Chapter 3

Harnessing the Benefits of Regional Infrastructure

3. Harnessing the Benefits of Regional Infrastructure

Volumes of evidence attest to the economic benefits of infrastructure in general.[29] It boosts growth, improves access to basic services and economic opportunities, and helps reduce poverty. At its best, infrastructure investment can spark a cycle of poverty reduction, improved service provision, and economic growth that sets the economy on a dynamic new development path.

Given that much national infrastructure has a regional impact and that regional infrastructure can be expected to have many of the same benefits as domestic connective infrastructure, it is worth summarizing some of this evidence. Calderon and Serven (2004) showed that the marginal productivity of telecommunications, transport, and power infrastructure significantly exceeded that of non-infrastructure capital in a sample of 100 countries. They also determined that a large proportion of Latin America's economic underperformance relative to East Asia in the 1980s and 1990s could be traced to the fall-off in its infrastructure investment. Hulten (1996) found that the effective use of infrastructure explained a quarter of the growth differential between Africa and East Asia, and more than 40% of that between low-growth and high-growth countries more generally.[30] Many studies have concluded that transport, electricity, gas, water, and communication facilities have a significant positive effect on economic growth.[31]

[29] Aschauer's (1989) seminal work on the relationship between public investment and economic growth has sparked a vast body of literature on the economic impact of infrastructure investment. But this has focused mainly on domestic infrastructure spending (Straub et al. 2008).

[30] See also Esfahani and Ramírez (2003), Estache (2005), and Rickards (2008) for growth impacts.

[31] For instance, Barnes and Binswanger (1986), Binswanger et al. (1989), Datt and Ravallion (1998), Elhance and Lakshamanan (1988), and Sahoo and Sexena (1999).

The impact on poverty is equally striking. Several broad studies show that better infrastructure, especially road transport and electricity, significantly reduced poverty in developing Asian countries.[32] Better access to roads and sanitation reduces income inequality, lowering Gini coefficients by between 0.05 and 0.13 (Calderon and Serven 2004). In Thailand, around 40% of survey respondents associated electricity with increases in income (Chatterjee et al. 2004). In India, poverty rates were lowest for households near good roads and with electricity, and highest for households with neither (ADB 2004). In the Lao PDR, all-weather road access lowered the incidence of poverty by around 6 percentage points (Warr 2005). Providing dry-season roads to villages that previously lacked road access is particularly pro-poor (Menon and Warr 2008). In Viet Nam, poor households living in rural communities with paved roads had a 67% higher probability of escaping poverty than those in communities without paved roads (Glewwe et al. 2002).

Infrastructure investment gives poor people and underdeveloped areas better access to markets and economic opportunities (Smith et al. 2001). It can also improve access to education and healthcare. Studies have found that improved transport increases school attendance (Levy 2004), and that access to electricity improves school performance by allowing more study time (Kulkarni et al. 2007). In Indonesia, 64% of women who lived near a paved road received antenatal care by a medically trained midwife, compared with 38% of those living near a nonpaved road (Ishimori 2003).

Infrastructure investment has been a significant part of the region's development strategy (Kuroda et al. 2008). Yet studies on the impact of regional infrastructure are scarce. Measuring the broader benefits of connecting national infrastructure networks together is particularly tricky. This chapter attempts to do so. It starts by examining the theoretical rationale for regional infrastructure. It then sets out evidence on the impacts of regional infrastructure projects on economic welfare and poverty. It also considers their potential negative social and economic impacts. It then presents three detailed case studies of the impacts of regional projects in Central, South, and Southeast Asia. It concludes by estimating the benefits to Asia and the world arising from

32 See, for instance, Datt and Ravallion (1998) and Fan and Zhang (2004).

pan-Asian connectivity through required infrastructure investment across the entire region.

3.1. Economics of Infrastructure Network

Economic theory suggests that infrastructure investment and development are strongly correlated. Connective infrastructure can reduce the economic distance between locations—the time and cost of trading between them—and thus expand and link markets. This enables firms to reap economies of scale, permits greater specialization in production, and allows a finer division of labor. In other words, it promotes development through regional (and global) integration. Areas of dense economic interaction also bring improved learning opportunities and greater knowledge spillovers. Creating and improving infrastructure networks can thus boost an economy's rate of innovation and technological advancement, lifting long-term growth (Straub et al. 2008).

Network Externalities

The main economic benefit of regional infrastructure derives from network externalities. These occur when the value of a product or system to any user rises as the number of other users increases. For instance, the more people who have a telephone, the more valuable having a telephone is. Network industries—which include telecommunications, computing, electricity, and transport—are pivotal to the economy. Their integration can generate huge economies of scale and substantial technical innovation (Economides 1998).

Network externalities can occur directly or indirectly. Direct effects arise when increasing the size of a network expands the number of economic agents with whom direct interaction becomes possible—for example, a road's value to a distribution facility increases with the number of businesses located along it. Indirect benefits exist when increasing the size of a network expands the range of complementary products and services available to its members. These are prevalent in communications, transport, and energy. For example, as a cable network's subscriber base increases, it may become profitable to offer a wider range of television channels, or broadband internet. Likewise, as the number of users connected to a power grid increases, it becomes profitable to sell a wider range of consumer products that require electricity, such as electric lamps and refrigerators.

Network externalities are prevalent in infrastructure in developing countries. In a study using panel data from 50 countries between 1960 and 1995, Hurlin (2006) found strong network effects.[33] When a country's infrastructure stock was very low, investment in the sector was found to be as productive as non-infrastructure investment. Once a minimum network was achieved, however, the marginal productivity of infrastructure investment was generally greater than that of other investments. The road sector showed particularly strong network effects. Importantly, the impact of infrastructure investment on productivity depends more on the size of a country's infrastructure network than on its level of development. This means that even poor countries can reap network productivity gains—and that connecting countries' networks together is particularly beneficial.

Network effects provide a strong rationale for infrastructure investment in general, and for regional infrastructure in particular. But regional infrastructure is a public good that is likely to be undersupplied unless governments act together to help provide it.

Infrastructure as Club Goods

Public goods are goods and services that are nonexcludable—once provided they are available to all, and nonpayers cannot be excluded from their use—and nonrival: their use by some does not reduce the supply for others. If exclusive rights to a product or service cannot be secured, there is little incentive for the private sector to provide them, and so government has to step in. Various types of public goods exist, depending on the degree of rivalry and excludability. Most transport and energy networks are considered "club goods," because access to

[33] Sample size and time period varied depending on sector.

them can be regulated—for instance, through highway tolls—but an extra car on the road does not necessarily diminish others' ability to drive on it by a corresponding amount, or even at all. Moreover, the quantity and quality of a club good provided depends on the efforts of the weakest individual member(s); for instance, the value of a regional logistics network is determined by its weakest link.

This gives rise to a free rider problem. If, for instance, all the members of the GMS except the Lao PDR were to upgrade their national road networks and cross-border connections, the Lao PDR would benefit too, without making any effort. At the same time, the Lao PDR's nonparticipation would prevent the rest of the GMS from reaping the full benefits of an improved and integrated road network; trade within the region would either have to transit slowly and more expensively through the Lao PDR or bypass it altogether. But in that case, other GMS members might question the value of investing in a regional road network, and the end results could be that everyone tries to free-ride, no network is built, and everyone misses out on its potential benefits. The challenge for regional cooperation, therefore, is to reduce the costs of collective action, find a way of sharing the costs of providing the club good in a broadly acceptable and equitable manner, and thus enable all members of the regional club to benefit from the collective gains of improved regional infrastructure networks.

Until recently, public goods theory paid no attention to transnational or network dimensions (Tanzi 2005a). However, the rise of regional entities—such as ASEAN, GMS, North American Free Trade Agreement (NAFTA), and European Union (EU)—has highlighted the need to provide public goods whose benefits are regional in scope. These remain undersupplied in the developing world, because individual governments lack sufficient means to provide them, and international organizations have until recently not provided support for them (Sandler 2004).

Club theory provides a means of conceptualizing a regional approach to providing public goods. It suggests that any collective endeavor must be self-sustaining and provide a large enough pool of net benefits so that it makes each of its members better off. A club's success or failure depends on whether the benefits of members acting together exceed the costs of collective action. Thus, for instance, neighboring governments that are antagonistic may fail to develop common hydroelectric resources even though they would each benefit economically from doing so. Conversely, a regional or subregional institution can greatly reduce the costs of collective action, to the benefit of all its members, particularly if they feel that they have shared interests and even elements of a common identity. However, larger groups may find it harder to agree among themselves, so that it may be preferable to start by creating subregional clubs and gradually extend cooperation among these.

