# 1

# The Infrastructure Challenge

East Asia's recent development performance makes for impressive headlines: As a group, the economies of the region have grown by more than 7 percent annually over the last 15 years. And the number of people living on less than $2 a day has fallen by more than 250 million.[1]

The story is similar in its infrastructure performance: Investment exceeds 7 percent of gross domestic product (GDP) annually in some countries, with a doubling of electricity generation capacity in only a decade in others, and increases in road networks of between 25 percent and 100 percent in still others.

Beyond the headlines, however, the story is more complicated. With large numbers of people surviving on less than $2 a day in even the fastest growing countries of the region, the remaining challenges are daunting.

And much of the aggregate growth and poverty reduction numbers are driven by a single country—China. Behind the aggregates, the developing countries of East Asia in fact differ vastly—by growth rates, wealth, population, and poverty incidence (see Table 1.1).

The group includes the most populous country in the world, and the Pacific island states, which have among the smallest populations in the world. It includes Malaysia, with a gross national income (GNI) per capita of more than $3,000, and Cambodia—the people of which enjoy less than one-tenth of that amount on a per capita basis. It includes the fast growers, like China and Vietnam, and a number in which growth is sporadic and slow. And, as we shall see, countries of the region differ too in their infrastructure performance.

**Table 1.1 Growth, income, poverty, and population, East Asia**

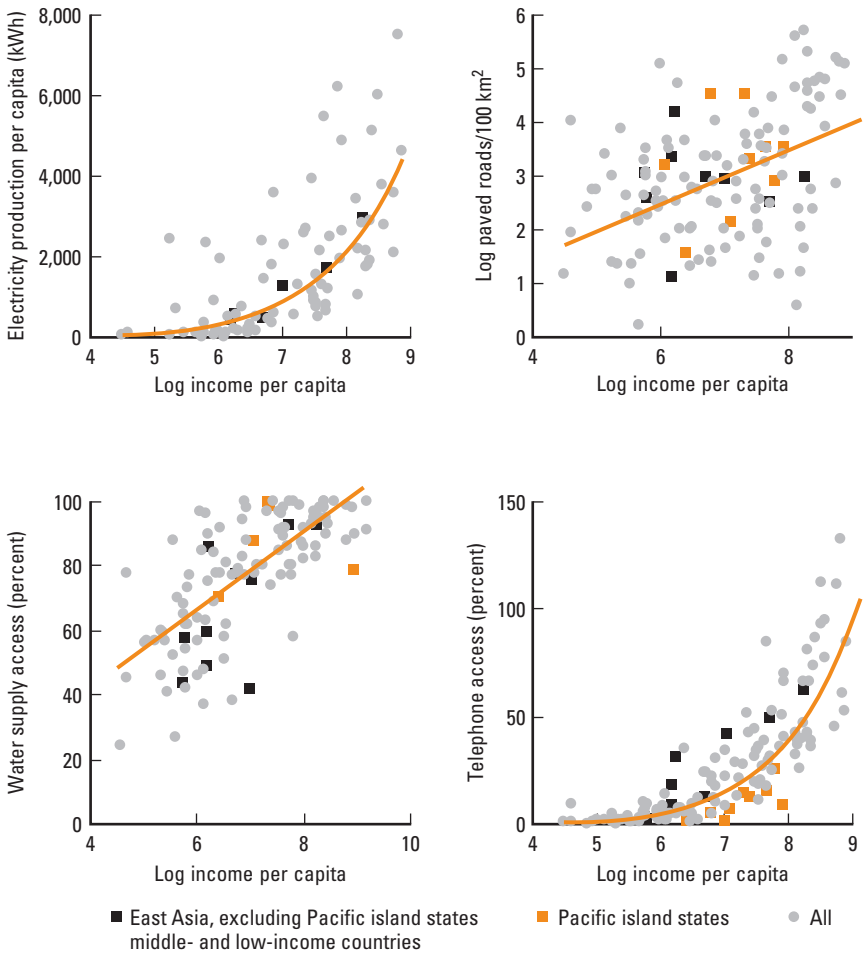
| | Average annual growth, 1994–2003 | Gross national income (current $, million), 2003 | Population (million), 2003 | GNI per capita (current $), 2003 | Number of poor (million), 2005 projected |
|---|---|---|---|---|---|
| Malaysia | 4.8 | 97,809 | 24.77 | 3,880 | 1.7 |
| Thailand | 2.8 | 140,277 | 62.01 | 2,190 | 11.6 |
| Philippines | 4.0 | 86,607 | 81.50 | 1,080 | — |
| China | 8.5 | 1,409,162 | 1,288.40 | 1,100 | 391.1 |
| Indonesia | 2.5 | 199,028 | 214.67 | 810 | 99.1 |
| Vietnam | 7.3 | 39,157 | 81.31 | 480 | 41.1 |
| Cambodia | 6.3 | 4,060 | 13.40 | 300 | 10.3 |
| Lao PDR | 5.9 | 2,084 | 5.66 | 340 | 4.3 |
| Mongolia | 0.1 | 1,252 | 2.48 | 480 | — |
| Palau | 3.0 | 130 | 0.02 | 6,500 | — |
| Marshall Islands | −1.7 | 139 | 0.05 | 2,710 | — |
| Fiji | 2.7 | 1,955 | 0.84 | 2,240 | — |
| Micronesia, Federated States of | 0.1 | 261 | 0.12 | 2,070 | — |
| Samoa | 4.2 | 265 | 0.18 | 1,440 | — |
| Tonga | 2.1 | 161 | 0.10 | 1,490 | — |
| Vanuatu | 0.9 | 279 | 0.21 | 1,180 | — |
| Kiribati | 4.7 | 85 | 0.10 | 860 | — |
| Papua New Guinea | 0.2 | 2,739 | 5.50 | 500 | 4.1 |
| Solomon Islands | −1.3 | 247 | 0.46 | 560 | — |
| Timor-Leste | −3.05[b] | 341 | 0.88 | 460 | — |
| Myanmar | — | — | — | — | — |

*Sources:* World Bank 2004d, 2004h.
*Note:* — = Not available.
a. living under $2/day, 2005.
b. annual average growth, 1998–2003.

There are a number of ways to tell the story of infrastructure in East Asia. In this chapter, we look at it from five interlinked perspectives. Each of these perspectives defines the context of infrastructure delivery in the region in different ways.

We start with the economic story, which places infrastructure squarely in the context of the region's remarkable growth performance, and its record in reducing poverty. Although growth and poverty reduction depend on much more than infrastructure alone (see Figure 1.1), the contribution of infrastructure to the region's macroeconomic story has been considerable. The context established here lays the ground for a

**Figure 1.1 The association between infrastructure outcomes and per capita income levels varies**




*Sources:* IEA 2004; World Bank 2004h; country-specific sources (publications, interviews, etc.); ITU Télécommunications Indicators Database.

detailed discussion of inclusive development in Chapter 2—the *how* of infrastructure, growth, and poverty reduction.

We then look at the spatial and demographic story, in particular at the region's fast-growing urban areas, and the challenges of connectivity and coordination that this raises. Approaches to addressing these challenges are dealt with in Chapter 2 and, through the focus on coordination, in Chapter 3.

In our third story, we look at infrastructure from the perspective of the environment. Many infrastructure investments have a positive impact on the environment, most prominently water and sanitation. But other kinds of infrastructure undertaking entail significant environmental risks—risks that can be mitigated if the political will is present. But mainstreaming environmental concerns in the design and implementation of infrastructure raises difficult coordination problems, similar in nature to those that we raise in Chapter 3.

Our fourth infrastructure story is the political story, which provides some of the context for our discussion of coordination in Chapter 3 and risk management and accountability in Chapter 4.

And finally to the question of East Asia's infrastructure service needs, and how they can be resourced. This is the subject of the last of our infrastructure stories—the funding story.

## The economic story

The economic performance of developing East Asia has been driven largely by fast-growing urban agglomerations in coastal China, Indonesia, Thailand, Malaysia, and Vietnam. It is associated with high investment, low or significantly decreasing poverty, and rapidly expanding output. The performance of these countries—particularly that of China—powers the region through an increasingly dynamic and complex web of trade, information, innovation, and investment links.

The forging of connections among countries in the region, as well as between East Asia and the rest of the world, has been an important part of the region's performance. Developing countries of East Asia have seen their share of world exports more than triple over the last 25 years (World Bank, 2005b).[2] East Asia intraregional trade now constitutes more than 7 percent of world trade (Ng and Yeats 2003).[3]

China has been central in this trade and growth equation.[4] Regional trade has allowed other East Asian countries to benefit from the remarkable expansion of the Chinese economy and markets. Since 1995, East Asia's exports to China have been growing at a rate of 11.5 percent annually (Ng and Yeats 2003). The role of logistical infrastructure—ports, roads, and rail—in supporting these connections is one of the themes of Chapter 2.

Within countries too, infrastructure has been an important part of the economic story. Investment has been sustained—in China and Vietnam, in particular, where gross fixed capital formation has averaged about

40 percent of GDP and 30 percent of GDP respectively over the last five years. And much of this investment has been in infrastructure (Table 1.2).

As a result, the faster growing developing countries of the region manage substantial infrastructure assets. In many cases, the stock of these assets has accumulated, and capacity to generate services has increased at remarkable rates (Table 1.3).

Sustained investment and efficiency in operations have helped some economies in the region—in particular Thailand and Malaysia—to achieve considerable competitive advantage across infrastructure sectors, both in international terms and when compared with the region's developed economies (a comparator group to which we shall return in

**Table 1.2 Infrastructure investment, percent GDP**

| 0–4% | 4–7% | More than 7% |
|---|---|---|
| Cambodia | Lao PDR | China |
| Indonesia | Mongolia | Thailand |
| Philippines | | Vietnam |

*Sources:* Latest year available, based on available data from country-specific sources (publications, interviews); World Bank PPI Database 2005.
*Note:* GDP = gross domestic product.

**Table 1.3 Total road network and electricity generating capacity, 1990–2000**

| | Total road network (km) | | | Electricity generating capacity (GW) | | | Annual average GDP growth (%) |
|---|---|---|---|---|---|---|---|
| | 1990 | 2000 | Growth (%) | 1990 | 2000 | Growth (%) | |
| China | 1,028,348 | 1,679,848 | 63 | 127 | 299 | 136 | 10.1 |
| Indonesia | 288,727 | 355,951 | 23 | 13 | 25 | 98 | 4.2 |
| Lao PDR | 13,971 | 23,922 | 71 | 0 | 0 | 92 | 6.3 |
| Philippines | 160,560 | 201,994 | 26 | 7 | 12 | 81 | 3.0 |
| Thailand | 52,305 | 60,354 | 15 | 8 | 19 | 125 | 4.5 |
| Vietnam | 105,557[a] | 215,628 | 104 | 2 | 6 | 180 | 7.6 |
| Argentina | 215,357 | *215,471* | 0 | 17 | 24 | 37 | 1.5 |
| Brazil | 1,670,148 | 1,724,929 | 3 | 52 | 69 | 32 | 4.5 |
| India | 2,000,000 | *3,319,644* | 66 | 72 | 108 | 51 | 2.7 |
| Poland | 363,116 | 364,656 | 0 | 27 | 29 | 9 | 5.5 |
| South Africa | 185,751 | 362,099 | 95 | 31 | 40 | 28 | 3.7 |
| Korea, Rep. of | 56,715 | 86,990 | 53 | 20 | 50 | 150 | 1.7 |

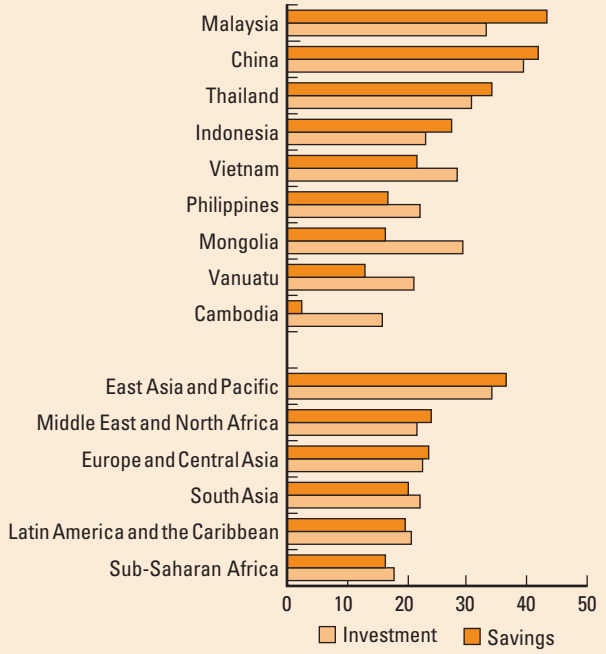
*Sources:* Country-specific sources; World Bank 2004h; U.S DOE; Energy Administration Information Database.
*Note:* Italics refer to data from prior year; GW = Giga Watts.
a. 1992 figure.

