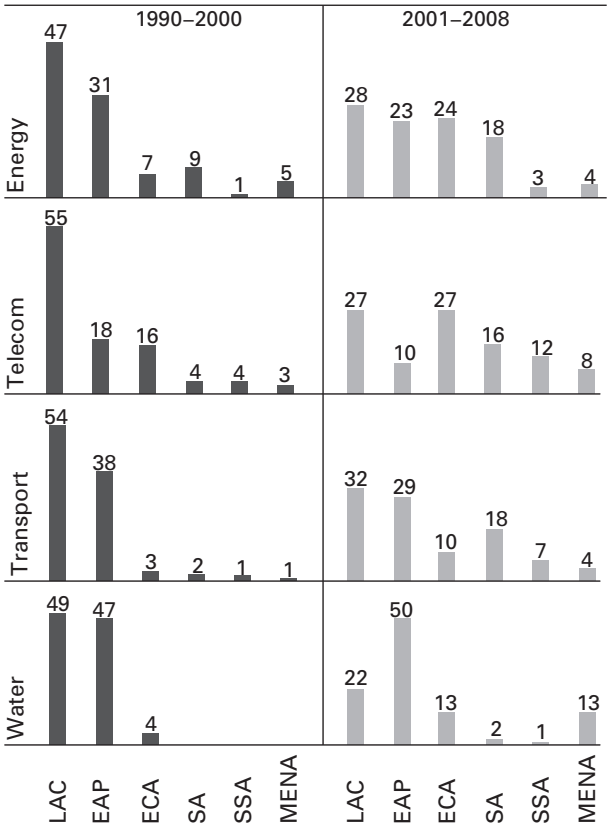
In sectors other than telecom, PPI remains more concentrated among upper-middle- and lower-middle-income countries. About 80 percent of PPI in energy in the 2000s has been for electricity generation, predominately in upper-middle-income countries, where generation is being separated from distribution to enable

competitive bidding for power-purchase contracts. Transport investment has also been more focused on upper-middle-income countries, and road projects have taken 45 percent of transport funds, the largest share. Investment in airports and railways increased but for only a small number of large projects, while investments for roads and seaports are more widely distributed. PPI in water and sanitation has been modest, with government investment still dominating. Activity has been mainly in lower-middle-income countries, and sewage treatment plants have received much of the investment. While activity in water and sanitation is a small share of PPI, because of the large size of PPI relative to ODA, the PPI funds involved have sometimes exceeded the dollar amounts of ODA flowing to this sector.

PPI has been spreading across more countries and regions, and its spread varies by sector, with telecom having the most ubiquitous private investment. The concentration of PPI among regions has been declining over time (see figure 13.7). In the 1990s, Latin America and East Asia received 96 percent of PPI funds. In the 2000s,

FIGURE 13.7

PPI is becoming less regionally concentrated: Investment percentage by region



Abbreviations: EAP, East Asia and Pacific; ECA, Europe and Central Asia; LAC, Latin America and Caribbean; MENA, Middle East andNorth Africa; SA, South Asia; SSA, sub-Saharan Africa.

SOURCE: Adapted from World Bank and Public-Private Infrastructure Advisory Facility (2011).

TABLE 13.4

Top 10 PPI recipients among developing countries, 2001–2008

Country	Investment (billion 2008 US$)	Percentage of total
Brazil	111.9	13.3
India	110.2	13.1
Russia	74.7	8.9
China	57.2	6.8
Mexico	49.3	5.9
Turkey	32	3.8
Poland	24.8	2.9
Indonesia	22.9	2.7
Nigeria	22.2	2.6
South Africa	21.4	2.5
Total	526.7	62.5

sources: World Bank and Public-Private Infrastructure Advisory Facility (2011); World Bank (2011).

these two regions have received 72 percent of PPI. Table 13.4 lists the top 10 countries receiving PPI funds in the 2000s. The top countries tend to be those with large economies and include upper-middle-, lower-middle-, and low-income countries.

Moving forward, countries once bypassed by PPI are likely to see increased PPI financing from other international banks or developing countries. The sub-Saharan Africa and Middle East and North Africa regions historically received the smallest amount of PPI. Infrastructure stocks are currently not keeping up with their rapid population growth, and needs are pressing, particularly in the water sector. In 2011 the IBRD, IFC, and the Islamic Development Bank responded by forming the Arab Financing Facility for Infrastructure to support public infrastructure services and public-private partnerships that follow conventional and Islamic-compliant financing. In addition, south-south flows of investment funds in infrastructure to sub-Saharan Africa are growing (box 13.2).

Recent Impediments to PPI

PPI has become increasingly popular in developing countries, largely because of fiscal constraints. In particular, developing cities typically have very limited fiscal space and modest local tax revenues to finance needed municipal infrastructure. Annez (2006) critiqued PPI's metropolitan performance for committing only 10 percent of its total infrastructure investment to urban areas, yet energy and telecommunications, the two largest PPI sectors that serve national and urban areas, were not included in that analysis.[3] PPI continues to spread across sectors and regions as developing cities are encouraged by the generally positive experience of

[3] Annez (2006) excluded all commitments from the energy and telecom sectors in urban-national calculations because of overlapping boundary issues. Physical infrastructure stocks can be located outside of the urban boundary yet provide service to urban areas. Together, telecom and energy comprise around 75 percent of total PPI commitments.