ADB has recognized the benefits of a regional strategy for infrastructure development through its subregional programs in South, Southeast, and Central Asia. It has identified projects that seek to develop networks and take advantage of the agglomeration forces and spillover benefits described above. These subregional programs provide the institutional structure needed to realize the benefits of these regional public goods. Tables A5.4–A5.8 in the Appendix list major projects in each subregional program in Asia.

Economic Geography and Agglomeration

Infrastructure networks affect the economic geography of a region by where activity is located and the pattern of trade across a location. A region can be conceived of as a set of gateways and hubs, multimodal corridors and integrated networks that often cut across politically determined national borders. Hub-and-spoke networks encourage economic activity to concentrate in hubs, because firms that are centrally located face lower transport costs than those that are in the spokes (Estache and Fay 2007). To maximize its effectiveness, infrastructure investment should seek to enable goods, services, information, and people to move seamlessly along the spokes while fully integrating them with the hubs. An integrated region needs to increase the efficiency of its spokes so as to reduce the cost of trading within it and thus reap economies of scale.

Such integration can strengthen a region's global competitiveness by creating reliable and secure connections between main urban gateways, enabling capital and labor to move efficiently between them (Rimmer and Dick 2008). But effective integration requires institutional support in order for gateways and multimodal corridors to enhance trade competitiveness and develop a regional network. True integration relies on a systems-based approach that rises above individual industries and economies and tackles infrastructure, policy, governance, and operational issues in an integrated policy framework (Kuroda et al. 2008).

The choice of where to locate infrastructure to serve a certain geographical area has important implications. Inevitably, some locations will benefit more than others—and that, in turn, will influence the pattern of migration, the establishment of new firms, the location of other capital investments, and so on. In order to maximize the gains from infrastructure investment, it is important to understand how patterns of economic activity may arise. Such activity tends to concentrate in certain areas, not just because of physical or geographical attributes—for instance, proximity to a natural harbor—but also because of economic forces of agglomeration, which in turn may be affected by policy interventions and the accumulation of infrastructure capital.

Firms tend to locate near each other, because this enables them to reap economies of scale. These may be internal or external to the firm. Internal scale economies arise either from demand effects—for instance, firms congregate in regions with bigger markets so as to be able to serve more customers—or from supply effects, for example, by locating near each other, firms' aggregate purchases may bid down input prices. External scale economies arise from positive spillovers among firms locating near each other. For instance, firms may learn from each other or may benefit from a deeper pool of skilled workers.

While these agglomeration effects tend to concentrate economic activity, countervailing dispersion forces tend to scatter it more widely. For example, a concentration of economic activity will tend to bid up the price of land, giving firms an incentive to move to cheaper locations. If workers are not perfectly mobile, it will also tend to bid up local wages, again encouraging firms to relocate to areas where labor is cheaper. Negative externalities such as congestion and pollution will accentuate these forces. And the pull of demand from other markets will also offset the attractions of agglomeration.

Transport costs often determine how the forces of agglomeration and dispersion shape the economic landscape (Krugman 1993). Infrastructure improvements that reduce the time and cost of connectivity encourage not only greater agglomeration in some areas but also a wider dispersion of economic activity, and thus increase total economic activity in a region. Economic activity tends to expand across many new smaller nodes rather than in a few large existing ones.

Improvements in transport free up the movement of resources. As goods and people move across borders more easily, the region can make full use of neighboring countries' diverse resource endowments and realize greater scale economies from agglomeration. Entrepreneurs can exploit new opportunities and combine resources with varying competitive advantage across borders. While it is still early to measure precisely the extent of agglomeration effects attributable to specific projects within ADB's subregional programs, developments at border areas are clearly at least partly associated with improvements in cross-border infrastructure. For example, the garment industry is flourishing in Poipet, on the border between Thailand and Cambodia, and likewise at the Thailand-Myanmar border at the western end of the East-West Economic Corridor (EWEC). Labor-intensive industries are multiplying in the Mae Sot District of Tak Province, where Thai garment firms employ many workers from Myanmar (Kudo 2007).

Modern theory and practical experience concur: prospects for development are improved when markets and government action stretch beyond the confines of a single country. The benefits of infrastructure projects, such as railways and power grids, not only extend beyond national boundaries but are enhanced across networks. The larger cross-border externalities are, the stronger the economic case for regional cooperation and coordination in infrastructure provision.

Network externalities ensure that all countries in the region benefit from these infrastructure projects.

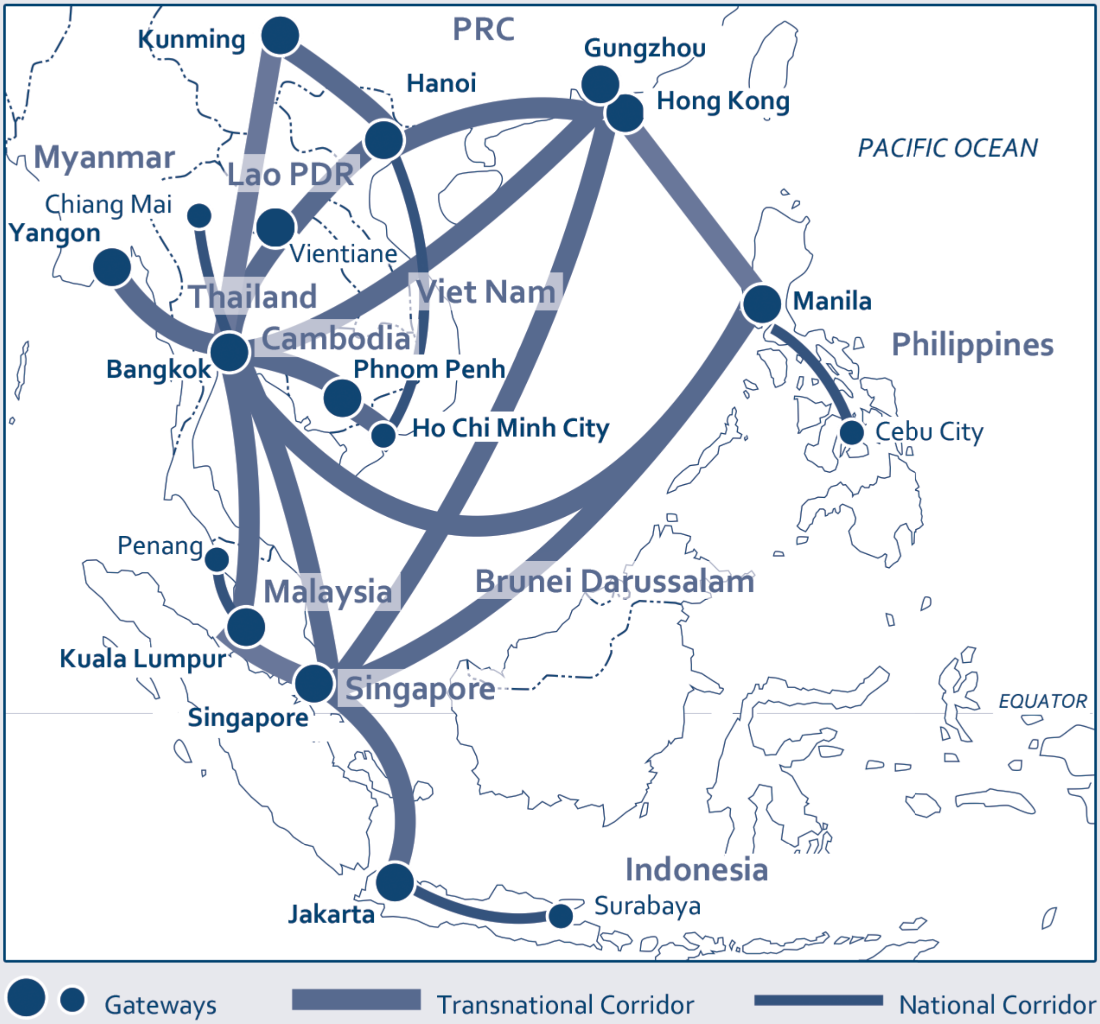
Economic Corridors

In practice, the benefits of regional infrastructure are often realized through the creation of cross-border economic corridors—improved transport connections between centers of economic activity that reduce the cost of moving and trading along them and promote development around them. These encourage trade, investment, and other economic opportunities, and can thus help reduce poverty, support the development of rural and border areas, increase the earnings of low-income groups, and promote tourism (ADB 2005d). The development of such corridors involves systematic and coordinated planning, and policy and institutional changes. In effect, they extend the scope of cross-border cooperation beyond the provision of collective infrastructure projects to seek to promote economic activities around them and to improve soft infrastructure, such as reducing delays at border crossing points (ADB 2006d). The best example of this in Asia is the ongoing economic corridors program within the GMS.