### Box 1.1 The demographic dividend

East Asia has benefited greatly from its "demographic dividend." A baby boom has been traveling through the age structure of the region's population since the 1950s and 1960s. These young people began entering the labor force from the late 1960s and early 1970s (at around the same time as the proportion of births started to decline). The working-age population rose from 56 percent of the total population in 1965 to 66 percent in 2000. It is expected to reach about 70 percent by between 2015–20 (World Bank 2004e).

One of the distinctive features of East Asia is that the high working-age population has been combined with institutions, traditions, and policies that have encouraged high savings levels in that age group and that have channeled those savings into domestic investment (Figure 1.2). Infrastructure has been a major beneficiary of that phenomenon.

**Figure 1.2 Savings and investment (percent GDP), average, 1993–2002**




*Source:* World Bank 2004h.

Chapter 3). In other large economies in this group—China, Indonesia, Vietnam, and the Philippines—performance has been less impressive (Figure 1.3).

This overall impression is mirrored in the response of East Asian firms to World Bank Investment Climate Surveys, nearly 20 percent of which report that inadequate infrastructure service provision is a serious obstacle to the operation and growth of their business.[5] This is a lower percentage than in the rest of the developing world, but it is high enough to be of considerable macroeconomic consequence.

In short, East Asia has provided the infrastructure underpinnings for economic growth better than other developing regions (on average), but there is much room for improvement, and supply needs to keep pace with rapidly rising demand.[6]

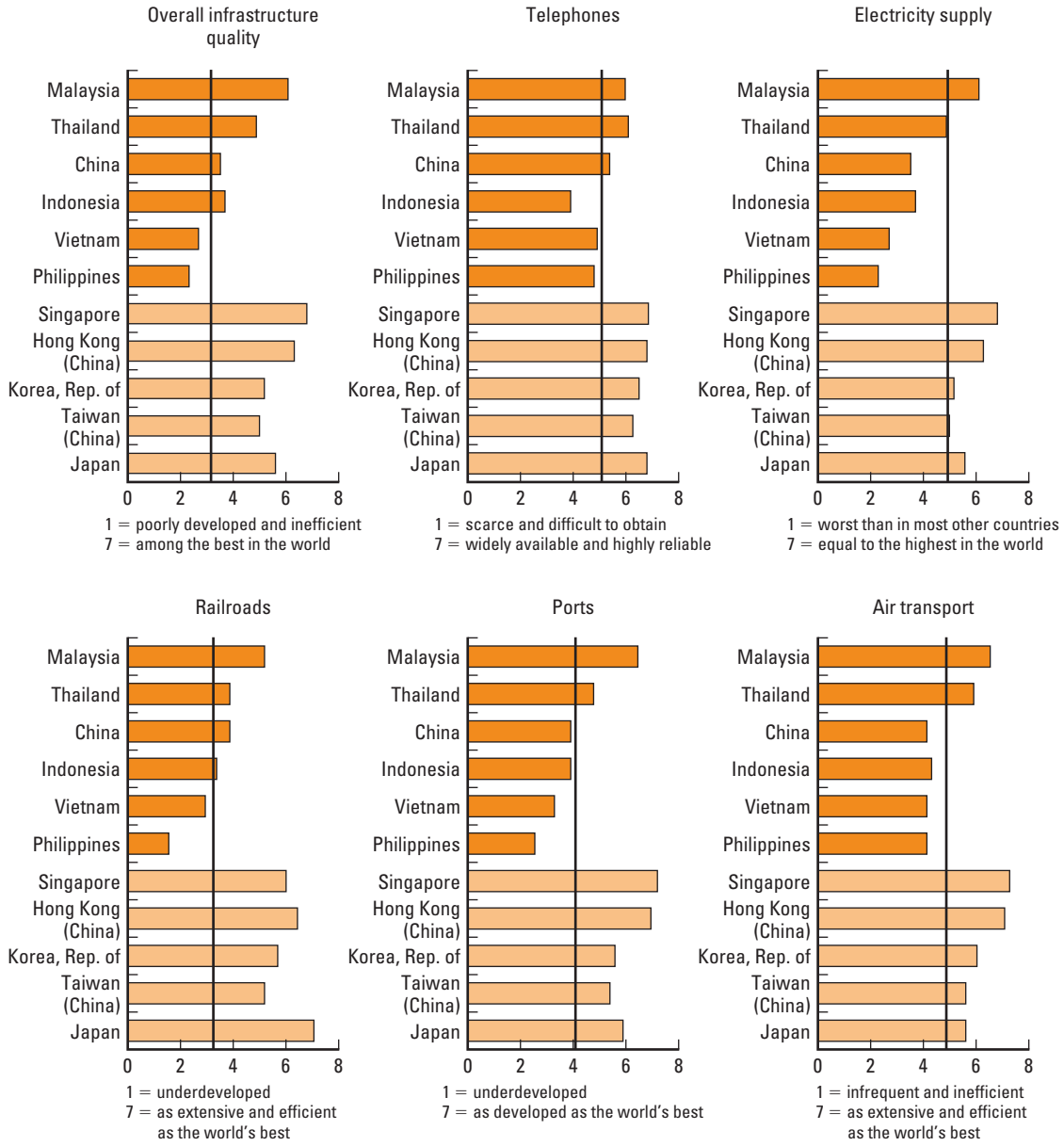
In those countries in which infrastructure investment has been most sustained—China and Vietnam in particular—high levels of investment have not always implied optimal investment. Often efficiency in the selection and management of investment, in general, and infrastructure, in particular, has been lacking. Too much investment may be as dangerous as too little. The governments of these countries now face the challenges of improving efficiency, avoiding "overheating" by restraining excessive investment, and managing a "soft landing" with sustainable growth and investment—a point we pick up in our discussion of Vietnam in Chapter 2.

In the countries most affected by the 1997 crisis, growth has recovered (that is, in Thailand, Malaysia, and to a lesser extent Indonesia and the Philippines), but this has been driven primarily by domestic consumption and exports, rather than by investment. In the Philippines, physical capital per worker has been growing at barely 1 percent per year since the early 1990s. In Indonesia, Malaysia, and Thailand, capital per worker was grown by 4 to 7 percent per year before the 1997 crisis, but by less than half that rate since then (World Bank 2004d).[7]

Clearly, the postcrisis recovery in growth has come from increased capacity utilization and enhanced labor productivity and innovation; however, these factors will eventually reach limits without an investment recovery. In these countries, therefore, the challenge is to enhance the investment climate and increase investment to underpin sustained economic growth (while continuing to realize efficiency gains in management of assets).

Access to infrastructure services in Malaysia and Thailand, as well as the Philippines, and to a lesser extent China, is generally higher than that

**Figure 1.3 Infrastructure quality ranking, *World Competitiveness Report*, East Asia**




*Source:* World Economic Forum 2003.

*Note:* Rankings are shown for developing East Asian economies (darker bars) and advanced East Asian economies (lighter bars). Black vertical line is the average for all 102 surveyed countries, both within and outside of East Asia.

**Table 1.4 Infrastructure access and stocks**

Access to water, electricity, and telecommunications

| | Water supply access[a] | Sanitation access[b] | Electricity access[c] | Telephone access[d] | Internet access[e] |
|---|---|---|---|---|---|
| Malaysia | 93 | — | 97 | 62 | 34.4 |
| Thailand | 93 | 98 | 84 | 50 | 11.1 |
| Philippines | 86 | 83 | 79 | 31 | 4.4 |
| China | 76 | 39 | 99 | 42 | 6.3 |
| Indonesia | 78 | 55 | 55 | 13 | 3.8 |
| Vietnam | 49 | 25 | 81 | 9 | 4.3 |
| Cambodia | 44 | 22 | 17 | 4 | 0.2 |
| Lao PDR | 58 | 30 | 41 | 3 | 0.3 |
| Mongolia | 60 | 30 | 90 | 19 | 5.8 |
| Palau | 79 | 100 | 60 | 42 | — |
| Marshall Islands | — | — | 100 | 9 | 2.6 |
| Fiji | — | 43 | 80 | 26 | 6.7 |
| Micronesia | — | — | 45 | 16 | 9.3 |
| Samoa | 99 | 99 | 95 | 13 | 2.2 |
| Tonga | 100 | — | 85 | 15 | 2.9 |
| Vanuatu | 88 | 100 | 26 | 7 | 3.6 |
| Kiribati | — | 48 | 40 | 6 | 2.3 |
| Papua New Guinea | 42 | 82 | 46 | 1 | 1.4 |
| Solomon Islands | 71 | 34 | 15 | 2 | 0.5 |
| Timor-Leste | — | — | 22 | — | — |
| Myanmar | 72 | 64 | 5 | 1 | 0.1 |
| Low and Middle Income | 77 | 70 | 64 | 27 | 6.5 |

Transport networks

| | Road network (km per 100 km$^2$) | Percentage paved road | Rail network (km per 100 km$^2$) |
|---|---|---|---|
| Malaysia | 20 | 76 | 0.49 |
| Thailand | 12 | 97 | 0.79 |
| Philippines | 68 | 22 | 0.16 |
| China | 19 | 91 | 0.64 |
| Indonesia | 20 | 58 | 0.25 |
| Vietnam | 29 | 25 | 0.97 |
| Cambodia | 22 | 4 | 0.42 |
| Lao PDR | 14 | 15 | — |
| Mongolia | 3 | 8 | 0.15 |
| Palau | — | — | — |
| Marshall Islands | 35 | — | — |
| Fiji | 19 | 49 | — |
| Micronesia | 34 | 18 | — |
| Samoa | 28 | 80 | — |
| Tonga | 94 | 27 | — |
| Vanuatu | 9 | 24 | — |
| Kiribati | 92 | — | — |
| Papua New Guinea | — | 4 | — |
| Solomon Islands | 5 | 3 | — |
| Timor-Leste | 25 | 41 | — |
| Myanmar | — | — | — |
| Low and Middle Income | 38 | 41 | 1.70 |

*Sources:* IEA 2003; World Bank 2004h; country-specific sources (publications, interviews, and so on); ITU database.
*Note:* Shaded values above category average for low- and middle-income countries; — = Not available.
a. Percentage of population with access to at least 20 liters per person per day from "improved" water supply technologies from a source within one kilometer of the user's dwelling (see W1 in the Statistical Annex).
b. Percentage of population with excreta disposal system "under improved" sanitation technologies, adequate if it private or shared (but not public) and if hygienically separates human excreta from human contact (see W4 in the Statistical Annex).
c. Percentage of households with electricity access through commercially sold electricity, both on-grid and off-grid (see E1 in the Statistical Annex).
d. Telephone subscribers per 100 inhabitants.
e. Number of users per 100 inhabitants.

of its less wealthy (in per capita terms) neighbors (Table 1.4). Similar outcomes have been achieved in some of the tiny Pacific island nations, although—as we set out in more detail in Box 1.2—the context of this achievement is substantially different.

**Box 1.2 Infrastructure challenges in the Pacific Island countries: A case apart**

The nine Pacific island countries covered by this study stand apart from the rest of the region in a number of respects, with important implications for their infrastructure challenges.

Together, the nine islands have a combined population smaller than Jamaica's, in a total land mass smaller than Cuba's, spread over an area larger than China.

The challenging topography and the low population density clearly complicate the task of infrastructure service provision. The spread of the high fixed cost of infrastructure investment over a small customer base inflates unit costs and depresses revenues from service provision. Because of their remoteness and lack of economies of scale, the Pacific island countries, in relation to other East Asian countries, have a significant comparative disadvantage in attracting private sector participation and sustaining competition in infrastructure.

The Pacific island countries are lagging behind East Asian countries in terms of access and quality of service provision. A stunning 70 percent or more of inhabitants lack access to electricity. Telecommunications access is largely limited to urban areas. Because of a lack of transport alternatives, interisland shipping and civil aviation play a crucial role in a complex transport system serving hundreds of sparsely populated small islands. Nevertheless, airports and ports are characterized by low throughput on a per capita basis.

But poor performance in infrastructure cannot be attributed exclusively to geography and lack of economies of scale. The Pacific Islands have lower levels of access to telecommunications, electricity, and improved water and sanitation, than similar countries with the same level of income (for example, in the Caribbean). Policy and institutional choices also matter:

*Poor coordination*. Many Pacific island countries suffer from poor coordination in infrastructure policy and implementation. Hidden subsidies to corporatized utilities do not compete with other fiscal priorities in a transparent manner. Regulatory and policy frameworks are often not fully aligned or contradict each other—for example, Fiji adopted the "landlord" model for port operations, but contracted out stevedoring operations to a monopoly government-owned provider, thus diluting the potential efficiency benefits stemming from competition in service provision.