BOX 13.2

South-south infrastructure finance: Chinese investment in sub-Saharan African cities

South-south investment in sub-Saharan Africa is growing at a rate similar to that of ODA for infrastructure in the region. Investments from non-OECD Arab, Chinese, and Indian financiers reached $8.3 billion in 2006, surpassing ODA's $4.0 billion (figure 13.8). China plays the largest role among non-OECD infrastructure investors (figure 13.9). China's investment in sub-Saharan Africa's infrastructure grew from less than US$0.5 billion in 2002 to more than US$7 billion in 2006, China's official "Year of Africa." China's investment focuses predominately on power (hydropower) and transport (railroads), while PPI is in telecommunications and roads, and ODA in water and sanitation. China's investment is geographically targeted in oil-rich states, primarily Nigeria and Angola, but 35 countries have received Chinese infrastructure development finance.

The majority of Chinese infrastructure investment in sub-Saharan Africa is from the Export-Import Bank of China (92 percent), given as loans (50 percent) and export credit (44 percent). Only five percent of investment is classified as foreign direct investment, and 1 percent is given through grants. The Export-Import Bank's financing terms fall roughly between those of ODA and PPI. Chinese loans average a 3.1 percent interest rate, a 3.6-year grace period, and a 13.2-year term, whereas ODA creditors offer 1.7 percent, 7.7 years, and 32.9 years, respectively. The Export-Import Bank adapted an investment approach previously used by Western corporations in the early 2000s, commonly knows as the "Angola mode" or "resources for infrastructure," in which loan repayment terms are stipulated in resource-based transactions, most notably oil. For example, China invested $1,020 million in Angola to repair infrastructure (power, transport, information and communication technology, and water) that had been damaged during the civil war via an oil-backed loan enabling China to receive 10,000 barrels of oil per day (Foster et al. 2008). Much of the investment is in Luanda, Angola, where infrastructure is inadequate to serve the capital city's estimated 5 million residents. China invested more than US$61 million in the rehabilitation and extension of Luanda's electrical system alone from 2002 to 2006 and is now involved in the "new cities" expansion project to provide 1 million new homes and infrastructure services in surrounding suburban areas. The long-term impact of China's resources for infrastructure approach is unclear because so far there has been a lack of financial mechanisms or technology transfer to ensure future maintenance. Moreover, training and technology transfer during construction have been modest because China provides the workers for most projects.

SOURCES: Foster et al. (2008); World Bank and Public-Private Infrastructure Advisory Facility (2011); World Bank (2011).

improved performance of PPI projects in high-income countries such as the United Kingdom and Australia and more recent successful projects in developing countries.[4]

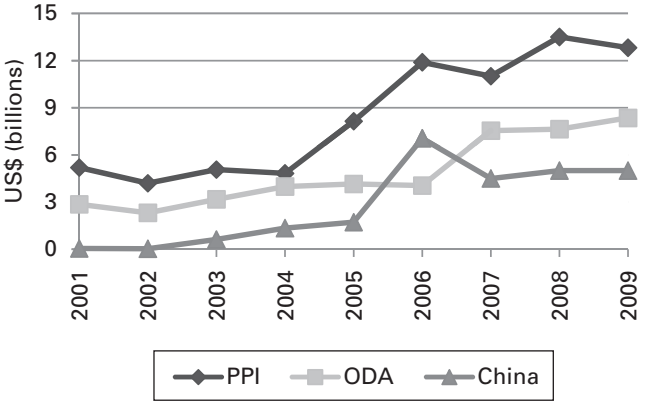
The results of PPI in the urban transport sector are mixed. Toll roads in metropolitan areas with established traffic generally perform well. But governments often face a dilemma when concessionaires demand toll increases to cover increased costs or when road users press the government to improve the condition or capacity of alternative routes.[5] PPI for urban rail projects has also emerged in the devel-

[4] For some recent assessments, see Arthur Anderson and Enterprise LSE (2000), Fitzgerald (2004), KPMG LLP (2007), National Audit Office (2003; 2007), and Partnerships U.K. (2006).

[5] For example, the Don Muang Airport Expressway in Bangkok, a toll road under a build-operate-transfer arrangement, ran into both problems in recent years.

FIGURE 13.8

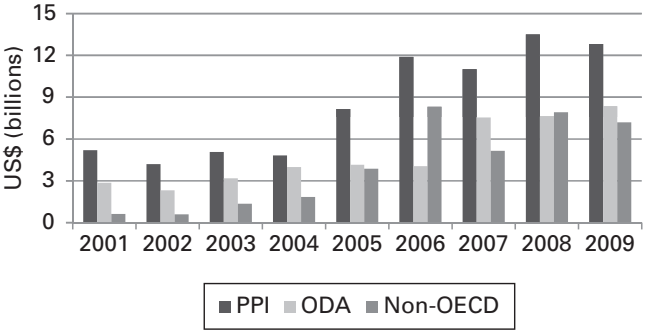
China is a significant infrastructure financier in sub-Saharan Africa



SOURCES: Foster et al. 2008; World Bank and Public-Private Infrastructure Advisory Facility (2011); World Bank (2011).