Economic corridors are a concrete way for policymakers to reap the network benefits of regional infrastructure. These are important not only for trade but also for shaping the economic geography of a region. Transport corridors attract many other economic activities, which can produce a chain reaction of increasing returns and broader economic development (Venables 2007). Figure 3.1 shows the major corridors in Southeast Asia.

The role of economic corridors varies. While all seek to promote efficient trade, they often also have broader economic goals. Some seek to promote economic activity along the corridor itself, while others aim to increase it at the international gateway at the end of the corridor. A corridor may also provide an international gateway for one or more landlocked countries that would otherwise have to conduct trade with countries beyond their immediate neighbors through intermediaries.

Figure 3.1. Gateways and Multimodal Corridors in Southeast Asia



Lao PDR = Lao People's Democratic Republic; PRC = People's Republic of China.
Source: Adapted from map by Rimmer and Dick (2008).

Corridors are often part of a broader effort to promote or expand an economic union. Closer integration was the rationale underlying the development of the corridors in the GMS, while the extension of the Trans-European Network (TEN) (explained in Chapter 4) transit network to Eastern Europe sought to support the EU's eastward enlargement (Tanzi 2008). Finally, some corridors exist solely to facilitate trade among countries by linking existing agreements or arrangements (Arnold 2006).[34] Efforts to create the AH have also followed this incremental approach.

3.2. Empirical Evidence

Marshaling empirical evidence on the impacts of regional infrastructure projects is difficult. Data are often inadequate or unavailable. This is a major concern, given the commitments to infrastructure formalized in the United Nations Millennium Development Goals. Policy-relevant research and reliable information are urgently needed (Estache and Fay 2007). In the case of transport, the flaws are glaring. It is known that road density in the poorest developing countries is around a third of that in the richest ones and around a sixth of that in developed countries, but these data do not capture the quality of the infrastructure: the same weight is given to a one-lane rural road as to a 12-lane ring road. This makes it hard to gauge the economic and social benefits of road improvements.

In the case of energy, most of the information on access rates is based on extrapolations from a small sample of representative countries. The last time comparative data were collected by the IEA was in 2000. Household surveys provide additional information, but there are major gaps as well as compatibility issues. Information on prices and quality in the sector depends on heroic assumptions, making it difficult to generate comparable cross-country data sets (Straub 2008). Monitoring infrastructure services may be difficult, but it is regrettable that information on changes in their affordability and quality is unavailable for most developing countries, even though these are vital dimensions of progress in reducing poverty.

[34] Such is the case for some land routes in the Middle East, including those from the eastern Mediterranean to Iraq, from Iran up through the Central Asian republics, and from Jordan through to Syria and Iraq.

A recent study on the impact of road upgrading and improvement under the AH network on overland trade expansion found that if required investment is made to the selected roads (totaling 15,842 km), total intraregional trade in 18 of 32 member countries of the AH network would increase by 35%, or equivalent to $89.5 billion annually (Parpiev and Sodikov 2008).

Studies of infrastructure projects in the GMS have found impressive benefits. The Phnom Penh to Ho Chi Minh City highway project was found to reduce the average time required to reach local healthcare services by around 30%, while travel times to schools and markets fell by around 40% (Phyrum et al. 2007). In the case of the EWEC project, travel time from the Lao PDR-Viet Nam border of Densavanh to Khanthabouly on Road 9 was reduced from around 12 hours in 2001 to 2.5–3 hours (Rattanatay 2007). After the completion of the Lao PDR road section in the North-South Economic Corridor (NSEC), travel time from Bangkok to Kunming was slashed from 78 hours in 2000 to 51 hours in 2006, and it is projected to be cut to 30 hours by 2015 (Banomyong 2007). Correspondingly, the cost of transporting one ton of rubber products from Bangkok to Kunming fell from $563 in 2000 to $392 in 2006, and is projected to decline to $210 by 2015 (Banomyong 2007: 12).

Reduced transport times generate larger traffic volumes. After the completion of the Champasak road improvement project, traffic volumes on the route grew at an average annual rate of 22% (growth of 5–7.5% had previously been projected). The number of passenger buses along the EWEC in the Lao PDR rose from around 600 in 2000 to around 1,560 in 2005, while the number of freight operators doubled over the same period (Rattanatay 2007). Traffic volume on the route of the Almaty-Bishkek regional road rehabilitation project in Central Asia grew by 25% after 2007 (ADB 2008g). This increased traffic enhanced the availability of labor, customers, alternative technologies, and other stimuli for economic development.

Some of the increased traffic stems from the rising number of visitors and tourists in the region. The number of tourists visiting the Lao PDR's Champasak Province rose 128% between 1998 and 2004, partly due to the Champasak road improvement project (ADB 2008g). The number of visitors (including tourists) crossing the Cambodia-Viet Nam border at Bavet-Moc Bai rose by an average of around 53% a year between 2003 and 2006, while the number of vehicles crossing the border rose by 38% a year (ADB 2008g). In the Lao PDR's Savannakhet Province, the number of tourist arrivals rose from 90,910 in 1999 to 222,063 in 2006. Following the opening of the second Mekong international bridge, the number of tourist arrivals increased by 8% in the first 2 months of 2007 alone. Most such tourism involves regional tours covering the Lao PDR, Thailand, and Viet Nam (Rattanatay 2007).

Much of the increased traffic is eventually expected to come from an expansion of regional trade. Trade between Cambodia and southern Viet Nam along the Southern Economic Corridor increased by around 40% a year between 2003 and 2006 (ADB 2008d). In Savannakhet Province, the Lao PDR's transit province along the EWEC, exports increased by 24 times and imports by 39 times between 2001 and 2005 (Rattanatay 2007).

In a broader study to analyze the determinants of regional trade and FDI flows in GMS countries in a Gravity model framework, Edmonds and Fujimura (2008) found that cross-border road development (expressed in road density) has had a distinctly positive impact on regional trade flows, controlling for other factors.

Improved cross-border transport infrastructure induces investments in new economic activities. In anticipation of closer economic links between Viet Nam and Cambodia, industrial districts such as the Trang Bang Industrial Park are developing on the Vietnamese side of the border along the Southern Economic Corridor, generating jobs for the local population (ADB 2008d). As discussed in the previous chapter, FDI is attracted to places where transport costs are low and resource complementarities are high. The value of FDI and joint ventures in Savannakhet Province increased from $96 million in 1995–2000 to $250 million in 2001–2005. More than half of these FDI projects were in agriculture, providing work for villagers in activities such as silk and cotton production, weaving, and handicrafts (Rattanatay 2007).

Phyrum et al. (2007) found that around 46% percent of households in the area around the Champasak road improvement project increased their agricultural output for sale at local markets, significantly increasing incomes. More than 70% of field survey respondents in the Southern Economic Corridor stated that their living standards had improved as a result of the project (Phyrum et al. 2007).

By increasing their mobility, infrastructure also increases poor people's employment opportunities. For example, many workers from Saravan Province of the Lao PDR, which is not even on the direct East-West Corridor route, work in Cambodia and Thailand (ADB 2006d). There is also evidence that such mobility improves labor standards. Cross-border workers in the GMS reported improved working conditions in 2001–2005, as border crossings eased and wage levels improved (Singh and Mitra 2006).

The benefits of energy cooperation in the GMS are particularly large, as Box 3.1 explains.

Box 3.1. Estimating the Benefits of Energy Cooperation in the GMS

ADB has worked with the GMS countries to draft a regional energy strategy. A model known as MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) was used to estimate the optimal supply pattern to meet the growing energy needs of the GMS. This is a system engineering optimization model used for medium- to long-term energy planning. It identifies the flow of energy from primary sources to estimated energy demands. It also sets out the investment choices required to provide the least-cost energy supply mix to meet a given energy demand. Demand is based on population and economic growth projections. Costs include investment costs (fixed and variable), operation and maintenance, fuel, and environmental costs. These are based on assumptions about the specific costs associated with various technologies over time. A detailed analysis of pollutant emissions is an integral part of this cost analysis. Many scenarios were constructed to understand the implications of different policy issues facing the region. These indicate that regional cooperation is the optimal strategy. By integrating its energy market, the GMS could reduce its energy costs by 19% over the base scenario—saving more than $220 billion.

Source: ADB (2008a).