*Low accountability*. In most of the Pacific island countries, government-owned utilities are in charge of providing the service and sanctioning its quality. Most of the governments have now recognized that this model does not create an enabling framework for accountability to end users, and have moved toward more accountable institutional arrangements, through corporatization of state-owned utilities.

However, with only a few exceptions, accountability to end users has remained low, as corporatized utilities are often still subject to micromanagement by the government. When the prospect for private sector engagement exists, the imbalance between the public sector and the private utilities in terms of monitoring capacity can sometimes lend excessive power to the

(Continued on the next page)

**Box 1.2 (Continued)**

privatized utilities or lead to collusive outcomes, with little improvement in accountability.

*Low capacity to manage risk.* The risk management model in the Pacific island countries is often based on a model of government as absorber of risk—government-owned utilities are generally insulated from risk, as losses flow through to the government and are eventually born by taxpayers. The cost of government risk-bearing is often high, as the Pacific island economies are particularly vulnerable to external shocks (such as oil price shocks), which also tend to have an impact on the cost of infrastructure service provision. The total cost of risk-bearing could be reduced through more sophisticated project design, which would enable more effective risk-sharing. Consumers and service providers should be called on to bear at least part of the risk, to the extent that they are able to absorb it.

Notwithstanding the specific infrastructure challenges faced by the Pacific island countries, a few successful examples of corporatization (such as the Fiji Electricity Authority, Samoa Ports Authority, and Samoa Water Authority) and the positive performance of the private electricity and water utility in Vanuatu demonstrates that the possibility exists for improved performance and accountability through better management and commercial focus. The challenge is to design time-bound performance-based subsidies to encourage more efficient and inclusive infrastructure service delivery. The establishment of regional bodies (such as the existing Pacific Power Association) should be encouraged as the way forward to ease individual country capacity constraints and promote policy coordination among the Pacific island countries.

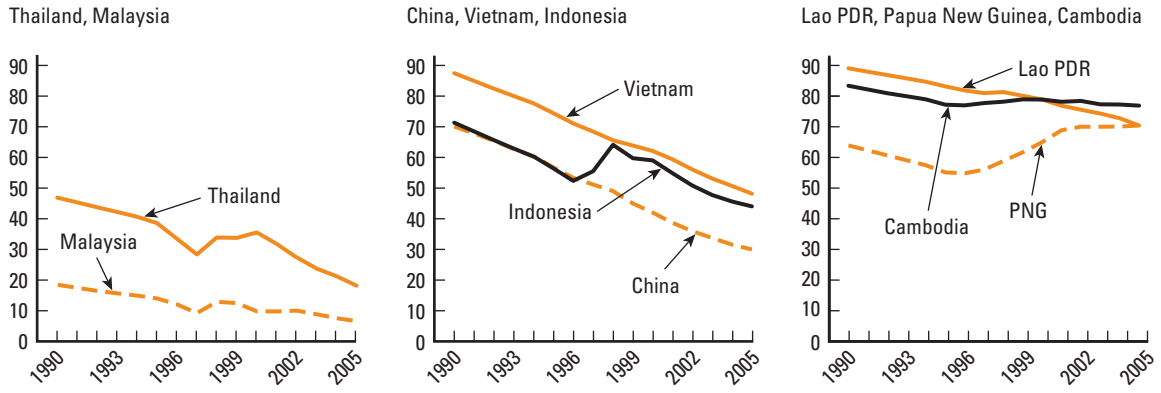
*Sources:* Castalia 2004b; Mellor and Jabes 2004.

The larger, faster growing economies also stand apart in the degree to which growth, investment, and poverty reduction have accompanied and supported each other. The poverty headcount in China has dropped from around 70 percent of the population in 1990 to close to 30 percent of the population today.[8] Vietnam has seen its poverty headcount drop from around 90 percent to 48 percent over the same period (Figure 1.4).

The risk of poverty, however, is much higher than the poverty headcount may suggest at any particular time. In all developing countries of East Asia, a far larger number of households fall intermittently below the poverty line than are permanently below it.[9] The 1997 crisis dramatically exposed this underlying risk, with lasting effects on policies and attitudes toward poverty, social stability, and vulnerability in the region.

In contrast to the region's best performers, a number of countries have been less successful in simultaneously nurturing growth and poverty reduction. In Cambodia—despite significant growth (albeit from a very

**Figure 1.4 Poverty headcount index ($2/day), percent, East Asia, selected countries**




*Source:* World Bank 2004d.
*Note:* Data interpolated between 1999 and 1996.

low base)—78 percent of the population is estimated to live on less than $2 a day. The corresponding figure for Lao People's Democratic Republic (PDR) is about 73 percent (World Bank 2004d). Infrastructure access, particularly those stocks that serve to connect and link (roads or rail), are significantly lower in Lao PDR and Cambodia (Table 1.4). And with investment levels at between one-third and one-half that of faster growing neighbors, a mutually supportive relationship between infrastructure, investment, growth, and poverty reduction is less apparent than elsewhere in the region.

Finally, other regions in East Asia remain isolated and relatively disconnected from the major growth centers of East Asia—most rural areas, the outlying islands of Indonesia, the Philippines, land-locked Mongolia, and most Pacific island states.

In the Pacific island countries, the poverty headcount is generally much lower, but economic growth rates tend also to be quite low and incomes are heavily dependent on aid flows, migrant labor remittances, or nonrenewable natural resources with volatile revenue streams. Populations in those countries therefore remain particularly vulnerable to poverty through slow economic growth and lack of economic diversity.

## The spatial and demographic story

East Asia's spatial and demographic challenge plays out across three interlinked dimensions. The first is the urban dimension: Cities drive East

Asian growth, and as they do, their populations are expanding rapidly. Infrastructure not only has to keep up with demand for services, but also has to play a crucial role in maintaining cities' competitiveness.

The second challenge relates to rural areas, where poverty levels are at their highest. Infrastructure can help improve livelihoods; it also has an important role to play in spreading the benefits of urban growth.

And the third challenge is a regional challenge: to create regional markets; enhance trade and regional integration; and connect poorer, isolated areas to the region's growth centers.

## The urban challenge

The urban agglomerations driving East Asia's growth have profound consequences for economic development. Cities account for 70 percent of the region's GDP growth. Urban populations are expanding rapidly. And with it come a host of infrastructure opportunities and challenges: challenges that entail integration and connection; and challenges that entail foresight and coordination. How to meet these challenges is one of the themes of our next two chapters.

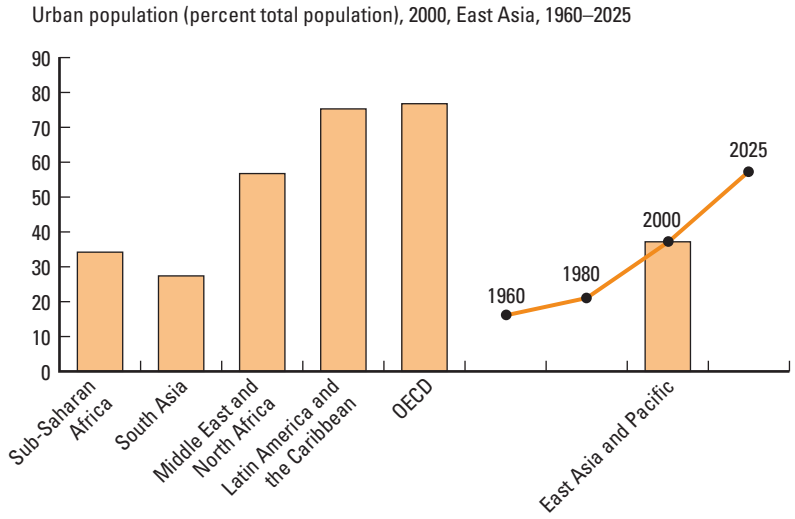
The urban share of East Asia's population is not yet high by global standards, but it is rising exponentially. From 16 percent in 1960, to 21 percent in 1980, and to 36 percent in 2000, it is expected to rise to 57 percent by 2025 (Figure 1.5). By then, East Asia will have about 500 million more urban dwellers than it does now, mainly as a result of migration from rural areas (World Bank 2004c).[10]

From 2000 to 2015, the population living in cities with more than 1 million residents is expected to increase by about half (to 500 million) and the population living in megacities with more than 10 million residents will rise by a similar proportion (to 120 million).

The most rapid population growth is taking place in peri-urban peripheries. In Chinese cities alone, peri-urban areas will grow by about 250 million people over the next 25 years (World Bank 2004c). And increasingly, neighboring East Asian cities are connecting with each other and forming large urban clusters. These include large parts of China's coastal zone, Bangkok's Eastern Seaboard, the Philippines' National Capital Region, and the cross-border cluster of Singapore-Riau-Johor.

In general, urbanization in East Asia is correlated with increasing national income levels (Figure 1.6). Cities have driven growth. The rapid growth of cities has been accompanied by a striking change in economic

**Figure 1.5 East Asia's urban population is not yet high by global standards, but it is rising exponentially**




*Sources:* World Bank 2004c, 2004h; United Nations 2003; World Bank staff calculations.
*Note:* OECD = Organisation for Economic Co-operation and Development.

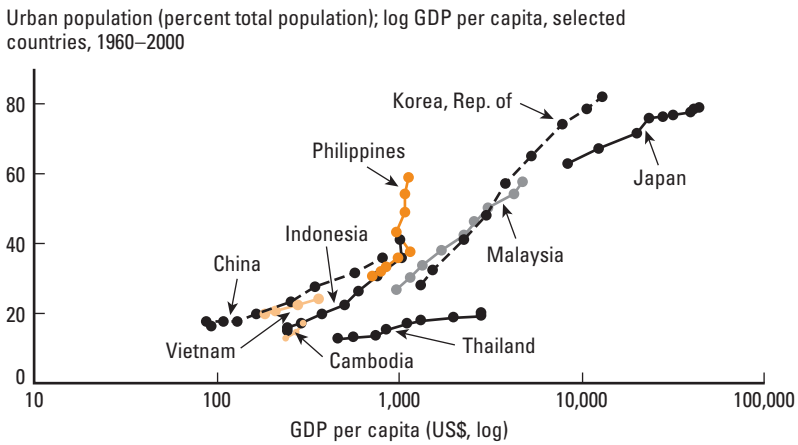
**Table 1.5 There is significant variation in the speed and level of urbanization across East Asian countries**

Level and rate of urbanization, percent total population, 2000, growth rate, 1995–2000

| | | Urbanization level | | |
|---|---|---|---|---|
| | | Low | Middle | High |
| Urbanization rate | Fast | Cambodia<br>Lao PDR | | Indonesia<br>Philippines |
| | Intermediate | | China<br>Vietnam<br>Myanmar | Malaysia |
| | Slow | Thailand | | Mongolia |

*Source:* UTCE/ALMEC 2004a, based on World Bank 2003e.
*Note:* Urbanization level: High >40%, 20% <middle<40%, Low<20%; Urbanization rate: Fast >6%, 2%<middle<4%, Low<2%.

**Figure 1.6 Urbanization and increasing income levels are correlated in East Asia**




*Sources:* UTCE/ALMEC 2004a; World Bank 2003e; UN 2002.
*Note:* Data are plotted for every five years.

structure.[11] Densely populated urban areas have provided markets for outputs, inputs, labor, and other services and allow firms to profit from economies of scale and scope, specialization, and the rapid diffusion of knowledge and innovation.

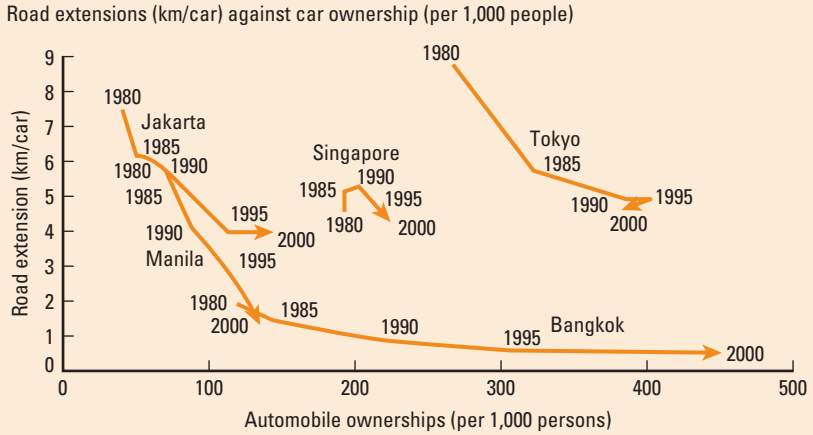
Agglomeration economies have been strong in East Asia. Their impact is enhanced by the role of urban areas in the process of globalization. Cities such as Bangkok, Beijing, Hong Kong (China), Jakarta, Kuala Lumpur, Manila, and Shanghai are now major world centers. Beijing's selection for the 2008 Olympics and Shanghai's for the 2010 World Expo bear ample testimony to that evolution. The connection of East Asia's cities to global markets makes them centers for international trade, communications, employment of migrants, and foreign direct investment. Such cities are experiencing unprecedented prosperity as a result of their advantages. For example, the per capita GDP of Shanghai alone is about 11 times that of China's per capita GDP, and Ho Chi Minh City has three times the per capita GDP of Vietnam (Yusuf, Evenett, Nabeshima, Shotten, and Webster 2001).