FIGURE 13.9

Non-OECD investors increase role in sub-Saharan Africa infrastructure



SOURCES: Foster et al. (2008); World Bank and Public-Private Infrastructure Advisory Facility (2011); World Bank (2011).

oping world since the 1990s. For example, seven contracts were awarded to build urban rail lines in Bangkok, Kuala Lumpur, and Manila. One of them, the Bangkok Elevated Road and Transit System (also known as the Hopewell Project), suffered severely from the 1997 financial crisis and was subsequently abandoned, but all other lines have been implemented and operate successfully. A detailed assessment of these lines concluded that despite various problems, these private investment projects were successful in delivering services to users and that the governments alone were unlikely able to build these lines in the same time frame (Allport 2005).

Despite various benefits of PPI, a number of impediments exist in the developing world. First, PPI projects are often carried out in an opportunistic rather than

systematic way. Countries that are more successful in PPI are those with a clear policy and program, and some have even published model concession documents. India's national highway sector, for example, successfully attracted a large volume of private financing over the last eight years. Many of the privately financed highways are located in the metropolitan areas where traffic grows rapidly. The National Highway Authority of India (NHAI) website publishes guidelines for investment in the sector, the location of road sections suitable for PPI, and model concession documents (see Ministry of Road Transport and Highways 2012; NHAI 2012). The Ministry of Finance also issued guidelines for government financial support to PPI. All these send a clear signal to the market and lay a policy foundation for success.

Second, government institutional capacity remains weak in dealing with PPI. Without technical assistance from the multilateral development banks (agencies considered to be without vested interest by developing cities), most municipal governments would be reluctant to attempt PPI, and few have the financial resources needed for capacity building and upstream project preparation. To address the capacity issues, in recent years, more and more developing countries have chosen to establish public-private partnership units for facilitating and managing infrastructure investments (Public-Private Infrastructure Advisory Facility and World Bank 2007).

Third, the presence of various legal constraints is a major impediment. For example, Thailand's law does not allow arbitration for contract disputes between the government and a private firm. This essentially increases the perceived risk of PPI contracts in the eyes of private investors. Such a legal constraint has its historical roots in the public perception of government. In the developed world, a government that enters a business contract with the private sector is seen as an equal party along with the private firms in the business deals. However, in regions such as East Asia, the public generally considers the result of arbitration against the government as government failure, instead of the outcome of a dispute resolution in a business transaction. Mediation may be an alternative to arbitration. However, to date, there are few (if any) cases of mediation clauses being built in public-private partnership contracts.

The fourth impediment is more related to a lack of bankable projects and the generally poor business climate in the lowest-income countries (Leigland 2010). Despite significant shortfalls in access to infrastructure services, the lowest-income countries are much less successful in PPI investments than are middle-income countries. PPI activities are heavily constrained by thin markets, insufficient revenue streams, and lack of investment-grade credit ratings.

Finally, decentralization of revenues and investment responsibilities is also a significant complicating factor for PPI in many countries (Ingram and Fay 2008). Decentralization of decisions about infrastructure investments generally improves knowledge about local needs and priorities, but local municipalities often lack the technical expertise to implement projects or even oversee project implementation. It also may lead to policy incoherence between municipalities, particularly for water supply and sanitation. Decentralization often replaces a central client agency with many local client agencies, which increases transaction costs for private inves-

tors and exposes them to local client agencies with highly varying technical capabilities and financial capacities. China's decentralization experience highlights the disparity among municipalities in their ability to produce infrastructure finance due to changing central-local fiscal arrangements that distort revenue sharing (Wu 2010).

The Emergence of New Domestic Financing Instruments

New financing instruments and refined older instruments have evolved in response to lessons of experience and changes in the policies and regulatory frameworks of national governments. Today, the patterns of municipal financing for infrastructure investments vary significantly, and cities often use a mix of financing instruments for projects (box 13.3). In China, municipal governments assume major fiscal responsibilities for urban infrastructure development, while the national government limits its role to financing the key national infrastructure. In Thailand and Malaysia, national governments still play a major role in the financing and provision of urban infrastructure. Even so, Bangkok and Kuala Lumpur were successful in attracting sizable private financing for urban rail projects in the 1990s. Some middle-income countries, such as Mexico, Brazil, South Africa, India, and the Philippines, now have municipal bonds (Martell and Guess 2006). Long-term debt financing of local public infrastructure has existed in a number of countries for years, and efforts have emerged recently to strengthen local fiscal responsibility and reduce the risks of local debt crisis through laws and regulations (Liu and Webb 2011). Sales of public land or land use rights have also become a significant source of local infrastructure financing in China, Ethiopia, and India (Peterson 2006).