Table 3.1. Impacts on the PRC and Thailand from Electricity Infrastructure Investment

Country	GDP ($ million)	Labor Payments ($ million)		SO_x (thousand tons)	CO_2 (million tons)
		Skilled	Unskilled		
China, People's Republic of	75.9	3.7	-13.8	0.9	-1.0
Thailand	45.7	-1.0	-6.1	-0.2	-0.9

$ = United States dollar; CO_2 = carbon dioxide; GDP = gross domestic product; SO_x = sulfur oxides.
Source: Bhattacharya and Kojima (2008).

Bhattacharya and Kojima (2008) showed that cross-border energy trade between the PRC and Thailand could enhance the gains from increased energy supplies. The Jinghong and Nuozhadu hydropower project, the largest energy project in the Lancang-Mekong basin, is expected to boost Thailand's GDP by 3.45% and the PRC's by 1.15% by increasing energy supplies by 12% in the PRC and 47% in Thailand. Including a trading scheme in these estimates increases gains in GDP in both countries, as Table 3.1 shows. It would also reduce both Thailand's and the PRC's carbon dioxide emissions by approximately 1 million tons.

While most of the evidence so far comes from the GMS, a few studies of Central Asia also exist. In a forward-looking study of the CAREC region, a multisector computable general equilibrium (CGE) model was employed to simulate the economic impact of regional cooperation in transport, transit, and trade policy, focusing on the Kyrgyz Republic (ADB 2006b). Its results indicate that the cumulative increase in the country's real GDP in 2006–2015 would be $2.1 billion, more than double the baseline scenario without regional cooperation. Poor households' incomes would nearly double over the same period.

In the case of railways, using common facilities for goods distribution centers could reduce costs by $21 million. Constructing a joint workshop for locomotive repair could cut costs by $11 million–$12 million, and renting track repair equipment in common could save a further $31 million (Overseas Economic Cooperation Fund [OECF] 1998). The OECF also calculated (in 1998) that by cooperating, Kazakhstan, Kyrgyz Republic, and Uzbekistan could reduce the investment cost of meeting their electricity needs in 2010 from $9.3 billion to $8.3 billion, a saving of over 10% (OECF 1998).

Regional infrastructure cooperation in Asia is still in its infancy. But so far its impact appears to be highly positive. The following section looks in greater detail at its impacts.

3.3. Regional Case Studies

This section presents the findings of three new case studies, prepared especially for this study, that attempt to measure the benefits of regional infrastructure projects and their impacts on household income and poverty levels in three Asian subregions using a CGE approach. These studies are more comprehensive than the cost-benefit analyses generally used for project appraisal and are particularly useful for measuring the broader benefits of infrastructure networks, as well as their distributional impact (see Box A3.1 in the Appendix). The first provides evidence from Central Asia, the second from South Asia, and the third from the GMS in Southeast Asia.

Evidence from Central Asia

Two regional infrastructure projects in Central Asia were examined to determine their impacts on economic growth and household welfare. The first is the road corridor development project in Kazakhstan; the second is the expansion of the Atasu-Alashankou oil pipeline from Kazakhstan to the PRC. The road network project aims to create a corridor throughout Kazakhstan, helping to link Uzbekistan and the Kyrgyz Republic with the PRC. Using estimates of the reduction in vehicle operating costs and transit times that the new corridor is expected to deliver (ADB 2006b), a CGE model of the region was used to ascertain the project's broader impacts (Roland-Holst 2008).

The road-corridor project is expected to give a big boost to Central Asia's GDP, as Table 3.2 details. Kazakhstan is expected to gain most,

Table 3.2. Real GDP Growth Premium (percentage of baseline GDP)

Country/Region	2015	2020	2025	2030
China, People's Rep. of	0.27	0.55	0.69	0.79
Kazakhstan	3.19	5.34	6.26	7.04
Kyrgyz Republic	2.41	4.12	4.82	5.37
Other CAREC countries	2.31	3.73	4.29	4.79
Mongolia	0.89	1.72	2.05	2.29
Russian Federation	0.24	0.42	0.51	0.58
Rest of East Asia	0.24	0.36	0.40	0.44
South Asia	0.27	0.46	0.56	0.63
Southeast Asia	0.22	0.32	0.37	0.42
EU-25	0.27	0.41	0.47	0.53
United States	0.15	0.23	0.26	0.29
Rest of the world	0.24	0.32	0.36	0.41

CAREC = Central Asia Regional Economic Cooperation; GDP = gross domestic product.
Notes: Other CAREC countries includes: Afghanistan, Azerbaijan, Tajikistan, and Uzbekistan. Rest of East Asia includes: Hong Kong, China; Japan; Republic of Korea; Mongolia; and Taipei,China. European Union (EU)-25 includes: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom.
Source: Roland-Holst (2008).

followed closely by the Kyrgyz Republic and other CAREC countries. Remarkably, the gains are found to extend across the world, because the corridor will create better connections with established land routes to the Russian Federation and Europe.

At the household level, most of the gains occur in Kazakhstan, where most of the road network is located, as Table 3.3 shows. This breaks down the source of the household income gains into three: improvements in productivity, declines in product losses, and gains from

Table 3.3. Sources of Real Household Income Growth (percentage change from baseline)

Country/Region	Productivity	Decline in Product Losses	Trade
China, People's Rep. of	0.15	0.11	0.08
Kazakhstan	1.74	2.45	3.26
Kyrgyz Republic	1.57	1.67	1.64
Other CAREC countries	1.10	1.09	1.01
Mongolia	0.59	0.54	0.43
Russian Federation	0.11	0.08	0.05
Rest of East Asia	0.08	0.06	0.03
South Asia	0.10	0.09	0.06
Southeast Asia	0.09	0.06	0.03

CAREC = Central Asia Regional Economic Cooperation.
Note: Other CAREC countries includes: Afghanistan, Azerbaijan, Tajikistan, and Uzbekistan. Rest of East Asia includes: Hong Kong, China; Japan; Republic of Korea; Mongolia; and Taipei,China.
Source: Roland-Holst (2008).

trade. Kazakhstan gains most from improved trade, but other CAREC countries, especially the Kyrgyz Republic, also gain substantially. Countries also gain from improvements in transport operations. Thus, while the project's primary goal is to improve regional transport links, it also greatly benefits domestic markets.

Central Asia is abundantly endowed with energy resources, and this is an important area for regional cooperation. One promising project is the Atasu-Alashankou pipeline extension, which would extend the existing oil pipeline 700 km westward, linking it directly to the Caspian Sea. It is estimated that this will reduce the costs of delivering oil to the PRC by as much as 40%, while also boosting the Kazakh economy.

The project is expected to boost Kazakhstan's GDP by just over 1% by 2020. Kazakh exports are expected to rise by nearly $2.3 billion, or 3.4% over their estimated 2010 level. The PRC's GDP will also rise.

Table 3.4. Aggregate Impacts of Pipeline Extension, 2020 (in 2002 $ million)

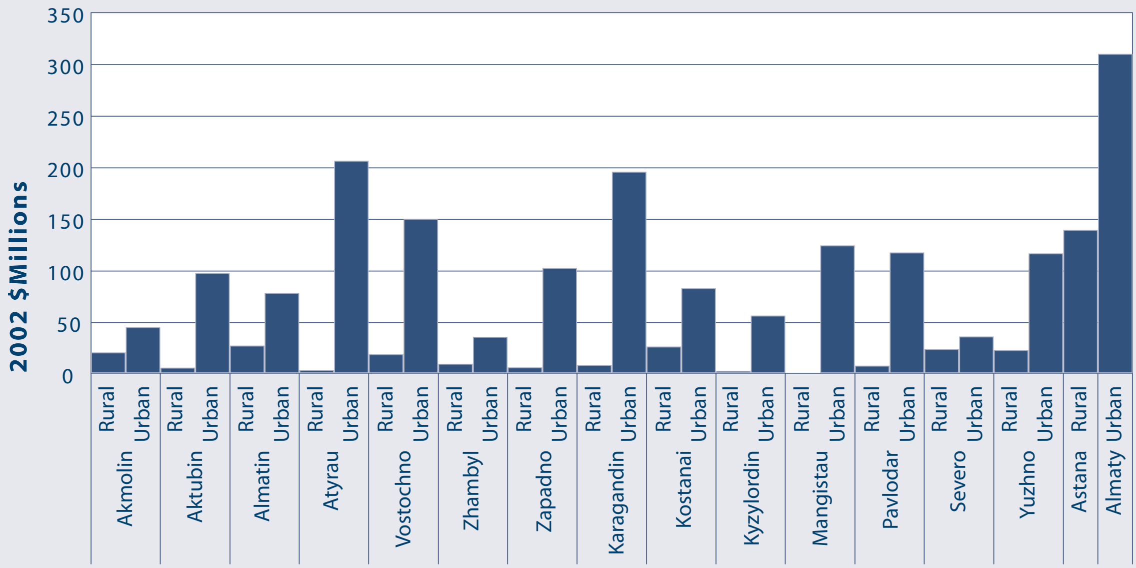
Country/Region	2020				
	GDP	Consumption	Investment	Exports	Imports
China, People's Rep. of	141	70	139	553	621
Kazakhstan	2,301	1,509	187	2,266	1,661
Russian Federation	-136	-80	-5	175	226
Other CAREC countries	-96	3	4	13	116
EU-25	126	243	81	288	486

CAREC = Central Asia Regional Economic Cooperation; GDP = gross domestic product.
Notes: Other CAREC countries includes: Afghanistan, Azerbaijan, Tajikistan, and Uzbekistan. European Union (EU)-25 includes: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom.
Source: Roland-Holst (2008).