But East Asia's urban growth brings with it a host of infrastructure challenges. Rapidly increasing and densely distributed urban populations impose increasing demands on infrastructure facilities and services, as well as the environmental and social risks of inadequate provision. Infrastructure gaps are emerging across urban infrastructure sectors (Box 1.3).

### Box 1.3 Emerging urban infrastructure gaps in East Asia

In many East Asian cities, infrastructure provision is failing to keep up with rapid urbanization and demand on services. Figure 1.7 illustrates one example. It plots increasing car ownership against road extension per vehicle, which shows how, in major East Asian cities, rapid motorization has outstripped the capacity of city authorities to meet demand.

#### Figure 1.7 Changes in vehicle ownership and road lengths




*Source:* JICA 2004.

*Note:* Data for Metro Manila: Philippines Statistical Yearbook (excluding barangay roads); Jakarta: Jakarta dalmn Angka (excluding army and diplomatic vehicles); Bangkok: Bangkok Metropolitan Area (BMA) (excluding soi and trucks); Singapore: World Road Statistics and Land Transport Authority (paved road only); Tokyo: Tokyo Metropolitan Government.

And these gaps tend to affect the poor, frequently in peri-urban, informal settlements, far more than the rest of the urban populations (Table 1.6). More generally, while cities have driven growth, and urban poverty is lower than rural poverty in every country in East Asia, urban poverty, and particularly inequality, is a real and potentially explosive problem. Densely populated cities can unleash new political risks and demands for government accountability, when the provision of basic services and the availability of jobs do not match popular expectations.

At the same time, infrastructure plays an enormous role in maintaining the competitiveness of East Asia's cities. Urban investment climates, and hence mass employment prospects, can depend critically on the quality of urban infrastructure.

**Table 1.6 Inequality in access to infrastructure services in urban areas**

Access to services, percent household with connection

| | | Piped water connection[a] | Sanitation | Electricity | Telephone | Access to water[b] |
|---|---|---|---|---|---|---|
| East Asia | Citywide | 65.9 | 58 | 94.4 | 57.1 | 94.8 |
| | Informal Settlements[c] | 38.3 | 7.4 | 75.7 | 25.4 | 89.1 |
| All Developing Countries | Citywide | 75.8 | 64 | 86.5 | 52.1 | 88.9 |
| | Informal Settlements[c] | 37.2 | 19.8 | 59.1 | 25.4 | 57.6 |

*Source:* UTCE/ALMEC 2004a.
*Note:* a. Refers to percentage of households with piped water connection.
b. Portable water within 200 meters of the residence and includes water connections.
c. Data on informal settlement may contain inaccuracies as sample sizes are small and measurement is uncertain.

Among these challenges: connecting cities to hinterlands and international markets through enhanced transport infrastructure, telecommunications, and logistical services. Exploiting the region's comparative advantage in high-value services and high-tech industry by providing advanced communications and just-in-time delivery—the increasing tendency for integrated production chains to spread across a number of countries in East Asia, makes this all the more important.

Creating urban clusters in which innovation thrives. Providing efficient urban transport for people to travel between home, work, school, and leisure activities. Minimizing transport congestion and emissions. Ensuring environmental health through effective and affordable water and sanitation services. Making reliable energy services available to businesses and individuals, and managing environmental impacts.

And perhaps the greatest challenge in rapidly-growing cities, making infrastructure choices before land use patterns become so established that retrofitting infrastructure becomes enormously expensive. Long-term vision, strategic planning, and coordination are at a premium in East Asia's urban areas.

Most East Asian countries have responded to pressures on infrastructure services arising from urbanization by decentralizing substantial government responsibility to the local level. This has taken many forms, depending on the economic needs, political context, and institutional traditions of the countries concerned.

But in most cases, decentralization has brought with it numerous issues. These include how to coordinate efforts across different jurisdictions and agencies; how to restructure infrastructure service providers

and how to regulate them; what the appropriate intergovernmental fiscal arrangements are; how to enhance municipal financing options; how much political autonomy different levels of government will enjoy and how accountability will work; and how to include greater participation by civil society and the private sector. These factors can profoundly shape the provision of infrastructure services.

We will take up these themes of strategic urban planning and management of infrastructure across decentralized jurisdictions in our discussion of coordination in Chapter 3.

## The rural challenge

While East Asia is rapidly urbanizing, about 60 percent (or 1.1 billion people) still live in rural areas. Moreover, East Asia's poverty is overwhelmingly rural, and rural-urban disparities—across income as well as access to services—provoke political concerns and demands for inclusion in economic development (sometimes with an ethnic minority element).[12] A number of generally fast-growing East Asian countries include large pockets of rural poverty, most notably in western China, the Central Highlands and Northern Mountains of Vietnam, Mindanao in the Philippines, Northeast Thailand (see Table 1.7), and eastern Indonesia.

Rural economies depend increasingly on urban economies—for markets, financial capital, and migrant employment. But urban economies also depend on rural economies for human capital and agricultural products. The contribution of infrastructure provision to the health of rural economies can therefore have major economic and political impacts in both rural and urban areas. For example, the provision of rural

**Table 1.7 Even in fast-growing Thailand, regional income and access to infrastructure can diverge significantly**

| | GDRP per capita (baht million) | Number of telephone lines per 1,000 people | Car ownership per 1,000 people[a] |
|---|---|---|---|
| (1) Bangkok | 228,921 | 31.6 | 348.3 |
| (2) Northeast Thailand | 25,367 | 2.16 | 34.9 |
| Ratio (1)/(2) | 9.0 | 14.6 | 10.0 |

*Source:* UTCE/ALMEC 2004a.
*Note:* GDRP = gross domestic regional product.
a. Data as of 2000, including cars, vans, and trucks.

feeder roads can allow the supply of perishable foods to high-value urban markets, and the income generated can be invested in health and education to improve the productivity of eventual migrants to the cities. Rural infrastructure is not always just for the benefit of rural populations.

But rural infrastructure is also comparatively more expensive to deliver than urban infrastructure. Policy makers are often ill-equipped to strike an appropriate balance, given limited resources. Thereafter, the challenge is how to provide infrastructure as cost-effectively as possible. This can involve making appropriate choices about technologies and service standards: decentralized solutions, such as small-scale solar or diesel generation, water pumps, septic tanks, and satellite-based telecommunications, can be preferable to network utility access. Furthermore, the external economic benefits of rural infrastructure need to be captured and channeled back into rural infrastructure financing.

There are also major challenges in reconciling those objectives with the desire to decentralize infrastructure responsibilities or to create space for community-based initiatives. Coordination between communities or local governments, or with higher levels of government, can be lacking. Decentralization, if not carefully managed, may sometimes enhance rural isolation rather than connectivity with the wider world (UTCE/ALMEC 2004b). After all, rural roads do need to connect with major highways, and common resources (such as watersheds) need to be managed in common.

## The regional challenge

Just as rural and urban economies need connection, so do countries and large provinces. Regional integration is a high priority for large swathes of East Asia and the Pacific, and has been responsible for much of the region's economic success. Growth in Japan, the newly industrializing countries, and now China has successively led to growth in the rest of the region.

Western China's poverty reduction and social stability depend on enhanced integration with coastal China, and coastal China needs to draw effectively on its rural agricultural hinterland. At the other end of the scale, Pacific island microstates could share some resources and coordinate relevant policies (indeed, because some states include literally hundreds of islands, internal integration is also an issue), and outlying islands of Indonesia and the Philippines need to be included in the benefits of national economic growth.

In between, the Greater Mekong Subregion (GMS) has great opportunities for integration of transport, water resource management, energy, and telecommunications.[13] And as China emerges as the growth engine of the region, connecting with its markets becomes a high priority. Regional integration is an economic matter of realizing economies of scale, spreading risk, and exploiting comparative advantage, but also of cementing stable relationships in postconflict situations and including ethnic minorities in mainstream society. We shall pick up these themes in our discussion of inclusive development in Chapter 2.

## The environmental story

Choices relating to many kinds of infrastructure—roads and road networks, power generation, solid-waste incineration, water supply, and sanitation—have potentially significant environmental impacts. Often these are negative.[14] (Although they may be positive too—sanitation plants, after all, can be key to reducing water pollution; some infrastructure can help encourage sustainable agricultural practices or create financially viable alternatives to exploitation of natural forests.)

High rates of economic growth and urbanization drive the environmental agenda in many countries in the region. And infrastructure, as we have seen, helps drive growth and urbanization. For many years, there was a widespread perception among policy makers in the region that environmental protection could wait, or at least take a back seat, to allow economies to grow without constraints.

However, in recent years, perceptions have started shifting, perhaps best exemplified by China's publication in 1994 of the "White Paper on China's Population, Environment, and Development in the 21st Century" (China's Agenda 21, 1994). This paper analyzed the environment as a resource whose exhaustion would constrain growth, rather than seeing environmental protection as primarily a constraint on growth. In parallel, there has been a gradually increasing focus on the quality of life, not merely on material living standards.

This shift in philosophy conditions policies relating to infrastructure and choices of infrastructure investments. Infrastructure policies and projects are increasingly judged by whether they improve the environment, or at least minimize environmental risks. Environmental priorities gaining strength in the region's agenda include improving

urban air quality, reducing emissions affecting greenhouse gases, increasing the availability of clean water and of sanitation services, and maintaining the functioning of ecosystems that provide livelihoods and other benefits.

Interventions at the project level can be important, ranging from environmental safeguards, to measures to mitigate (or compensate for) environmental risks and costs, to alternative project design, or even to alternative projects: One can deselect projects if environmental costs are likely to outweigh other positive economic impacts. One can conserve the remaining parts of affected habitats. One can decide to use small-scale hydrogeneration rather than alternative, more polluting technologies, or design urban transport to minimize car use. One can even try to avoid catastrophic flooding by protecting watersheds and their associated hydrological functions, rather than build expensive and potentially damaging downstream hardware.

But the underlying causes of environmental problems cannot be addressed at the project level. The challenge, rather, is to effectively mainstream environmental concerns within national policy-making agendas.

There are a number of tools at the policy maker's disposal: Adequate environmental legislation can be adopted, and efforts focused on building capacity related to traditional responsibilities of social and environmental agencies. Improved information and transparency can go a long way—about the magnitude and incidence of environmental damage related to infrastructure, the costs associated with infrastructure projects, their direct and underlying causes, and remedial measures. Training measures can be taken to better inform communities about environmental issues. Awareness about cost-effective technologies can be raised within infrastructure-related agencies and enterprises. (Box 1.4)

In the medium term, measures can be taken to encourage the systematic use of environmental impact assessments, not only at the project level, but at the sectoral and national level too. Environmental objectives can be costed into pricing and other policies in key sectors such as energy, water, agriculture, and transport.

Box 1.5 outlines the use of the Strategic Environmental Assessment (SEA), referred to above, using the example of urban infrastructure development in Bali, Indonesia. SEAs can identify links and trade-offs, as well as institutional responsibilities for coordinating and implementing key elements of a program.

**Box 1.4 Indications of the high cost of environmental pollution in China**

Many analyses of the environmental damage in the region are based on China's experience. There is enormous variation in the results of the many studies conducted to express this in monetary terms, but even the lowest estimates indicate significant impacts of environmental degradation on GNP.

One major study estimated that environmental damage from pollution alone cost an equivalent of 7.7 percent of GDP, when willingness-to-pay valuation methods are used, or 3.5 percent of GNP when a human capital approach is taken (World Bank 1997).

In human and physical terms, estimations of costs are equally sobering, and include the following:

- 178,000 premature deaths in major cities each year, because of air pollution that primarily is generated by the consumption of high sulfur coal.
- 6.4 million work years lost annually because of air pollution–related health damages.
- 52 urban river sections contaminated to such an extent that they are not suitable even for irrigation.
- 10 percent of land areas threatened by acid rain.
- More than 1.5 million $km^2$ affected by soil erosion, losing the equivalent of twice the national production of fertilizer.