The key question is how developing metropolitan areas create sustainable sources of financing for capital investment. PPI is significant but also volatile; for example, investment levels dropped during financial crises in 1997 and 2008. It took several years for PPI to regain momentum after the 1997 financial crisis. The post-2008 slowdown in private infrastructure investment stems to a large degree from the accompanying disruption of financial markets. The 2008 crisis reduced the availability of private bank financing for project initiation and construction and also hindered the longer-term project-supported nonrecourse bond issues and senior debt that create necessary leverage for producing sufficient returns on project developers' equity investments (Leigland and Russell 2009). For example, many of Chile's bond investments in the transportation sector were downgraded, putting projects on hold, while sub-Saharan African countries report fewer lenders and higher interest rates from international banks.

Sources of local public funds gained importance amid the financial crisis and also with decentralization, which increased the need for large metropolitan areas to provide the funds required under public-private partnerships, to make public-sector investments, and to finance maintenance of publicly owned infrastructure assets. Property tax revenues, an important local revenue source in many OECD countries, contribute a relatively large share of subnational expenditures in developing countries (table 13.5). But the message is mixed on the property tax because subnational expenditures are a small share of government expenditures, indicating that decentralization is a work in progress in many developing countries. As a result,

BOX 13.3

Developing cities use a variety of financing instruments for urban rail

Urban rail systems are very expensive to build and operate, because construction costs per kilometer vary from US$50 million (for elevated light rail in an easy urban setting) to US$180 million (for underground heavy rail). Urban rail is often one of a city's largest investments, and its financing can be a major test of the city's ability to mobilize financial resources. Moreover, the operating cost recovery ratio of most of the world's urban rail systems is less than 1.0. This means that cities must subsidize operations and maintenance deficits, which pose the risk of becoming an enduring and growing financial burden.

Despite these impediments, an increasing number of developing cities have overcome the financial constraints to build and operate urban rail systems in the last 20 years. Brazil financed urban rail investments with a combination of financial resources from federal and state governments and multilateral development bank loans guaranteed by the federal government and the National Bank of Brazil. The Chilean national government financed Santiago's subway infrastructure, and the subway company financed the rolling stock and equipment with a guarantee from the national government. Bangkok built and operated an elevated light rail system under a build-operate-transfer (BOT) arrangement without government subsidies; the national government financed the civil works of the underground Blue Line with a Japan Bank for International Cooperation ODA loan, and a BOT concession financed the equipment and operations. Kuala Lumpur built three urban rail lines, each with varying BOT agreements and government guarantees for domestic debt; however, the government took control over operations after a few years when the rail lines faced financial difficulties.

More than 30 major Chinese cities have built or are currently planning and building urban rail lines. China's national government does not provide financial support for urban rail projects. Instead, cities use revenues from land concessions, commercial loans from the municipal government-owned local investment corporations, and local government surcharges and earmarked taxes to finance capital investments. New Delhi financed its metro system with equity capital from both central and local governments and soft loans from Japan Bank for International Cooperation. The Indian government introduced a scheme to fill the financing gap to the extent of 40 percent of the capital cost of infrastructure projects with public-private partnerships, and now its cities are initiating public-private metro projects in anticipation of obtaining central government financial support. Metropolitan areas are learning from one another as lessons from various financing schemes are transferred. Some cities are adapting the successful property-financed funding model (or codevelopment model) developed in Hong Kong, which provides a long-lasting revenue stream to support operations and maintenance.

SOURCES: Allport (2005); Briginshaw (2011); Gevert (2004); Rebelo (1999).

property tax revenues are a much smaller share of GDP in developing than in developed countries; hence, the potential of this local revenue source is yet to be realized.

The evolution of municipal financing in China during the 1990s and 2000s is perhaps one of the most striking and unique cases. During this period, China experienced rapid income growth and urbanization. GDP grew at an average rate of 10 percent a year, and the nation's share of urban population increased from 26 percent in 1990 to nearly 50 percent in 2010 (see chapter 11, figure 11.1). This is equivalent to rural-to-urban migration of 17 million people per year. Personal income growth and urbanization both create rapidly growing demands for quality and quantity of urban infrastructure services, well beyond levels that the conventional sources of municipal revenues could finance.

To accommodate this extraordinary growth in demand, most Chinese city governments have created local investment corporations (LICs) to manage and finance

TABLE 13.5

Property tax performance in select country groups, 2000s

Country group	Government expenditure (percentage of GDP)	Subnational expenditure (percentage of government expenditures)	Property tax	
			Percentage of GDP	Percentage of subnational expenditures
OECD	42.3	32.7	2.12	12.40
Developing	24.6	13.0	0.60	18.37
Transitional	23.4	30.3	0.68	9.43

SOURCE: Bahl and Martinez-Vazquez (2008).

urban infrastructure development on behalf of the governments. Usually, the LICs are given some land parcels and/or municipality-owned, revenue-generating utility companies (e.g., water supply or gas supply) as initial corporate assets. LICs clarify to lenders what the assets are that back the loans and also protect firms from project-related liability. With these assets as collateral, LICs are able to borrow from China Development Bank and commercial banks. Many LICs are fiscally backed (they do not have stable revenue streams) and thus rely on municipal revenues to pay off debt services.