While the rest of CAREC and the Russian Federation will experience short-term declines in GDP, they too will experience increased trade. These estimated gains far exceed the projected project costs of $850 million (Roland-Holst 2008). Table 3.4 details the impact of the pipeline extension in 2002 US dollars.

More detailed household income results are available only for Kazakhstan. The benefits to households from the pipeline project are twofold. First, there are direct income and employment gains from increased energy production and trade. These accrue primarily to urban households with workers in the energy-producing regions, and those living near the project. Second, there are indirect income and employment gains from the multiplier effects of spending by the direct beneficiaries. These are more widespread, but still benefit mainly urban populations, with some gains to the rural sector through the food market.

Figure 3.2. Household Real Income Effects in Kazakhstan



Source: Roland-Holst (2008).

The total changes in real household income from these two effects are positive across the board (Figure 3.2). But while they are negligible for the rural population of Mangistav, they exceed $300 million for urban households in Almaty. In general, urban dwellers and larger energy users gain more than rural populations, with large metropolitan centers gaining most.

Evidence from South Asia

South Asia inherited an integrated transport infrastructure from the British. However, this infrastructure was fractured by the partition of India and its political aftermath. Today, South Asia faces many challenges in rebuilding this infrastructure for regional connectivity. For example, northeastern India is a landlocked region connected to the rest of India by a narrow, long, and congested land corridor that borders Bangladesh and Nepal. As this region trades with the rest of

India and the world through this strip of land, the costs of transporting goods to and from the area are very high. Third-country trade with both Nepal and Bhutan also goes through this corridor, causing delays and higher costs. An appropriate solution to this issue is to build a corridor from this region to the Chittagong port of Bangladesh. This will provide cost effective access for transporting goods to and from the landlocked region including northeastern India, Bhutan, and Nepal (ADB 2007i).

Improving the region's infrastructure in order to reduce poverty is a major policy objective. South Asia is home to the world's largest concentrations of poor people. Over 40% of rural Indians live on less than $1 a day, and some 88% on less than $2. A multiregional competitive CGE model—which covered Bangladesh, India, Nepal, Pakistan, and Sri Lanka, as well as (incompletely) the rest of the world—was used to determine the welfare impacts of developing transport infrastructure in northeastern India (Gilbert and Banik 2008). The road transport component of trade costs was reduced for intra-SASEC transport margins. The reduction was based on estimates that improved roads and transit would reduce the time spent on transport and processing by 20% (ADB 2007i).

The model predicts that transport improvements in the passage would boost GDP a little throughout the region (Table 3.5). Trade would also rise, with Bangladesh and Nepal gaining the most as a

Table 3.5. Aggregate Outcomes in South Asia

Aggregate Outcome	Pakistan	Bangladesh	India	Sri Lanka	Nepal
Change in GDP (%)	0.06	0.11	0.00	0.11	0.32
Change in exports (%)	0.12	0.48	0.06	0.10	0.63
Change in imports (%)	0.28	0.66	0.13	0.12	0.98
EV ($ million)	52.00	45.90	86.60	18.70	41.10
Cumulative EV ($ million)	2,600.80	2,295.10	4,330.30	933.80	2,057.10
Cumulative EV (% of GDP)	2.70	4.10	0.70	4.60	14.80

$ = United States dollar; EV = equivalent variation, an expression of changes in utility or welfare measured in dollars; GDP = gross domestic product.
Source: Gilbert and Banik (2008).

percentage of total trade. Taking the cumulative welfare gains over the life of the project and expressing them as a percentage of current GDP shows that Nepal would gain (14.8%) more than Sri Lanka (4.6%). In absolute terms, India would gain the most, by over $4.3 billion, followed by Pakistan at $2.6 billion. The region's total welfare gains would greatly exceed the $80 million in anticipated loans from ADB.

The impact on household welfare of a reduction in regional transport costs is presented in Table 3.6. All household groups in Nepal would benefit, and these results are robust for all households. The biggest gainers would be small farm households (H3) and landless rural groups (H1), while smaller gains would accrue to large farm

Table 3.6. Household Welfare Impact of Transport Cost Reductions ($ million)

Household Category	Pakistan	Bangladesh	India	Sri Lanka	Nepal
H1	0.4	0.6	92.3	3.5	11.3
H2	0.9	6.8	-6.6	5.1	10.4
H3	0.2	-1.2	14.6	1.6	14.2
H4	0.9	-11.7	-4.0	4.6	5.3
H5	2.6	10.7	0.8	3.8	
H6	0.9	6.6	-2.9		
H7	0.8	4.1	-2.7		
H8	4.5	4.4	-2.0		
H9	1.5	8.7	-2.9		
H10	0.6	17.1			
H11	0.6				
H12	0.2				
H13	0.4				
H14	1.2				
H15	0.1				
H16	6.7				
H17	1.7				
H18	24.7				
H19	3.2				
Total	**52.0**	**45.9**	**86.6**	**18.7**	**41.1**

$ = United States dollar.
Note: Household (H) categories are defined in Table A3.1 in the Appendix.
Source: Gilbert and Banik (2008).

households (H2) and the urban group (H4) (who tend to be richer on average). The distribution of gains in Nepal implies that a reduction in international transport margins would be pro-poor in both an absolute and a relative sense.

In Bangladesh, a reduction in transport margins has a positive impact on the welfare of all household groups except small (H3) and larger (H4) farmers. Small farmers, one of the poorer groups in the country, lose slightly; relatively large (and relatively rich) farmers lose more. The poorest groups, the rural landless (H1), marginal farmers (H2), and the urban illiterate (H7), all experience rising income. This suggests that a reduction in transport margins would be pro-poor in Bangladesh in an absolute sense. However, by far the largest gains accrue to the urban highly educated (H10), the richest household grouping in Bangladesh. Thus the changes are unlikely to lower relative poverty (i.e., income inequality) in Bangladesh.

India is expected to experience the largest absolute gains and the most severe distributional consequences. Welfare is predicted to fall among rural agricultural labor (H2) and other rural households (H4), as well as the urban self-employed (H6), salaried (H7), urban casual labor (H8), and other urban households (H9); although, only the results for the urban self-employed and urban salaried are robust. This may be problematic, since rural agricultural labor and other rural households are the poorest groups in the country. Of the three poorest groups, only rural non-agricultural labor (H3) sees a modest income increase. By far the biggest gainers as a group are large farmers (H1), who are middle income. This is due to the rise in (especially agricultural) export prices. This suggests that increases in the value of agricultural land would be the primary driver of household income changes in India. Overall, the policy may be marginally pro-poor in a relative sense, since the welfare of the richest groups fall, but it is unlikely to be pro-poor in an absolute sense. In effect, a reduction in transport margins would benefit agricultural landowners most.

The household impacts in Pakistan, where the most detailed household data are available, are all positive, suggesting a drop in absolute poverty levels. But the urban rich (H18) are by far the biggest gainers, so relative poverty may increase. In Sri Lanka, the gains are relatively uniform across all household categories, although the impact on rural low-income households (H2) is sensitive to the parameters of the model.

Evidence from Southeast Asia

As the GMS of Southeast Asia has moved away from seeking self-sufficiency and instead has embraced regional cooperation, it has sought to develop its infrastructure links through a number of economic corridor projects. These have been supported by international agencies, including ADB, in the hope that they will greatly improve the region's prospects.

The GMS is very diverse. It includes the landlocked Lao PDR as well as Viet Nam, which has over 3,400 km of coastline. Population density ranges from 25 people per square kilometer in the Lao PDR to more than 270 in Viet Nam. The GMS is home to some of Asia's poorest people (in Cambodia and the Lao PDR, for example) as well as a relatively prosperous country (Thailand). The diversity of the GMS is both a challenge and an opportunity for regional cooperation.