*Source:* Warford 2004.

Fundamentally, however, the challenge of mainstreaming is a governance challenge. And the challenge is difficult indeed. Measurement of environmental risks, costs, and benefits, for instance, is fraught with uncertainty, and hence value judgments play a major role. This means that data can easily be manipulated and even corrupted. The politically powerful can exploit their influence over information dissemination and decision-making processes to exclude the interests of politically marginalized groups, who tend to be affected disproportionately by environmental degradation. The economic interests of the powerful therefore will tend to override environmental concerns, unless broader accountability, participation, and transparency mechanisms can evolve to counteract that tendency.

Perhaps more benign than political asymmetry, but nonetheless very difficult, is the sheer coordination challenge posed by mainstreaming environmental issues. For example, improving urban air quality may require a shift from individual to mass transit. This can involve

**Box 1.5 Strategic environmental assessments: The Bali urban infrastructure project**

The Bali Urban Infrastructure Project was designed to improve urban infrastructure services throughout the island of Bali, Indonesia, and included major subprojects in urban roads and traffic management, water supply and sanitation, drainage, and flood control.

Although not legally required, a Strategic Environmental Assessment (SEA) was conducted to help address the most critical environmental issues in Bali, given the threat to water catchments, forests, and cultural property posed by population growth, industrial development, and tourism. The SEA was designed to ensure that urban infrastructure development would take place in the context of, and be sensitive to, these environmental issues.

The SEA involved extensive public consultation at local levels, which led to several concrete recommendations relating to implementation of the subprojects, as well as to the selection of priorities. It included detailed recommendations for institutional capacity building required to ensure proper execution of the investment program.

The SEA produced a comprehensive environmental profile of Bali and, in particular, a set of maps defining environmental zones. Subprojects and their potential impacts were assessed in relation to the different zones. This information was indispensable to determining appropriate land uses in different zones and to helping avoid adverse environmental and social consequences of urban infrastructure development programs.

*Source:* Warford 2004.

investments in urban rail, integration with other public transport systems, coordination with residential and commercial land use plans, taxation on fuel and private vehicles, fuel efficiency and quality regulation, regulation of user charges, urban road construction and traffic management, and many other aspects.

In a different context, a hydropower development program may have a negative environmental impact on water catchments, but a positive impact on carbon emissions, because it allows reduction of coal-fired generation. This involves complex environmental trade-offs and coordination among many different actors.

More profoundly, policies with environmental impact may be deeply embedded in broader policy and institutional frameworks, and reform would be required on many fronts to make progress on an environmental issue. Reforming water prices to encourage water conservation, for example, might depend on parallel reforms in the enterprise, financial, and social sectors, as one study from China shows (Warford and Li 2002).

Finally, responsibilities for policies or programs with environmental implications will often be fragmented across many state agencies, and private sector and civil society stakeholders may be intimately involved. Environmental ministries may not have the political clout to coordinate effectively, and more powerful agencies may have other priorities. Decentralization may complicate the process, in the absence of good horizontal coordination, when externalities spill over from one jurisdiction to others (UTCE/ALMEC 2004b). Coordinating across all these dimensions challenges government capabilities in any country.

## The political story

The financial and economic challenges of delivering infrastructure on the scale required in East Asia have an important political dimension. Among the most important (and discussed) aspects of this political dimension are the ideological battle over public versus private participation in infrastructure and the interplay of ownership, regulation, financing, planning, and policy making.

In infrastructure sectors, investments often have an economic impact well beyond the revenue recouped by the service provider—that is, economic rates of return frequently exceed financial rates of return by a substantial margin. This creates an a priori case for some form of government intervention to supplement the workings of markets. At the same time, economies of scale in infrastructure can yield substantial market power over often essential—and, hence, highly politicized—services. Such market power generally induces governments to control prices tightly in infrastructure sectors to protect against abuse of consumers. This control can be effected indirectly through regulation or directly through public provision.

Where infrastructure provision is potentially private, the existence of tight price regulation creates substantial political risk. Infrastructure is typically large and immobile; massive capital costs are sunk and cannot be salvaged. After investments have been made, governments can undertake creeping expropriation of investors' assets, but those investors are likely to continue operating as long as their variable costs are covered by revenues. An investor threat to withdraw in the face of such government behavior is often not credible. In short, any bargain struck with a government to give investors rights to a revenue stream that gives an

adequate return on capital employed can obsolesce rapidly once the deal is struck.

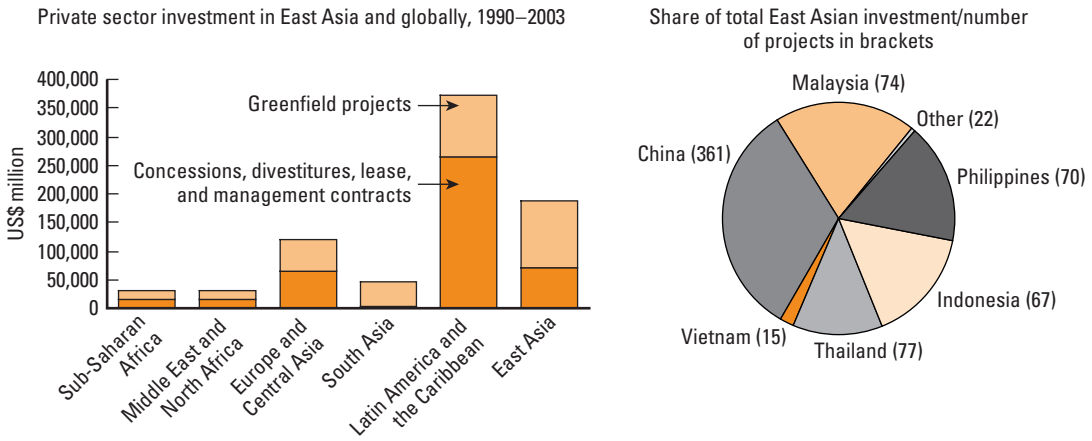
In industrial countries, private firms created a substantial portion of the initial infrastructure, but over time this led to underinvestment in the face of political risk or lack of competitive pressure, and to some abuse of market power. After World War II, an ideological shift in favor of public ownership encompassed infrastructure also, and public provision became the dominant model. This occurred within a political environment that favored centralized economic planning—often of a highly dirigiste nature. This model was subsequently exported to developing countries, many of which were newly independent and were seeking to expand their infrastructure rapidly. In many cases, this preference in developing countries for public provision of infrastructure was accentuated by a postcolonial antipathy to foreign investment, at a time in which private domestic capital for large-scale investment was almost nonexistent.

But public infrastructure performance was often below expectations. Prices were frequently kept below costs, and costs were often excessively high. Competition or other incentive mechanisms to reduce costs proved difficult to implement in the state sector, even when technological advance made it more feasible. Vested interests resisted performance improvements to retain the benefits of overstaffing or appropriation of monopoly rents for personal or political purposes. Accountability to customers or citizens for performance was generally weak. Supply-driven or corruption pressures led to white elephant investments and an inherent bias against funding maintenance. State-owned enterprises were burdened with many noncommercial objectives.

Low tariffs were often not targeted to the poor (who frequently didn't have service access anyway because of funding constraints), but instead were directed at middle-class groups with political voice. Sometimes the resulting deficits were funded from cross-subsidies, often from commercial customers (thereby effectively taxing production and employment). Sometimes they were funded by government budgets or quasi-fiscal loans from state-controlled financial institutions, often with poor repayment records. And sometimes the deficits were funded by capital consumption (lack of maintenance or capital replacement) or by reducing operations.

In the late 1970s and early 1980s, many countries started to undergo fiscal compression as a result of global recession, inflation, and commodity price shocks. This was compounded by an ideological shift in favor of

**Figure 1.8 East Asia has attracted significant levels of private sector investment in infrastructure, although largely concentrated in a small number of countries**




*Source:* World Bank PPI Database 2005.
*Note:* Other = Cambodia (15); Fiji (2); Papua New Guinea (2); Samoa (1); Solomon Islands (1); Vanuatu (1).

the private sector, and ushered in an era of fiscal conservatism and slimming down the direct economic role of government. An impetus toward private provision of infrastructure reemerged and, by the late 1980s, had spread to East Asia in a range of forms, from management contracts to transfer of ownership to the private sector. This trend accelerated in the early 1990s. Indonesia, the Philippines, Thailand, and Malaysia were initially at the forefront of this process, but China, Vietnam, and others were players also (Figure 1.8).

In many cases, private participation in infrastructure was pursued under fiscal pressure.[15] Subsidies were drying up, and infrastructure assets were seen as a potential source of public revenue if privatized. Poor performance resulting from underfunding increased public support for change. East Asia was growing rapidly, and was attracting investor interest; global costs of capital were cyclically low, appetites for emerging market risk were correspondingly high, and planning horizons generally short. Few actors had yet had bad experience—or indeed much experience at all—in private infrastructure in developing countries.

But the underlying political economy had not greatly changed. The political incentives remained for government to regulate prices tightly. In fact, years of subsidies to the middle classes had strengthened those

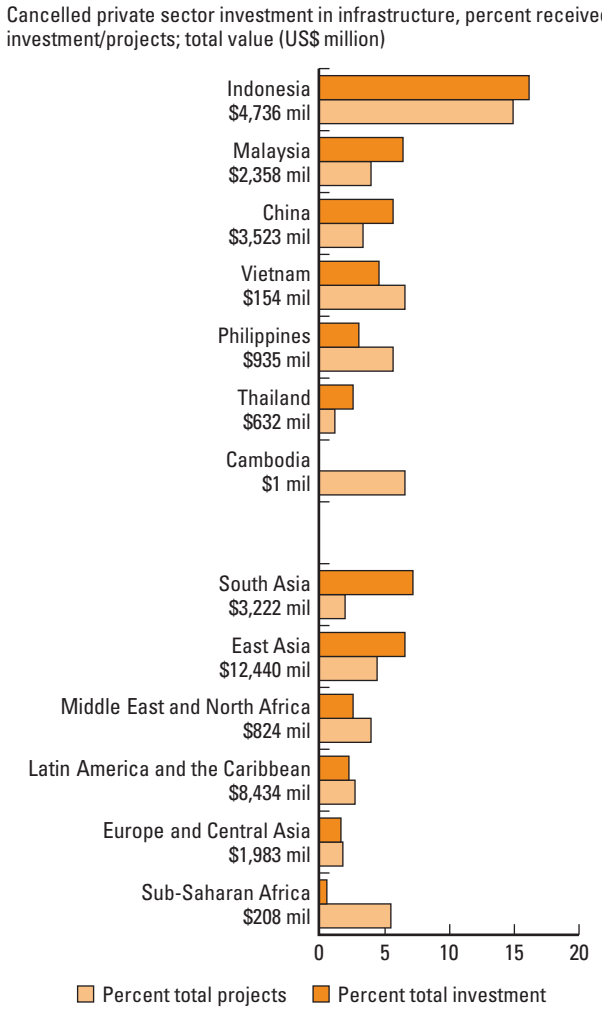
incentives. Concession contracts or regulatory frameworks may have implied cost-reflective tariffs, but, politically, realities in countries where property rights can be fragile suggested otherwise. And fiscal conservatism meant that subsidies were often not available to cover the deficits that resulted from low tariffs (or subsidies were kept off the fiscal books, which made it hard to ensure that they would be honored in times of fiscal crisis).

Firms therefore wanted to push up tariffs, while governments wanted to keep them down (that is, to have firms fund the subsidies to the middle class that governments didn't want to pay for themselves). Lack of sector restructuring to accompany private participation meant that competitive pressures to reduce costs and improve performance were often not much greater than they had been under public ownership—so cost-reflective tariffs were high and politically contentious. Some deals created perceptions of corruption and cronyism. The warning signs for private infrastructure were in place.

And then, in the late 1990s, came financial crisis in emerging markets, rapid currency declines, the bursting of the bubble in global capital markets, and sectoral crises in the wake of the Enron scandal and the end of the telecoms boom. Several East Asian countries faced economic collapse, which plunged millions into poverty. In turn, this economic crisis brought in a period of dramatic political change—a wave of democratization has since been sweeping the region.

Under these pressures, many private infrastructure deals were renegotiated (voluntarily or otherwise), damaging investor perceptions. Many were cancelled (see Figure 1.9). Tariff adjustments to offset currency depreciation were highly unattractive both politically and economically in such a period. Governments suddenly found they had underwritten more contingent off-budget support for private infrastructure than they had realized or now felt they could afford. The role of capital flight and currency speculation in the financial crisis turned public sentiment against foreign investment. In some countries, democratization brought a flourishing civil society newly vocal in its criticisms of government policies, including those on private participation, financial management, and tariff adjustments. Private investor interest declined sharply, governments became more cautious, and civil society was decidedly skeptical. For a while private investment in infrastructure was out of fashion in East Asia. Nobody—government, private sector, or civil society—wanted to take the risk.