LICs provide an increasing share of infrastructure funding. They already account for 16 percent of domestic infrastructure finance demand in the East Asia/Pacific region. For example, the Suzhou Infrastructure Investment Company, established in 2001, manages the construction, financing, and operation of infrastructure projects. In this arrangement, the Suzhou city government plans its infrastructure, and the company is tasked with raising finance and developing the projects. Loan and project finance sources include the China Development Bank, local commercial banks, trust funds, build-operate-transfer arrangements, land sales revenue, and project revenue from user charges and fees. However, commercial bank lending to LICs formed by local governments in China has recently come under closer scrutiny. In June 2011, China's regulators planned a US$308–463 billion bailout (amounting to nearly 10 percent of annual GDP) for highly indebted local governments and their LICs (for a detailed account of LICs, see chapter 11).

In addition to financing through LICs, almost all Chinese cities rely on revenues from land concessions. City governments acquire rural land, service the land with basic infrastructure, and auction off the serviced land to real estate developers. In this way, the city governments capture the increased land values created by the infrastructure investment and change of land to urban use. This is one of the most comprehensive betterment levies currently in use.

Betterment levies that are less comprehensive than the practice in China have a long-standing history in many other cities. Bogotá has used betterment levies since the 1930s to finance infrastructure, including roads, water and sewer, and, more recently, sidewalks and public parks (Borrero et al. 2011). In the 1960s, betterment levies accounted for 16 percent of the total revenue in Bogotá; in Medellín, the share reached 45 percent. The levy is a flexible instrument whose revenue cannot

exceed the cost of an infrastructure project. Bogotá's district administration takes into account taxpayers' capacities to pay the levy and the benefit produced by the project in quantitative and qualitative terms (e.g., travel savings, real estate value increases, and quality-of-life improvements).

Betterment levies based on land value increases related to mass rail transit (MRT) investments have been used in East Asia and are now spreading to other regions, a point illustrated in box 13.3. For example, MRT companies in Hong Kong and Tokyo have used revenues from the codevelopment of residential communities and commercial areas around new transit stations to help finance MRT projects. In Tokyo, nonfare revenue is 30–50 percent of total revenue for some MRT lines. In both cities, ongoing revenue from property management is becoming more important than profits from development projects and provides a sustainable income stream (Murakami 2012).

Several metropolitan areas around the world have been experimenting with the direct sale of municipal bonds on the national and international market. "Jozi bonds," developed in Johannesburg, are one variant on this theme. Johannesburg faced bankruptcy in the mid-1990s, with 4 million residents and a capital budget of less than $50 million. Most municipalities had recently incorporated poorly served townships within their borders, and this led to a decline of private bank lending to municipalities following the end of apartheid in 1994. The former townships lacked infrastructure services, particularly access to water and electricity, and the investment demands were straining the capacity of municipalities. Seeking new sources of financing, in 2004 the city of Johannesburg purchased a partial bond guarantee for 40 percent of the principal from the Development Bank of Southern Africa and the IFC (Ngobeni 2008). This improved the bond issues' Fitch rating to AA– and allowed for a doubling of the maturity to 12 years compared with nonguaranteed bonds. The Jozi bonds raised more than $22 million in their first month and expanded thereafter. Buyers must be South African residents to purchase the bonds, which are denominated in South African rand. The city of Johannesburg then offered Africa's first municipal bonds in 2007 with a return of about 10 percent a year.

After successfully issuing domestic bonds, in 2001 Bogotá became the first Colombian city to issue international bonds (Trelles Zabala 2004). The capital district of Santa Fe de Bogotá sold US$100 million in bonds with an interest rate of 9.5 percent and a five-year term for financing infrastructure projects. The bonds received global ratings by Fitch of BB+ and by Standard & Poor's of BB. The 2001 Bogotá bonds had no sovereign guarantee nor (as did the Jozi bonds) additional comfort or guarantees from governmental or international agencies.

India has been issuing municipal bonds; about 55 percent of the total of more than $200 million have tax-free status (Asian Development Bank 2008). Municipal bonds issued through private placement are not yet listed on the stock exchange. To reduce the risk and increase the marketability of these bonds, the India Securities Exchange Board is issuing guidelines to increase the transparency of issuances and to protect investors' interests. The political risks associated with these bonds is being reduced by taking steps to (1) require that the public operating agency is legally separated from the local government that is raising the revenue; (2) assure

that tariffs will be adjusted to maintain a minimum debt service ratio; (3) include a clause to prohibit the government from building directly competing investments; and (4) include performance standards that allow the government to change management or call in the credit if standards are not met.

Municipal bonds are a more stable source of finance suitable for investments in urban infrastructure that are long-lived. Such bonds can also serve as a catalyst for reform in municipal financial management systems. However, low-income countries should not wait to implement municipal financial management system reform until the conditions are ripe for municipal bonds. Although a municipal bond market has not developed in China, the national government issued local bonds on behalf of select local governments and passed the proceeds to local governments under an on-lending arrangement. The receiving local governments are supposed to repay the national government. In case of default, the national government could hold a local government responsible by withholding part of the intergovernmental transfers such as local tax rebates and the local share of centrally collected tax revenues. This appears to be a practical option for long-term debt financing of local infrastructure before the conditions for a municipal bond market mature.