Several studies have attempted to measure the impacts of various aspects of the GMS regional transport network, based on which economic projections were made using the global CGE model, Global Trade Analysis Project (GTAP) (Stone et al. 2008).[35] These estimated impacts were based on progress on two fronts: improvements in physical connectivity from better roads and bridges along the various economic corridors, and the easier movement of goods and people thanks to the Cross-Border Transport Agreement (CBTA). Based on several

[35] Details of these data and underlying assumptions can be found in Hertel (1997) and the GTAP website: https//www.gtap.agecon.purdue.edu.

Table 3.7. Aggregate Impacts of Reduced Costs of Road Transport in the GMS

Aggregate Impact	Cambodia	Lao PDR	Myanmar	PRC	Thailand	Viet Nam
GDP ($ million)	403.9	173.4	363.2	1,201.8	1,822.3	1,539.2
GDP (%)	8.3	7.1	4.7	0.1	1.1	3.6
GDP % *excluding PRC*	7.7	6.9	4.1	0.0	0.7	2.4
Exports ($ million)	226.6	-28.1	50.5	1,787.1	3,356.8	1,201.0
Exports (%)	5.3	-4.3	1.7	0.3	2.8	3.7
EV ($ million)	480.6	261.3	618.6	1,441.0	2,955.5	2,157.9
EV *excluding PRC*	460.4	259.5	557.6	-206.5	1,734.9	1,390.7
Contribution to welfare (%)						
Allocative efficiency	12.6	4.8	12.5	6.0	16.8	5.0
Improved terms of trade	10.5	22.6	37.3	15.7	39.9	21.8
Improved transport	0.1	3.6	3.9	2.2	2.8	5.7
Improved trade facilitation	71.8	62.7	47.2	77.4	45.0	66.7

$ = United States dollar; EV = equivalent variation, an expression of changes in utility or welfare measured in dollars; GDP = gross domestic product; GMS = Greater Mekong Subregion; Lao PDR = Lao People's Democratic Republic; PRC = People's Republic of China.
Source: Stone et al. (2008).

studies,[36] the cost of land transport within the GMS was estimated to have declined by 45% and the cost of imports by 25%.[37]

The model predicts that all GMS economies record gains in real GDP, ranging from 0.1% in the PRC to more than 8% in Cambodia (Table 3.7). Economies with relatively high transport costs, such as Cambodia and the Lao PDR, gain most. Overall, the transport improvements are projected to boost the region's GDP by $5.5 billion, of which around a fifth is due to reduced costs between the GMS and the PRC.[38] For Thailand and Viet Nam, the impacts of improved

[36] See Stone and Strutt (2009) for a review of these studies.

[37] Given that only two provinces of the PRC are part of the GMS, the cost reductions were prorated when applied to the PRC. The reduction in land transport cost was assumed to be 25%, and the import-cost reduction 5%, in line with the two provinces' share in PRC trade.

[38] Since sufficient input-output data are not generally available for Yunnan Province and the Guangxi Zhuang Autonomous Region, the PRC as a whole is included as a basis for analysis. However, the PRC's impact has been noted for some results.

transport links with the PRC account for over half of their GDP gains. Other GMS economies gain more from improved connections to other countries.

Exports increase everywhere except the Lao PDR, which experiences a slight loss in export share to countries outside the region. However, as the GMS economies realize the projected GDP gains shown in Table 3.7, the Lao PDR would most likely find ready local markets to replace these potential export declines. All GMS economies are expected to experience welfare gains, totaling almost $8 billion overall.

Of the $5.4 billion of transport and trade-related projects completed or ongoing in the GMS, $36.7 million has been devoted to facilitating cross-border trade and investment and the rest has been invested in the three transport corridor programs (East-West, North-South, and Southern). Using the conservative estimates reported above, the regional benefits of the entire program to date are almost 50% greater than the outlays. In the long term, as dynamic network externalities play out, these gains are likely to increase considerably.

Table 3.8 outlines the impact on poverty across various groups. Across the GMS-4—Cambodia, Lao PDR, Thailand, and Viet Nam—over 400,000 people move out of extreme poverty (a 4.5% decline), and some 1.75 million are lifted above the $2 a day poverty line (a 3.6% decline).[39] Over half of those lifted above the $1 a day line are in Cambodia, and over half of those lifted above $2 a day are in Viet Nam. Most of the poverty reduction occurs in rural areas, with rural diversified households accounting for almost half of the poverty reduction at both poverty levels.

Comparing these results with those from country-specific studies highlights the substantial benefits of implementing projects regionally. For instance, the net benefits of the East-West Corridor to the Lao PDR and Viet Nam have been estimated at $295.5 million (ADB 2007f). But the benefits of integrating the entire GMS are far greater, producing welfare gains in excess of $260 million for the Lao PDR alone and

[39] Sufficient household data for Myanmar were not available (see Stone et al. 2008).

of over $2.4 billion for the Lao PDR and Viet Nam combined, as Table 3.7 shows. The welfare gains to the GMS, excluding the PRC, exceed $4.4 billion.

Table 3.8. Change in Poverty Headcount (by stratum and country)

$1/day					
Stratum	**Cambodia**	**Lao PDR**	**Thailand**	**Viet Nam**	**GMS-4**
Agriculture	83,504	54,483	936	7,720	146,643
Non-agriculture	7,289	2,760	1,087	1,035	12,171
Urban labor	4,272	1,121	230	2,280	7,903
Rural labor	3,905	303	2,879	6,219	13,306
Transfer payments	1,658	236	9,670	6,010	17,574
Urban diversified	14,858	5,409	3,206	1,741	25,214
Rural diversified	101,467	11,323	35,994	34,762	183,546
Total	**216,953**	**75,635**	**54,002**	**59,767**	**406,357**
Percent Change	**4.7**	**4.6**	**3.7**	**4.8**	**4.5**

$2/day					
Stratum	**Cambodia**	**Lao PDR**	**Thailand**	**Viet Nam**	**GMS-4**
Agriculture	106,708	102,610	6,263	62,333	277,914
Non-agriculture	22,648	5,472	25,440	14,039	67,599
Urban labor	7,291	3,640	14,010	82,203	107,144
Rural labor	6,747	409	44,533	34,885	86,574
Transfer payments	1,333	190	22,142	4,560	28,225
Urban diversified	39,558	15,507	33,258	146,793	235,116
Rural diversified	198,348	36,923	161,429	549,520	946,220
Total	**382,633**	**164,751**	**307,075**	**894,333**	**1,748,792**
Percent Change	**3.6**	**4.0**	**1.9**	**4.2**	**3.6**

$ = United States dollar; Lao PDR = Lao People's Democratic Republic.
Note: Greater Mekong Subregion (GMS)-4 includes: Cambodia, Lao PDR, Thailand, and Viet Nam.
Source: Stone et al. (2008).

Looking at the relative impacts on poverty, Menon and Warr (2008) found that improving road quality in the Lao PDR alone lifts slightly over 1% of the population out of poverty. Regional action, in contrast, reduces the number of people in the Lao PDR living on less than $1 a day by 4.6%, and the number of people living on less than $2 a day by 4%. Clearly, the benefits of regional integration are significant.

3.4. Potential Negative Impacts

While regional infrastructure projects can bring big economic gains, they may also have negative impacts. For example, people may be displaced by hydropower schemes, agricultural land disrupted by road building, telecommunications towers located in highly populated regions. Unsightly or highly polluting installations such as power plants are often located in areas where the population is poor, vulnerable, and unable to fight such location decisions effectively.

An in-depth field survey on the impacts of the GMS NSEC in Cambodia conducted between September 2006 and February 2007 reported that 70% of residents along the corridor feared an increase in traffic accidents (Phyrum et al. 2007). Over 40% worried that human and drug trafficking would increase, while over 30% expressed concern about potential damage to the local environment and natural resources. Over 25% worried that HIV/AIDS[40] transmission would rise with the increase in transit traffic, travelers, and prostitution.

Traffic accidents are a major concern across the developing world. A World Bank study found that, while death rates from most other factors tend to fall with development, traffic accidents are a notable exception (Koptis and Cropper 2003). Road traffic deaths per capita are increasing across the developing world, including Southeast Asia. The annual economic loss from road accidents in the GMS has been estimated at more than $4.7 billion, or more than 2% percent of

[40] HIV is human immunodeficiency virus; AIDS is acquired immunodeficiency syndrome.

GDP (ADB 2005d).[41] Lost time, damaged cargo and vehicles, lack of insurance, injuries, and even death all add to the high costs of traffic accidents.