**Figure 1.9 Levels of cancelled private sector infrastructure investment in East Asia are among the highest in the world**




*Source:* World Bank PPI Database 2005.

The economic crisis is now over, most countries have resumed high growth levels, and private investment, in general, is beginning to recover. But private investment in infrastructure is returning only very cautiously, and governments are sometimes tentative in their response.

The pendulum-swings between public and private provision of infrastructure reveal an underlying political reality: A policy and

institutional environment that is lousy for the private sector is lousy for the public sector too. Governments that have long-term economic vision and plans for the future can acknowledge the importance of efficiency incentives for infrastructure and of ensuring sustainable infrastructure financing mechanisms, regardless of ownership. Those governments will have a conception of how infrastructure makes its macroeconomic contribution, how it will be financed, how policies should be coordinated, and how institutions should be developed.

Governments that live for the short term will be tempted to deprive long-lived infrastructure assets of adequate funding, and will be reluctant to undertake risky sector reforms—again regardless of ownership. In those countries, infrastructure development will be more piecemeal, financing more ad hoc, and institutions more fragile and fragmented.

## The funding story

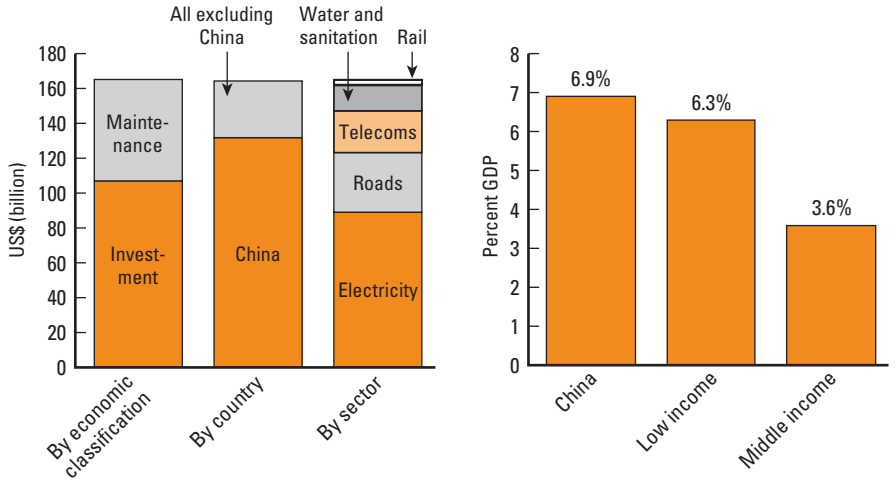
And so finally to the question of funding—that is, the scale of the resource requirement to address East Asia's infrastructure challenge, and how this requirement can be sourced. According to analysis undertaken for this study, to meet expected infrastructure service needs, East Asia would have to spend $165 billion a year over the next five years—or roughly 6.2 percent of its GDP annually—on electricity, telecommunications, water and sanitation, and major transport networks (see Figure 1.10).[16]

These estimates take into account both investment and maintenance of assets (an equally and sometimes more cost-effective way of meeting service goals). In meeting these needs, it is estimated that 65 percent of expenditure would need to take the form of new investment, with the remaining 35 percent channeled toward maintenance of existing assets.

In China alone, total needs account for almost 7 percent of GDP (and China's infrastructure needs account for 80 percent of the region's total). In low-income countries the needs are relatively greater than in middle-income ones. When other infrastructure needs are included (such as ports, airports, bridges, secondary roads, urban transport, and gas grids), the overall estimated need rises above $200 billion a year.

Moreover, these estimates do not incorporate any strategic decisions to invest in infrastructure ahead of demand, or to increase access for the poor in line with the Millennium Development Goals (MDGs) or other targets. But in East Asia, many national or local governments do indeed

**Figure 1.10 Estimated annual infrastructure need, East Asia, 2006–10**



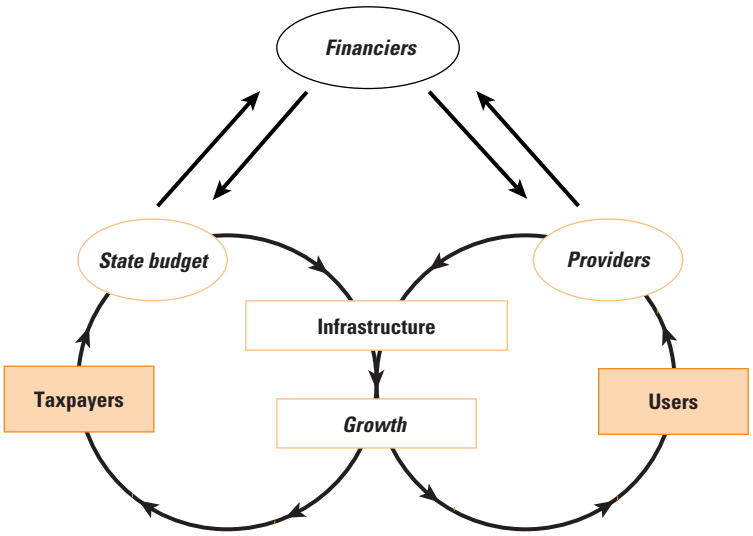

*Source:* Yepes 2004.

follow such policies: Thailand's Eastern Seaboard, Lao PDR's rural electrification, Shanghai's urban development strategy, and rural development policies in Western China are some striking examples of this approach. "Strategic" approaches to infrastructure investment can circumscribe financial discipline, and therefore bring risks of inefficiencies and corruption, but there are nonetheless plenty of regional success stories. Therefore, infrastructure needs in the region could legitimately be even higher than estimated.

## Who funds infrastructure? Taxpayers, consumers, and the role of finance

How can East Asia achieve the resources required to meet these estimated needs? Ultimately, there are only two ways in which infrastructure is funded: by consumers (via user charges) and by taxpayers (via subsidies)—as shown in Figure 1.11. Financiers—whether the private sector, or official lenders and donors—can change the requisite time profile of taxes or user charges by providing financing in the form of loans or equity, but eventually those loans need to be repaid or remunerated (or, at least, failure to do so will generally rebound to taxpayers or, subsequently, to consumers through a higher cost of capital).

**Figure 1.11 The circular flow of funds for infrastructure**




This ability to change the time profile of taxes and user charges can be very important politically—effectively allowing a smoothing of tax or tariff increases. It can also be welcomed from the point of view of competitiveness for the economy or affordability for households, permitting time to adjust to higher tariffs levels. But loans and equity per se do not generally add to the total resources available to an economy over time.[17] In effect, they unlock the potential of other resources by allowing investment to take place despite economic or political constraints—taxes and user charges remain central.

Financiers of infrastructure can source their capital from domestic savings or foreign savings. At one level, the distinction does not matter: Savings are mobile internationally and will generally seek the highest return regardless of borders. In that sense, one could argue that East Asia's high domestic savings are irrelevant to the region's financing availability. However, in reality, savings are not entirely mobile: Regulatory barriers to capital mobility exist. In part, they exist for reasons of macroeconomic stability and, in part, to allow governments to direct domestic savings into activities they deem to be of a high national priority—a common practice in East Asia. In addition, holders of domestic savings (or their intermediaries) can have lower risk assessments of investment opportunities in their

**Box 1.6 What about efficiency?**

East Asia has seen considerable amounts of investment in infrastructure in the past. And equally large amounts are likely to be spent in the future.

Delivering infrastructure services clearly requires resources. And this is why policy makers focus on expenditure levels (whether on investment or operations and maintenance).

But the same level of spending can yield very different service outcomes. Efficiency of expenditure—getting the most service out of every baht, yuan, peso, dollar, or rupiah—matters enormously.

In the framework we set out in this study, inefficiency is not a theme. It is an outcome that arises when the focus of policy is not inclusivity, when coordination is poor, when accountability is lacking, and when risks are badly managed.

When we talk about costly environmental infrastructure impacts, we are talking about inefficiency. And likewise when we consider poorly aligned spatial and sectoral planning, infrastructure retrofitting, badly funded utilities providing poor services because consumers pay too little, taxpayers subsidize too little, or both (Chapter 1).

Inefficiency also occurs when infrastructure has lower economic returns because the poor were not taken into account; when disabled access has to be funded postinvestment; when returns on infrastructure are lowered because regional coordination was not pursued; and when infrastructure did not link the right people, to the right market, at the right time (Chapter 2).

Inefficiency also occurs when infrastructure investments are not aligned with long-term development strategies; when financing is out of synch with planning; when not enough emphasis is given to maintenance of existing assets; when spillovers across municipalities are poorly managed; where different jurisdictions engage in "destructive competition"; when scarce resources are fragmented; and when vertical coordination is weak (Chapter 3).

And it also occurs when accountability breaks down, financial risks are realized, and corruption destroys value (Chapter 4).

home country than foreigners do. Those savings therefore demand lower returns at home and are more likely to be invested domestically. This makes the development of local capital markets an important component of infrastructure financing.[18] However, the returns still need to be there—financial engineering won't create them.

## When consumers fund infrastructure

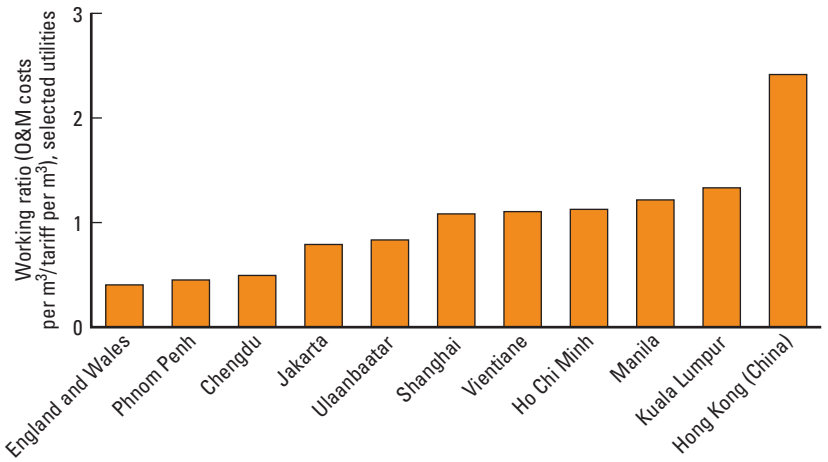
Covering infrastructure costs means charging consumers for the use of infrastructure services. At first sight, a simple proposition. But in reality, one that gives rise to a host of policy issues. How much of the costs of

infrastructure provision should consumers pay, and how much should be subsidized by taxpayers? When are users unwilling to pay, and when are they are unable to pay? Should the poor pay less than the nonpoor? Is it preferable to provide a less expensive service at a lower rate? If costs are to be subsidized, which users capture those subsidies? And when is cost recovery a matter of low tariffs, and when is it a matter of inefficient service provision leading to high costs? These are just some of the many questions, to which the answers vary by sector, country, and policy regime.

In the water sector, for instance, tariffs are insufficient to cover even operating and maintenance costs of many of the region's water utilities (Figure 1.12). Taking into account capital costs, it is unlikely that any water utilities in East Asia (and few in the world) achieve full cost recovery.[19] This is not a situation that is evident in every sector (among infrastructure sectors, water most exhibits natural monopoly characteristics, and is least amenable to competition), but it is an instructive example nonetheless.

Non-cost-reflective (average) tariffs may arise for many reasons. They may reflect the excessively high costs of inefficiently run services, which consumers cannot reasonably meet. Sometimes costs may be high for good reason (reflecting, for instance, the cost of network expansion or natural supply constraints), but nonetheless unaffordable.

**Figure 1.12 Few water utilities cover even operating and maintenance costs**




*Source:* ADB 2004b.

Sometimes tariffs remain low when there is a case for raising them for political reasons: Infrastructure assets are often long-lived, and so infrastructure providers can be starved of funds before deterioration becomes noticeable. When politicians have a short time frame, the popularity of low tariffs is more important to them than the medium-term costs.

Sometimes policy makers keep average tariffs below cost recovery levels to protect the poor. And this is where many of the key policy questions we flagged arise. In fact, when government lacks good information about where the poor live, how they access infrastructure, and the decisions they would make if they could choose among different services and price options, keeping average tariffs low may not be an unreasonable position.