Funds from carbon credits, which are payments for activities that sequester carbon or reduce carbon emissions, also are evolving as sources of infrastructure finance. The World Bank is beginning to access future carbon credit cash flows to subsidize infrastructure projects by identifying infrastructure-related opportunities for reducing carbon emissions. In 2007, the Municipal Corporation of Greater Mumbai used carbon credits to finance the Gorai landfill closure and gas capture project (Bhardwaj and Inocentes 2011). The landfill operated from 1972 to 2008, taking in approximately 1,200 tons of solid waste daily, which imposed environmental and health threats on the nearby Gorai Creek and residential development. The Asian Development Bank provided financial assistance to the project through the certified emissions reductions (CERs) or generation of carbon credit funds. One CER amounts to a savings of one ton of carbon dioxide. Industrialized countries offset emissions they generate by purchasing the CERs from developing countries. Upon completion in 2010, the project became India's first clean development mechanism and its first landfill closure and gas capture project.

The Way Forward

The annual projected cost of infrastructure investment and maintenance needs in developing countries (US$755 billion) totals nearly 5 percent of the countries' aggregate GDP, with about 3 percent of GDP for investment in new capacity (US$450 billion) and nearly 2 percent for maintenance (US$305 billion). Because country infrastructure stocks seem unrelated to the level of urbanization, a country's urban share of this investment and maintenance is likely to be proportional to the country's urban share of its GDP, especially for energy and transport. This proportional relationship should be adjusted for location-specific preexisting stocks, specific needs, and infrastructure priorities. While the investment amounts are large, the most recent estimates of external funding commitments devoted to infrastructure

in 2008 were, for ODA, US$18 billion in 2009; IBRD/IDA, US$23.7 billion in 2010, and PPI, US$154.4 billion. Adjusting for double counting, these flows sum to roughly US$190 billion, or about 42 percent of projected annual infrastructure investment. To fill the infrastructure finance gap, metropolitan areas should look internally to increase efficiency of existing infrastructure, define fiscal responsibilities, reduce subsidies, and set efficient tariffs, and they should look externally to draw in international investment.

Developing cities can assess the efficiency of service provision from existing stocks when reviewing the need for investment. Data are widely available for efficiency indicators such as the annual kilowatt hours produced per kilowatt of installed generating capacity or the loss of water from leakage and theft. Many cities, regardless of income level, can improve the efficiency of existing infrastructure stocks and services, because infrastructure performance is not strongly related to income. Much inefficiency is rooted in inadequate maintenance leading to sanitation system overflows, irrigation canal leakages, road deterioration, and power distribution loss. Investment in infrastructure maintenance is often underfunded, and providers must combine revenue from user charges and from public budgets to provide adequate maintenance. A reduction in road maintenance increases private vehicle user costs by much more than the maintenance savings. Repairing neglected roads is two to three times more costly than appropriate ongoing maintenance.

Defining metropolitan infrastructure investment responsibilities becomes increasingly important with fiscal decentralization, as some infrastructure stocks located beyond the metropolitan boundary support urban areas. In countries where funds for metropolitan level expenditures are mainly transferred from the central government, financing metropolitan level infrastructure investment raises few boundary or definitional difficulties because finance and debt service are either the direct or indirect responsibility of the central government. However, decentralization to the metropolitan level of the authority to raise revenues, allocate expenditures, and service debt reduces the responsibility of central governments for metropolitan finance in general and for the funding of infrastructure in particular. It also increases the importance of defining metropolitan fiscal responsibilities for infrastructure investment. Experience with decentralization highlights the importance of clarity and transparency in municipal financial planning, budgeting, programming, borrowing, and expenditures, as well as debt management.

Decentralization usually curtails the willingness of central governments to guarantee debts incurred by metropolitan areas to finance local infrastructure or other investments. This has created challenges for institutions like the World Bank, which requires its loans be guaranteed by the central government. Progress has been made in this area, with some metropolitan areas directly accessing international bond markets and some countries developing domestic municipal bond markets to finance infrastructure. However, if metropolitan areas have weak or ineffective restraints on borrowing, their direct or indirect indebtedness to domestic banks and to domestic and international bond holders can quickly become a problem. For example, excessive borrowing by LICs in China has recently led to a central government takeover of their indebtedness amounting to 10 percent of China's GDP.

Other internal approaches include pricing infrastructure services so that revenues cover costs. This promotes end-user efficiency and can substantially moderate demand. While subsidies are often defended on social welfare grounds, their beneficiaries are predominantly the nonpoor, who have access to regular services, while the poor are left with higher-cost, nonregular suppliers. Tank-truck-delivered water in favelas or slums that lack regular water service is the most notorious example of high-cost nonregular supply. Connection subsidies for services such as electricity and water (which favor the poor, because the rich are already connected) are a more effective means to increase access. Tariff schedules that do not cover full costs are common, with the weakest cost recovery in Africa and South Asia (Ingram and Fay 2008). The underlying demand is for infrastructure services, not physical stocks, and delivering higher flows of efficiently priced services from existing stocks can forestall or reduce the need to invest in additional capacity.