Border regions are often associated with drugs and human trafficking, and improvements in connectivity create opportunities for illegal businesses as well as legitimate ones. It has been reported that nearly a quarter of the local population in frontier villages of Cambodia are habitual drug users (ADB 2006d). Cross-border movement of illegal arms and terrorists is another menace; Southeast Asian governments began unofficially to share terrorist-related information after the Bali incidents in 2002 and 2005 (Japan International Cooperation Agency [JICA] 2007). It is debatable, however, to what extent such activities are caused by cross-border infrastructure projects, and to what extent they happen to coexist in border regions.

Perhaps most importantly, infrastructure projects give rise to environmental concerns. Specific projects often fail to consider the spillover impacts on neighboring regions and ecosystems. For example, drainage systems along road networks may cause flooding and thus affect the transportation network, and hydroelectric dams may affect downstream farms and fishing.

More broadly, it is vital that Asia's investments in regional infrastructure support its shift to a low-carbon economy. Future energy supply plans, especially for power generation, need to shift toward greater emphasis on energy efficiency and renewable energy sources. Efficiency gains from regional connectivity and trading will be essential. Transport will also need to become greener, with greater priority given to low-carbon railways and waterways, and to the use of more fuel-efficient vehicles and cleaner fuels. Limiting deforestation and land degradation is another priority. Box 3.2 explains how the environmental impact of the GMS transport corridors could be improved.

[41] This value is substantiated by the EU, which states that road crashes costs 1-3% of a country's GDP. See http://www.ertico.com/en/subprojects/euindia/about_eu-india/road_safety_in_india/.

Box 3.2. Greening the GMS Transport Corridors

Transport is a major and growing source of greenhouse gas emissions in the GMS. Increases in economic growth and population are lengthening supply and distribution chains and increasing traffic. Road-based traffic is projected to more than double across the subregion by 2015, with much of it due to increased freight haulage as intraregional trade increases. Without measures to mitigate the impact on air pollution and public health, improve energy and cost efficiency, and curb greenhouse-gas emissions, the increase in traffic is likely to have serious repercussions on development and the environment.

Freight traffic is already making a measurable contribution to GMS carbon dioxide emissions. Preliminary investigations show that freight traffic in the EWEC accounts for around 3% of total freight traffic in the region, and the NSEC around 4%. The EWEC from Da Nang in Viet Nam to Maulamyine in Myanmar contributes around 1 million tons of carbon dioxide annually, of which just over half comes from freight traffic. Without improvements in engine efficiency, carbon dioxide emissions from freight traffic will reach around 1.44 million tons by 2015, compared with 530,000 tons now.

The NSEC from Kunming in the PRC to Bangkok in Thailand produces 2 million tons, of which about 1.2 million tons is from freight traffic. Without improvements in engine efficiency, carbon dioxide from freight traffic emissions will rise from 0.7 million tons to around 2.2 million tons by 2015.

How can carbon intensity be reduced? One medium-term option is to increase carbon sequestration by maintaining and expanding forest cover in watersheds along transport corridors as well as undertaking strip plantation along GMS highways. This would have the added benefit of generating rural employment and encouraging the development of wood processing industries. Such efforts could be combined with the development and deployment of second-generation biofuels to reduce dependence on traditional fuels.

Policy frameworks and fiscal incentives can also help promote carbon reduction and carbon avoidance strategies. Logistics and haulage companies in the GMS could reduce their carbon emissions by deploying more fuel-efficient trucks. Governments could help achieve this by imposing tighter fuel-efficiency standards and providing fiscal incentives to promote the marketing of fuel-efficient freight engines and cover the cost of adjusting to low-carbon freight fleets.

The ADB-GMS Environment Operations Center is developing an investment framework for 2011–2015 that includes feasibility assessments of "greening" options for the EWEC and NSEC. It will focus on reducing the transport sector's carbon footprint, improving system efficiencies, and strengthening forward and backward linkages with rural economies.

Source: ADB staff (2008).

3.5. Overall Gains from Pan-Asian Connectivity

Earlier sections have provided compelling evidence of the broader gains from creating subregional infrastructure networks in Asia. This section presents estimates of the overall real income gains from pan-Asian connectivity through required investment in infrastructure, namely transport, telecommunications, and energy.[42]

The estimates reported in this section are based on a CGE model to simulate the impact of an expansion of infrastructure in developing Asian economies. The methodology for estimating the gains is presented in Box 3.3.

The results show that developing Asia would gain significantly—as would the rest of the world. If the required investment toward pan-Asian connectivity were made in the region's transport, communications, and energy infrastructure during 2010–2020 (as estimated in Chapter 5), the total net income gains (measured in present value in 2008 dollars) of developing Asia could reach $12.98 trillion, of which $4.43 trillion would be gained during 2010–2020 and $8.55 trillion would be gained beyond 2020. These benefits are particularly large for two types of regional economies: those that depend heavily on external trade and those for which the need for improved infrastructure is particularly acute.

The economy-wide gains stem from positive network externalities as discussed in section 3.1. In the case of investment in transport and communications infrastructure, one of the most important externalities is that it increases market access by lowering trade costs. The calculation assumes an investment of some $320 billion a year in transport and communications between 2010 and 2020. The estimated reduction in trade costs from increased infrastructure investment is presented in Table 3.9. Transport improvements would slash Indonesia's trade costs by a quarter, India's by more than a fifth, and the PRC's by a seventh. The rest of Asia's would also fall by a fifth. Improvements in communications would cut India's trade costs by 11.2%.

42 Based on Zhai (2009).

Box 3.3. Methodology for Estimating Overall Gains from Pan-Asian Connectivity

The estimates reported in this section are based on a CGE model using the GTAP 7.0 database with a base year of 2004 to simulate the impact of an expansion of infrastructure in developing Asian economies. The model used in this exercise is a recursive dynamic version of the global CGE model (Zhai 2008). A key feature of the model is the incorporation of firm heterogeneity and fixed costs of exporting—in addition to variable trade costs. This facilitates the investigation of the intra-industry reallocation of resources and the exporting decision by firms, and thereby captures both the intensive and extensive margin of trade in the model. Dynamics of the model originate from exogenous population and labor growth, labor-augmented technological progress, as well as capital accumulation driven by savings. At first, a baseline scenario is established assuming no trade cost reduction from 2010 to 2020; and it serves as a basis of comparison for counterfactual scenarios with policy shocks. Then, three scenarios of a seamless Asia are considered. In the first scenario, the trade cost reductions expected from transport infrastructure investment in Asia are gradually introduced for the period 2010–2020. In the second scenario, the trade cost reductions from both transport infrastructure and communication infrastructure are fully included. The third scenario combines all the positive externality effects from transport, communication, and energy infrastructure. The differences between the above three scenarios and the baseline scenario reflect the impacts resulting from the development of regional infrastructure.

Francois et al. (2009) estimated the elasticity of trade cost with respect to the quality of infrastructure for several Asian economies that were used to introduce the trade costs reductions in this exercise. In particular, the linear regression equations between elasticity of trade costs with respect to the quality of infrastructure and the logarithm of per capita GDP for selected economies (Table 3.9) are estimated based on the above study. The exercise produced forecast values of these elasticities for the period 2010–2020 based on population projection and the assumed baseline GDP growth rates for these economies. Using the stock of infrastructure in the transport and communication sector as proxies of infrastructure quality, the trade costs reductions resulting from infrastructure expansion for each year over the period 2010–2020 were estimated.

In the case of investment in energy infrastructure, the main externality is improvement in the efficiency of energy production and use. A recent study by Integriertes Ressourcen Management (2008) found that an energy-integrated GMS would be able to save overall energy costs of 19%. Based on this empirical finding, the calculations assume that the overall efficiency of energy supply in developing Asia (excluding newly industrialized economies [NIEs]) would improve gradually during 2010–2020, leading to a 20% increase in energy efficiency in 2020, as a result of the investment in regional energy infrastructure.

Source: Zhai (2009).

Table 3.9. Accumulated Reduction in Trade Costs Resulting from Infrastructure Investment, 2010–2020
(percentage of trade value)

Country/Region	From Transport Infrastructure	From Communication Infrastructure
China, People's Rep. of	14.0	0.7
Indonesia	25.3	6.6
Malaysia	11.4	1.7
Philippines	15.6	0.0
Thailand	12.1	5.9
Viet Nam	13.2	3.1
Bangladesh	12.9	9.9
India	21.6	11.2
Pakistan	12.9	1.2
Sri Lanka	10.6	6.5
Central Asia	11.5	12.1
Rest of Asia	20.3	21.3

Source: Zhai (2009).