Although this too has a downside: Research over the past decade has repeatedly shown that it's primarily the relatively well-off who are able to connect to utilities networks that price below cost—extending services to the poor is too expensive for the utility. This leaves the poor to provide for themselves, frequently at much higher prices. In Indonesia, for instance, one survey suggests that people unable to access the services provided by the local utility, Perusahaan Daerah Air Minum (PDAM), paid between 33 and 122 times the price per volume paid by PDAM customers (World Bank 2004a).

There is now a growing consensus that subsidies can be used to meet the needs of consumers who are too poor to pay for services. The challenge is how to design instruments that most effectively target the most needy, while trying to ensure that average tariffs are as close to cost recovery levels as possible.

There are a host of options, but they basically work in three main ways (Estache 2004): by reducing bills, through, for instance, means-tested subsidies; by reducing the cost of services by improving efficiency; and by making it easier for the poor to pay their bills. But effective targeting is difficult. It requires data that are often unavailable (Gomez-Lobo, Foster, and Halpern 2000). And of course subsidies also bring with them economic efficiency and incentive cost problems—although recent analysis suggests that, in many cases, these costs are modest (Ravallion 2003).

## When taxpayers fund infrastructure

The kind of subsidies we have been talking about frequently are transfers from taxpayers to infrastructure users. When taxpayers fund

infrastructure, a number of important microeconomic questions arise. Is the tax revenue channeled into public expenditures with the highest rates of return? Are the expenditures transparent or are there contingent liabilities that are hard to monitor? In East Asia, with its high levels of directed lending from state-controlled financial institutions and revenue guarantees to infrastructure service providers (both, in essence, quasi-fiscal subsidies), this is a hugely important question. Are subsidies designed in a cost-minimizing manner? Is there an exit strategy to phase out subsidies? Is the balance between expenditures on investment and on operations and maintenance appropriate? Subsidies also have important implications for risk management and accountability—issues we shall discuss in detail in Chapter 4.

There are also vital *macro*economic questions: Is there too much public expenditure on infrastructure, thus jeopardizing fiscal stability (and hence also the investment climate)? Or is there too little expenditure, thus endangering economic growth and poverty reduction? This has become known as the "fiscal space" debate, and has arisen primarily as the result of a decade of fiscal austerity in Latin America (as mentioned in "the macroeconomic story" above), although it is of relevance to other regions.

In East Asia, the essential question is whether there are countries that have a sufficiently robust track record on fiscal stability, but that have such low levels of expenditure (public and private) on infrastructure that future economic growth and, hence, long-term fiscal sustainability are under threat. In Figure 1.11, the Circular Flow of Funds for Infrastructure, this would be manifested in two vicious circles: first, of low public expenditure leading to low growth, and second, of low growth depressing both user charges and taxes.

Higher public expenditure on infrastructure in such countries could instead yield two virtuous circles. In those countries, a balance of more vigorous promotion of private financing, tariff adjustment where needed, and higher fiscal space for infrastructure would be appropriate. This is particularly likely for lower-income countries, and for countries recovering from crisis, where infrastructure needs are high, and attracting the private sector may be only a gradual process. The challenge for countries is to ensure that they are fiscally sound enough to embark on this course, and to determine whether they have adequate coordination to achieve the necessary balance between fiscal space and other policies.[20] We pick up this theme in Chapter 3.

**Box 1.7 So why didn't the private sector solve East Asia's infrastructure problems?**

There are a number of possible reasons as to why the private sector did not live up to expectations:

(1) The initial expectations about levels of private investment were not realistic. The majority of infrastructure investment in the majority of countries—industrial or developing—is publicly owned and operated. It would take a long time for private investment to overtake public investment let alone displace it. Not all sectors are created equal—some are more attractive to private investment than others.

(2) There was a global downturn in capital markets, generally, and in the power and telecommunications sector, in particular. However, when those markets recovered, East Asian investment turned up only slightly. Clearly, local factors were more important than global ones.

(3) East Asia undertook only limited infrastructure sector reform, and minimal privatization of existing assets (most investments were greenfield). Competition and independent regulation did not play a major role. Most private investment therefore took place within more or less the same incentives framework as had previously existed, so performance could not really be expected to change much. Lack of reform meant that many private providers had only one customer—a state enterprise. This was risky.

(4) Government often proved to be unpredictable and property rights were difficult to enforce. Judicial systems did not always help much. Bargains obsolesced once investments were sunk. Market growth helped offset these political risks to some extent, but not enough.

(5) The subsidy framework was very unclear. Infrastructure services often enjoyed hidden subsidies that were reduced quite abruptly when the private sector came in. Consequent tariff increases created political backlashes against the private sector (particularly foreign investment). Sometimes tariffs increases came early, service improvements only later.

(6) However, some hidden subsidies remained, particularly in the form of guarantees where the state was the sole customer for the private provider (these guarantees usually went unrecognized in fiscal accounts). The 1997 crisis caused many of those guarantees to be called up: As a result, governments either faced unexpected fiscal pressure or reneged on guarantees. This discredited the concept of private investment.

(7) Contractual agreements with the private sector were not crisis-proof. Although currency crises can be expected to occur some time during the long life of an infrastructure asset, few contracts anticipated that eventuality.

(8) Too many private sector deals were tainted with corruption allegations. Few people made a comparison between the alleged corruption in those private sector deals and the corruption in public sector projects.

(Continued on the next page)

**Box 1.7 (Continued)**

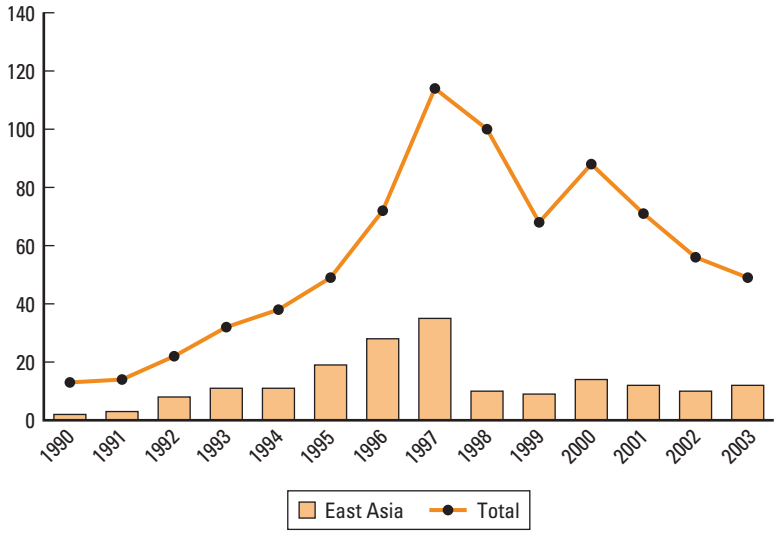
(9) Determining how best to allocate risk between public and private sectors in infrastructure is an experimental process. What is initially seen as outright failure, can be seen as a learning experience after the dust has settled. And life can then move on.

## When the private sector finances infrastructure

As for private financing of infrastructure, developments in East Asia have to be viewed against global trends. Private investors have invested approximately $190 billion in East Asian infrastructure since 1990.[21] But even at its mid-1990's peak, this represented only a minor share of total infrastructure investment in the developing world (20 to 25 percent) as well as in much of the industrial world.[22] And the private investment bubble of the mid-1990s has now burst throughout the developing world.[23]

However, annual private infrastructure investment levels in developing countries as a whole were still about 50 percent higher in 2001–03 than in 1990–95, while in the region they were roughly the same over those two periods (see Figure 1.13 and World Bank 2004f). In short, the

**Figure 1.13 Private sector investment in infrastructure (US$ billion)**

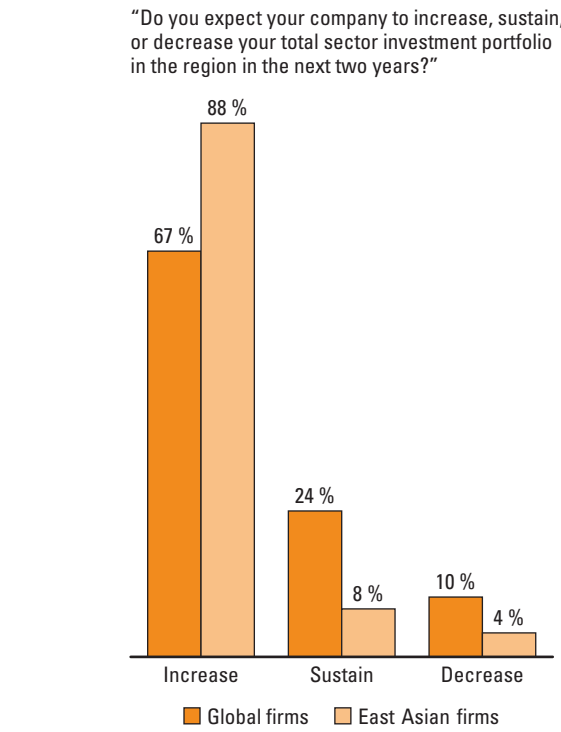



*Source:* World Bank PPI Database 2005.

current levels of actual new direct investment in East Asia appear to have stabilized at the levels of about 10 years ago, lagging behind the global average. Private investment appears to finance only about 5 percent of the region's total investment needs today, compared with perhaps 20 percent at its peak. Clearly these trends are partly an issue of movements in global capital markets, and partly a matter of the investment climate for infrastructure in the region.

A survey undertaken for this study shows very positive sentiment among potential private investors in East Asian infrastructure. But this sentiment varies by country and sector, and is contingent on policy improvements to reduce risk (see Figure 1.14).[24] East Asian investors are somewhat more optimistic than investors from outside the region, but a large majority of those surveyed—both in East Asia and the rest of the world—plan to "wait and see" whatever their origin.

**Figure 1.14 Private sector intentions to invest in East Asian infrastructure**




*Source: East Asia and Pacific Private Investors in Infrastructure Perception Survey* 2004.

Much needs to be done on the policy and institutional front to mitigate risks for the private sector—but most of the work needs to be done for the public sector too. In essence, the core issues are not public versus private, but about how they can share the risk and rewards in a way that works for both sides, and how the public sector harnesses the efficiency gains that the private sector can bring. The sources of funding and ownership are secondary.

## When official lenders and donors finance infrastructure

And so to the role of official lenders and donors.[25] In purely monetary terms official development assistance (ODA) has never been more than a small portion of infrastructure financing needs. ODA and official aid accounts for approximately 1 percent of gross investment in low- and middle-income countries of East Asia, although these flows are more important in some countries than in others (see Table 1.8).[26]

In the mid-1990s some official lenders and donors reduced their financing of infrastructure on expectations of greater private investment, and because of a view by some that other sectors had more direct impact on poverty reduction. Official financing also fell temporarily in the aftermath of the 1997 financial crisis due to creditworthiness concerns.

Official financing of infrastructure in the region is on the rise again. The contribution of infrastructure to poverty reduction—indeed of growth to poverty reduction—has been reappraised. The depth of the policy and institutional challenge in infrastructure, and the long-term nature of reform, are now better appreciated. The emphasis has shifted away from the private sector's potential replacement of the public sector, toward a relationship of mutual support and partnership between private and public actors. And so official lenders and donors are repositioning themselves, and infrastructure now has a higher profile in the development community at large.

In most infrastructure sectors, there are activities in which private sector financing can help unlock resources. But there are others in which private sector interest is likely to be limited, in which private sector participation is more difficult to structure, or in which the private participation cannot demonstrate additional value. This includes most rural infrastructure, except where smart subsidies can be brought to bear; infrastructure with strong natural monopoly characteristics, like high-voltage transmission lines; most roads, except where traffic

**Table 1.8 Aid dependency in East Asia and the Pacific, 2003**

| | Per capita income ($) | Aid[a] per capita ($) | Aid as percentage of | |
|---|---|---|---|---|
| | | | GNI | Gross fixed investment |
| Malaysia | 3,880 | 4 | 0.1 | 0.5 |
| Thailand | 2,190 | −16 | −0.7 | −2.7 |
| China | 1,100 | 1 | 0.1 | 0.2 |
| Philippines | 1,080 | 9 | 0.9 | 4.9 |
| Indonesia | 810 | 8 | 0.9 | 5.2 |
| Vietnam | 480 | 22 | 4.5 | 12.9 |
| Mongolia | 480 | 100 | 19.7 | 51.0 |
| Lao PDR | 340 | 53 | 14.3 | 69.2 |
| Cambodia | 300 | 38 | 12.5 | 54.1 |
| Palau | 6,500 | — | 19.7 | — |
| Marshall Islands | 2,710 | 1,076 | 40.6 | — |
| Tonga | 1,490 | 270 | 17.1 | — |
| Samoa | 1,440 | 186 | 12.5 | — |
| Fiji | 2,240 | 61 | 2.6 | — |
| Micronesia, Fed. Sts. of | 2,070 | 923 | 44.0 | — |
| Vanuatu | 1,180 | 154 | 11.6 | — |
| Kiribati | 860 | 191 | 21.7 | — |
| Solomon Islands | 560 | 132 | 24.4 | — |
| Papua New Guinea | 500 | 40 | 8.1 | 46.3 |
| Timor-Leste | 460 | 172 | 47.9 | — |
| East Asia Average | 1,070 | 4 | 0.4 | 0.9 |

*Source:* World Bank 2004h.
*Note:* East Asia Average includes Samoa, Cambodia, China, Fiji, Indonesia, Kiribati, Korea, Rep. of, Lao PDR, Malaysia, Marshall Islands, Micronesia, Fed. Sts. of, Mongolia, Myanmar, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Thailand, Timor-Leste, Tonga, Vanuatu and Vietnam; — = Not available.
a. Includes both official development assistance (ODA) and official aid.

volumes (and willingness to pay) are high enough to justify tolls; and even potentially competitive elements of network utilities that are rendered uncompetitive by their small scale.