Metropolitan areas can look externally to draw in international investment, particularly PPI, which has increased from 2.5 times the size of ODA in 1990 to 7.4 times in 2008. While PPI mainly flows to middle-income countries, lower-income countries receive development assistance. ODA includes development assistance with at least a 25 percent grant element, and ODA commitments for infrastructure in 2008 are similar in size to the infrastructure investment projections for low-income countries. Unfortunately, only about a quarter of total ODA funds flowed to low-income countries in 2008, and data on the infrastructure share disbursed to low-income countries are not readily available. Some developing countries are beginning to make infrastructure investments in other developing countries, including low-income countries in sub-Saharan Africa, and these south-south flows are also likely to grow.

As metropolitan areas invest to fill the finance gap, they need to be aware of the relation between infrastructure investment and growth. As with national governments, metropolitan areas should invest in infrastructure capacity that supports their respective growth activity. The total investment projections (US$755 billion) for developing countries are aggregates for all countries across income groups and assume an average annual rate of economic growth of 5 percent. The investment projections vary directly with income growth, so countries that grow faster than average would need to devote a larger share of GDP to infrastructure investment. For example, if a lower-middle-income country growing at 5 percent per year was projected to spend 3.5 percent of GDP on infrastructure investment, such a country growing at 10 percent would have an infrastructure investment projection of 7 percent of GDP. Projections of maintenance expenditures are based on the size of existing stocks of infrastructure and do not vary directly with income growth rates.

Metropolitan infrastructure finance changed dramatically in the past 20 years. In addition to the enormous growth of PPI, several new (or renewed) financing options show particular promise, such as bond financing, south-south funding, and betterment levies based on increases in land values (often related to transport, water, or sanitation investments). While they require oversight, LICs that have well-defined assets can facilitate financing from banks and pension funds. Financing based on the sale of carbon credits also has promise, particularly in the energy

and transport sectors. One area where more progress needs to be made is in reducing subsidies and setting service tariffs at a level that covers the cost of service. This has been achieved in mobile telecommunications, largely through user charges, but remains an elusive goal in most other infrastructure services. While external funding for infrastructure investment is substantial and growing, it does not now (and is unlikely in the future to) cover most of the financing requirements of developing countries and their metropolitan areas, so they will need to provide most of the infrastructure financing themselves. To this end, metropolitan areas need to learn from one another's experiences with infrastructure financing, efficiency improvements, and service delivery. International institutions have an important role in facilitating the required exchange of knowledge in these areas.

REFERENCES

Allport, Roger. 2005. Urban rail concessions: Experience in Bangkok, Kuala Lumpur and Manila. Transport Working Paper No. 2. China Sustainable Development Unit, East Asia and Pacific Region. Washington, DC: World Bank.

Andres, Luis, Vivien Foster, and José Luis Guasch. 2006. The impact of privatization on the performance of the infrastructure sector: The case of electricity distribution in Latin American countries. Policy Research Working Paper No. 3936. Washington, DC: World Bank.

Annez, Patricia. 2006. Urban infrastructure finance from private operators: What have we learned from recent experience? World Bank Policy Research Working Paper No. 4045. Washington, DC: World Bank.

Arthur Anderson and Enterprise LSE. 2000. Value for money drivers in the private finance initiatives. London: U.K. Treasury Taskforce.

Asian Development Bank. 2008. *Managing Asian cities.* Mandaluyong City.

Bahl, Roy, and Jorge Martinez-Vazquez. 2008. The determinants of revenue performance. In *Making the property tax work: Experiences in developing and transitional countries*, ed. Roy Bahl, Jorge Martinez-Vazquez, and Joan Youngman, 35–60. Cambridge, MA: Lincoln Institute of Land Policy.

Bahl, Roy, Jorge Martinez-Vazquez, and Joan Youngman, eds. 2008. *Making the property tax work: Experiences in developing and transitional countries*. Cambridge, MA: Lincoln Institute of Land Policy.

Bhardwaj, Nishant, and Daisy Inocentes. 2011. Carbon credits: Improving financing and sustainability of a landfill closure project. In *Knowledge showcase*. Asian Development Bank. http://www2.adb.org/documents/information/knowledge-showcase/gorai-landfill-closure.pdf

Borrero, Oscar, Esperanza Durán, Jorge Hernández, and Magda Montaña. 2011. Evaluating the practice of betterment levies in Colombia: The experience of Bogotá and Manizales. Working Paper. Cambridge, MA: Lincoln Institute of Land Policy.

Briginshaw, David. 2011. Brazil: A privatization model that works. *International Railway Journal* (July).

Canning, David. 1998. A database of world infrastructure stocks, 1950–1995. Policy Research Working Paper No. 1929. Washington, DC: World Bank.