The estimated total gains in real income, measured in present value in 2008 dollars using a discount rate of 5%, are set out in Table 3.10. It shows that developing Asia as a whole would reap net income gains of $7,840 billion from the expanded regional transport infrastructure; $11,240 billion from the investments in both transport and communications; and $12,980 billion from the investments in transport, communications, and energy. The PRC and India would be the biggest beneficiaries, gaining $3,550 billion and $3,140 billion, respectively. Southeast Asian countries could be significant winners, mainly due to their high dependence on trade and large infrastructure requirements. The total gains of Indonesia ($1,280 billion), Malaysia ($830 billion), Philippines ($220 billion), Thailand ($1,240 billion), and Viet Nam ($400 billion) would be $3,970 billion, higher than both the PRC and India, thanks to improvements in pan-Asian connections.

In South Asia, Bangladesh, Pakistan, and Sri Lanka would gain $260 billion, $140 billion, and $90 billion, respectively. Central Asia could gain substantially, too ($470 billion).

Although those Asian developing economies with infrastructure investment would capture the majority of the overall gains, accounting for more than 90%, the regional economies without any assumption of infrastructure investment in the model, such as Australia, New Zealand, Japan, NIEs, and the rest of the world, would also benefit from the improved infrastructure network in developing Asia. The NIEs could gain $740 billion, while Australia and New Zealand could benefit ($100 billion) from the improved infrastructure in developing

Table 3.10. Present Discounted Value of Net Income Gains from Pan-Asian Connectivity (in 2008 $ billion)

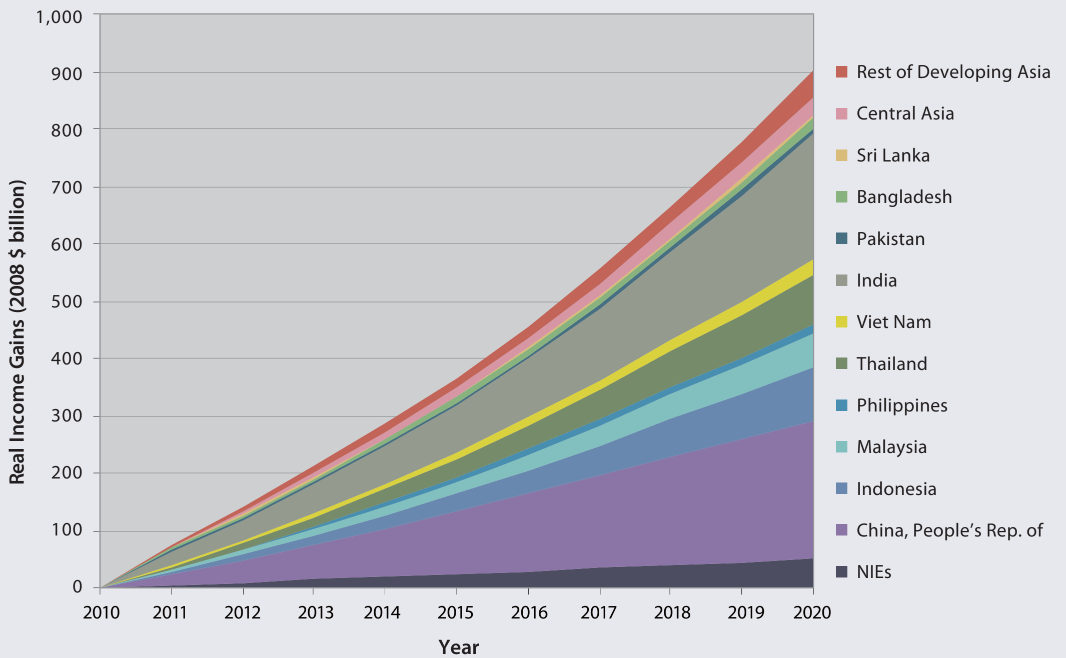
Country/Region	Transport			Transport and Communications			Transport, Communications, and Energy		
	2010–2020	Post–2020	Total	2010–2020	Post–2020	Total	2010–2020	Post–2020	Total
Developing Asia	**2,723.8**	**5,118.9**	**7,842.8**	**3,893.0**	**7,344.4**	**11,237.5**	**4,430.3**	**8,550.4**	**12,980.7**
NIEs	248.8	445.5	694.3	275.2	484.9	760.2	268.2	472.2	740.4
China, People's Rep. of	1,016.1	1,829.2	2,845.2	1,047.9	1,887.4	2,935.3	1,247.7	2,301.5	3,549.2
Indonesia	251.6	490.4	742.0	371.0	754.2	1,125.2	415.4	869.2	1,284.5
Malaysia	201.7	398.4	600.1	261.8	511.2	773.0	278.0	551.9	829.9
Philippines	70.4	129.2	199.7	69.8	129.3	199.1	77.9	146.2	224.1
Thailand	206.6	425.9	632.5	362.0	738.8	1,100.8	402.6	832.8	1,235.4
Viet Nam	97.1	171.4	268.5	119.6	220.8	340.5	136.5	258.9	395.4
Bangladesh	31.2	59.1	90.3	96.1	148.8	244.9	100.3	158.0	258.3
India	424.5	851.7	1,276.2	884.2	1,725.4	2,609.6	1,049.0	2,092.6	3,141.6
Pakistan	37.8	66.4	104.1	42.2	76.4	118.6	50.0	93.1	143.1
Sri Lanka	13.0	23.6	36.7	26.2	48.3	74.5	30.6	58.6	89.2
Central Asia	62.9	103.7	166.6	144.3	256.8	401.1	163.7	304.5	468.3
Rest of Developing Asia	62.1	124.4	186.6	192.7	362.1	554.7	210.4	410.9	621.3
Australia and New Zealand	25.6	47.1	72.7	33.9	61.9	95.8	34.7	63.6	98.3
Japan	64.9	118.7	183.6	70.1	128.0	198.1	68.5	129.2	197.7
Rest of World	182.9	437.8	620.8	280.8	647.2	927.9	282.6	680.9	963.5
Total	**2,997.2**	**5,722.5**	**8,719.9**	**4,277.8**	**8,181.5**	**12,459.3**	**4,816.1**	**9,424.1**	**14,240.2**

$ = United States dollar; NIEs = newly industrialized economies in Asia, including: Republic of Korea; Hong Kong, China; Singapore; Taipei,China.
Source: Zhai (2009).

Asia. Japan could capture a significant gain of $200 billion from infrastructure improvements in developing Asia. Real income gains in the rest of the world would be $960 billion.

Figure 3.3 shows trends in real income gains for developing Asia over 2010–2020 by country and country group. The annual gains would vary from $80 billion in 2011 to $370 billion in 2015 and $900 billion in 2020. On average, annual gains in the second half (2016–2020), around $670 billion per year, are much larger than in the first half (2011–2015), about $210 billion a year. The higher growth rate after 2016 can be explained by the effects of cumulative infrastructure investments made during the first half. This trend is visible in every country in the analysis. There are also large benefits even after 2020—when no new or replacement investments take place—but these benefits decline over time with the depreciation of infrastructure stock.

Figure 3.3. Trends in Real Income Gains During 2010–2020



$ = United States dollar; NIEs = newly industrialized economies in Asia, including: Republic of Korea; Hong Kong, China; Singapore; Taipei,China.
Source: Zhai (2009).

3.6. Conclusions

The evidence presented in this chapter shows that regional infrastructure projects can boost growth and income, reduce poverty, and improve household welfare. Regional energy projects can also benefit the environment by reducing carbon emissions. The benefits of regional projects often spill over across countries in the region and beyond, illustrating the substantial and positive impact of creating regional infrastructure networks. The chapter finds that the benefits of subregional infrastructure projects in Central Asia, the GMS, and South Asia greatly exceed their costs. Furthermore, poverty declines substantially in each country in the respective subregions, particularly in the rural sector. Furthermore, improving pan-Asian connectivity in transport, telecommunications, and energy infrastructure would bring Asia very large income gains during 2010–2020 and beyond through increased market access, reduced trade costs, and more efficient energy production and use.

Notwithstanding the social and economic gains that large regional infrastructure projects bring, they also generate negative social and environmental impacts such as the displacement of people, human and drug trafficking, communicable diseases, smuggling, road accidents, environmental damage, and climate change. Addressing negative externalities through appropriate policies and institutions is extremely important. Chapter 4 discusses appropriate institutions and policies to address major negative externalities of infrastructure projects. To harness the gains of regional networks and ensure that those potentially disadvantaged by such projects are properly compensated, an effective project management system is needed. Managing regional projects is particularly complex and time consuming, and requires a systematic approach.