In these situations official financing plays an important role in unlocking a country's own resources to meet infrastructure challenges.[27] It may also play a role in leveraging private sector finance. (Some studies suggest that official finance—in particular concessional loans—may even encourage domestic revenue mobilization.[28])

However, the role of official lenders and donors is always going to be limited in comparison with the scale of East Asia's funding needs (although relative importance may vary by country). The challenge is how to focus those relatively small amounts of official financing so that

**Box 1.8 Risk, return, and private investment in East Asian infrastructure**

Given East Asia's large markets, and significant potential returns, it is difficult to imagine that private sector interest will not eventually revive.

While it is not possible to predict when this will be, we can be fairly confident about the conditions under which this return will take place: when the financial returns to capital exceed the perceived risks.

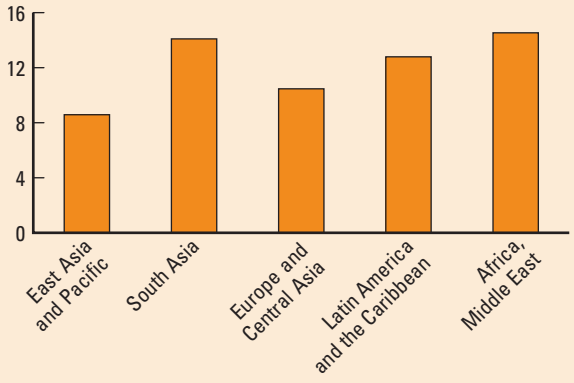
How, in this respect, does East Asia compare with other emerging and developing regions?

Evidence based on a sample of companies active in electricity, water, ports, and railways suggests that the average risk-adjusted cost of capital (CoC)—the hurdle rate faced by investors—has been significantly lower in East Asia over the period 1998–2002 than in any other region of the world (Figure 1.15).

And the same evidence suggests that East Asia is the only region in which returns on equity (RoE) are higher than the cost of equity (CoE), although just so (Figure 1.16).

One could speculate that market growth is the primary driver rather than policy reform, because East Asia has been slow to reform. But given that returns are just sufficient to compensate the CoC, policy reform could push returns high enough to lead to significant private sector investment. And with

**Figure 1.15 Cost of capital, by region, percent, 1998–2002**

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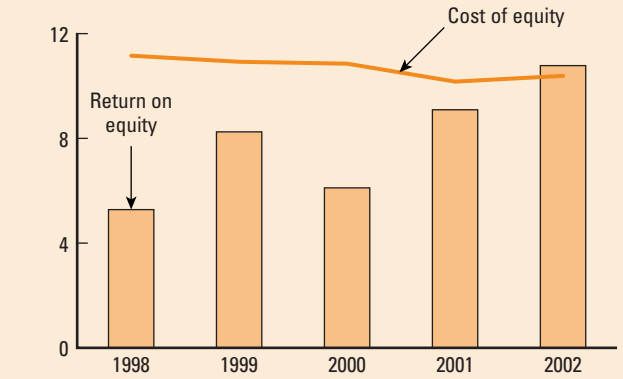
**Box 1.8 (Continued)**

**Figure 1.16 East Asia, cost of equity versus returns on equity, percent, 1998–2002**




*Source:* Estache and Pinglo 2004

huge infrastructure needs, countries in the region have every incentive to undertake those reforms.

*Source:* Estache and Pinglo 2004.

their role is maximized in a variety of efforts, including stimulating experimentation and innovation; supporting efficiency gains; mainstreaming environmental and social considerations; attracting private investors to share risks with the public sector; and building effective institutions to plan, coordinate, and regulate infrastructure services. We will pick up this topic again in Chapter 5, where we look more broadly at the role of official lenders and donors.

# Annex 1: Estimation of infrastructure needs

## Overview of methodology

Developing economies in East Asia will need to spend an estimated total of $165 billion per year between 2006–10 in certain infrastructure sectors, namely electricity, telecommunications, major paved interurban roads, rail routes, and water and sanitation (compared with an estimated $147 billion per year in 2000–05).[29] This amounts to nearly 6.2 percent of the GDP for the region, comprising 4.0 percent for investment and 2.2 percent for maintenance. Furthermore, China alone is expected to account for 80 percent of infrastructure expenditures in the region. Among the sectors, electricity in China has the largest share (44 percent) of total annual expenditure in infrastructure in the region. See Tables 1.9, 1.10, and 1.11 for detailed breakdowns.

These predictions follow the methodology used in Fay and Yepes (2003). Infrastructure stock trends are obtained from a panel data estimation of the eight East Asian countries[30] for which adequate data were available using lagged dependent variables and controlling for economic growth and economic geographic variables. Projected stocks levels were then valued at best-practice costs. Investment expenditures are calculated as the increment in stock values over time, while the annual maintenance expenditures are estimated as a fixed percentage[31] of the stock value.

Projections for 12 other countries[32] were obtained by assuming the same sector expenditure as a percentage of GDP as for those countries in

**Table 1.9 Investment and maintenance needs, East Asia, 2006–10, $ and percent GDP**

| | Investment | Maintenance ($ million) | Total | Investment | Maintenance (percent of GDP) | Total |
|---|---|---|---|---|---|---|
| Electricity | 63,446 | 25,744 | 89,190 | 2.4 | 1.0 | 3.4 |
| Telecom | 13,800 | 10,371 | 24,171 | 0.5 | 0.4 | 0.9 |
| Roads | 23,175 | 10,926 | 34,102 | 0.9 | 0.4 | 1.3 |
| Rails | 1,170 | 1,598 | 2,768 | 0.0 | 0.1 | 0.1 |
| Water | 2,571 | 5,228 | 7,799 | 0.1 | 0.2 | 0.3 |
| Sanitation | 2,887 | 4,131 | 7,017 | 0.1 | 0.2 | 0.3 |
| Total | 107,049 | 57,998 | 165,047 | 4.0 | 2.3 | 6.3 |

*Source:* Yepes 2004.

**Table 1.10 Investment and maintenance needs, China 2006–10, $ and percent GDP**

| | Investment | Maintenance ($ million) | Total | Investment | Maintenance (percent GDP) | Total |
|---|---|---|---|---|---|---|
| Electricity | 51,668 | 20,739 | 72,407 | 2.7 | 1.1 | 3.8 |
| Telecom | 11,735 | 8,232 | 19,967 | 0.6 | 0.4 | 1.0 |
| Roads | 19,345 | 7,424 | 26,769 | 1.0 | 0.4 | 1.4 |
| Rails | 963 | 1,258 | 2,221 | 0.1 | 0.1 | 0.1 |
| Water | 2,097 | 4,090 | 6,187 | 0.1 | 0.2 | 0.3 |
| Sanitation | 1,830 | 2,644 | 4,474 | 0.1 | 0.1 | 0.2 |
| Total | 87,638 | 44,387 | 132,025 | 4.6 | 2.3 | 6.8 |

*Source:* Yepes 2004.

**Table 1.11 Investment and maintenance needs, East Asia excluding China, 2006–10, $ and percent GDP**

| | Investment | Maintenance ($ million) | Total | Investment | Maintenance (percent GDP) | Total |
|---|---|---|---|---|---|---|
| Electricity | 11,778 | 5,005 | 16,783 | 1.6 | 0.7 | 2.3 |
| Telecom | 2,065 | 2,139 | 4,204 | 0.3 | 0.3 | 0.6 |
| Roads | 3,830 | 3,503 | 7,333 | 0.5 | 0.5 | 1.0 |
| Rails | 207 | 341 | 547 | 0.0 | 0.0 | 0.1 |
| Water | 474 | 1,138 | 1,612 | 0.1 | 0.2 | 0.2 |
| Sanitation | 1,057 | 1,486 | 2,544 | 0.1 | 0.2 | 0.3 |
| Total | 19,411 | 13,612 | 33,023 | 2.6 | 1.9 | 4.5 |

*Source:* Yepes 2004.

# Annex 1: Estimation of infrastructure needs

## Overview of methodology

Developing economies in East Asia will need to spend an estimated total of $165 billion per year between 2006–10 in certain infrastructure sectors, namely electricity, telecommunications, major paved interurban roads, rail routes, and water and sanitation (compared with an estimated $147 billion per year in 2000–05).[29] This amounts to nearly 6.2 percent of the GDP for the region, comprising 4.0 percent for investment and 2.2 percent for maintenance. Furthermore, China alone is expected to

## Methodology by sector

**Electricity** Estimates for electricity include power generation capacity and associated networks for transmission and distribution. A model is used to project kilowatts of generation capacity per capita based on a dataset in five-year blocks covering 1960–2000. Physical stock is then valued at $1,000 per kilowatt of plant generation capacity plus $900 for the associated transmission and distribution networks (based on IEA 2003, which estimates that investment in generation in developing countries will account for about half of the total investments in the sector).

Generation capacity is a supply indicator and our estimations work with the assumption that governments provide it based on planned demand to avoid recurrent outages.

**Telecommunications** Estimates of infrastructure investment needed in East Asia are also strongly driven by demand from the telecom sector. This is expected to be the result of a rapidly expanding mobile market, which is already the biggest in the world. In China, the penetration rate for mobile phones is already up to 170 lines per 1,000 people in 2003 compared with 18 lines in 2000. For the region as a whole, there were approximately 230 million mobile phone users in 2003, and market analysts estimate the market to be growing at 4 million per month. Furthermore, unmet demand for landlines remains quite high in East Asia. The waiting period for telephone connections is more than 10 years in the Philippines, and about 2.6 years in Indonesia in 1993. Together these two factors—that is, growth in cellular phone usage and existing unmet demand—will contribute to a significant demand for investment.

Unit costs for telecommunications are particularly difficult to project given the high rate of technological progress in the sector. The cost projections are taken from Pyramid (see Ure 2004 and Yepes 2004) and World Bank sector specialists, but they are subject to a considerable margin of error.

**Roads and rails** Estimations for the stock of roads (and the investment required to maintain and add to the stock) refer to the paved networks, taking into consideration expressways and first- and second-class roads. These results do not include urban and county networks, and unpaved roads. Paved roads were divided into land area to capture country size differentials (the same has been done for all other sectors

by dividing the stock by population). Roads as well as rails used five-year data blocks.

The unit cost for roads is the average of paving-type interventions available for the region in the Road Costs Knowledge System (ROCKS) database. The Chinese National Trunk Highway System, to be completed in 2007, was accounted for at an implicit unit cost of $150 billion for 35,000 km. The figures assume the level of highways in China to continue growing at the same rate after 2007.

Other transportation subsectors were not included because of a lack of historic information. Data on waterways—including any ocean or inter-island shipping routes, ports, or airports—are hardly available for this period and not likely to depend on the determinants that we use to project infrastructure stocks.

**Water and sanitation** Lack of historic and consistent information across countries is one of the main hurdles in water and sanitation analysis, because of considerable heterogeneity in supply mechanisms across countries. Even the definition of what is acceptable access to water or sanitation is fraught with differences. This report uses definitions currently used in the World Development Indicators. The definitions are as follows:

- Access to an improved water source refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 liters per person per day from a source within one kilometer of the dwelling.
- Access to improved sanitation facilities refers to the percentage of the population with at least adequate excreta disposal facilities (private or shared, but not public) that can effectively prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained.

Comparable data for access water and sanitation are available only for 1990 and 2000. We estimate a random coefficients panel data model for

those two years using 139 middle- and low-income countries across the world.

Multiplying projected access rates by projected number of households yields estimates for stock of connections available for each period in time. The estimated stock has then been valued at best-practice unit cost to yield sector stocks values that provide the basis to calculate the variation (investment need) and depreciation (maintenance need).