Chatterton, Isabel, and Olga Susana Puerto. 2005. *Estimations of infrastructure investment needed in the South Asia region*. Washington, DC: World Bank.

Fay, Marianne, and Charlotte Opal. 1999. Urbanization without growth: A not-so-uncommon phenomenon. Policy Research Working Paper No. 2412. Washington, DC: World Bank (November).

Fay, Marianne, and Tito Yepes. 2003. Investing in infrastructure: What is needed from 2000 to 2010? Policy Research Working Paper No. 3102. Washington, DC: World Bank (July).

Fitzgerald, Peter. 2004. Review of partnerships: Victoria provided infrastructure. A report commissioned by the Department of Treasury and Finance, Government of Victoria (Australia). Melbourne, Victoria: Growth Solutions Group.

Foster, Viven, and Cecelia Briceño-Garmendia, eds. 2010. *Africa's infrastructure: A time for transformation*. Washington, DC: World Bank.

Foster, Vivien, William Butterfield, C. Chen, and Nataliya Pushak. 2008. *Building bridges: China's growing role as infrastructure financier for Africa*. Washington, DC: Public-Private Infrastructure Advisory Facility and World Bank.

Gassner, Katharina, Alexander Popov, and Nataliya Pushak. 2008, Does private sector participation improve performance in electricity and water distribution? Trends and Policy Options, No. 6, PPIAF. Washington DC: World Bank.

Gevert, Theodor. 2004. SuperVia unveils radical surface metro plan: Privatization and investment have revived Rio de Janeiro's once-ailing suburban rail network. *International Railway Journal* (August):41.

Ingram, Gregory, and Marianne Fay. 2008. Physical Infrastructure. In *International handbook of development economics*, ed. Amitava K. Dutt and Jaime Ros, 26, 301–315. Cheltenham, U.K.: Edward Elgar.

Ingram, Gregory, and Zhi Liu. 1999. Determinants of motorization and road provision. In *Essays in transportation economics and policy*, ed. Jose A. Gomez-Ibanez, William B. Tye, and Clifford Winston. Washington, DC: Brookings Institution.

International Road Federation. 2010. World road statistics. Geneva.

International Telecommunications Union. 2010. World telecommunications development report. Geneva.

KPMG LLP. 2007. Effectiveness of operational contracts in PFI. London.

Leigland, James. 2010. PPI in poor countries. *Gridlines* 51:1–4.

Leigland, James, and Henry Russell. 2009. Another lost decade? Effects of the financial crisis on project finance for infrastructure. *Gridlines* 48:1–4.

Liu, Lili, and Steven B. Webb. 2011. Laws for fiscal responsibility for subnational discipline: International experience. Policy Research Working Paper No. 5587. Washington, DC: World Bank.

Martell, Christine, and George M. Guess. 2006. Development of local government debt financing markets: Application of a market-based framework. *Public Budgeting and Finance* 26(1):88–119.

Ministry of Road Transport and Highways, Government of India. 2012. Guidelines for investment in road sector. www.nhai.org/Doc/15Nov12/Guidelines%20for%20Investment%20in%20Road%20Sector%20%28as%20on%2031%20October%202012%29.pdf

Murakami, Jin. 2012. Transit value capture: New town codevelopment models and land market updates in Tokyo and Hong Kong. In *Value capture and land policies*, ed. Gregory K. Ingram and Yu-Hung Hong, 285–320. Cambridge, MA: Lincoln Institute of Land Policy.

National Audit Office. 2003. PFI: Construction performance. London.

———. 2007. Benchmarking and market testing the ongoing services component of PFI projects. London.

Ngobeni, Jason. 2008. Asking the right questions: Johannesburg completes a groundbreaking municipal bond issue. *Gridlines* 33:1–4.

NHAI. 2012. Home page. www.nhai.org

OECD. 2011. Quick wizard for international development statistics. Paris.

Partnerships U.K. 2006. Report on operational PFI projects. London.

Peterson, George E. 2006. Land leasing and land sale as an infrastructure financing option. Policy Research Working Paper No. 4043. Washington, DC: World Bank.

Public-Private Infrastructure Advisory Facility and World Bank. 2007. *PPP units for infrastructure: Lessons for their design and use*. Washington, DC: Public-Private Infrastructure Advisory Facility and World Bank.

Rebelo, Jorge M. 1999. Rail and subway concessions in Rio de Janeiro: Designing contracts and bidding processes. *Viewpoint* 183:1–8.

Trelles Zabala, Rodrigo. 2004. Colombia. In *Subnational capital markets in developing countries*, ed. Maria Freire and John Petersen. Washington, DC: World Bank.

World Bank. 2004. *Global development finance: Harnessing cyclical gains for development*. Washington, DC.

———. 2011. World development indicators. Washington, DC.

World Bank and Public-Private Infrastructure Advisory Facility. 2011. Private participation in infrastructure (PPI) project database. Washington, DC.

Wu, Weiping. 2010. Urban infrastructure financing and economic performance in China. *Urban Geography* 31(5):648–667.