

# Infrastructure and Poverty Reduction — What is the Connection?

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**P**overty reduction requires economic growth which, when accompanied by sound macroeconomic management and good governance, results in sustainable and socially inclusive development (ADB 1999). Greater access of the poor to education and health services, water and sanitation, employment, credit, and markets for produce is needed. Moreover, the vulnerability of the poor to economic shocks and natural disasters must be reduced to enhance their well-being and encourage investment in human capital and in higher-risk and higher-return activities. Public policy reforms and investment in physical infrastructure will significantly contribute to the pursuit of socially inclusive development.

Two schools of thought emerged in the 1990s regarding physical infrastructure and poverty reduction. On one hand, great importance was attached to physical infrastructure in the poverty reduction efforts of developing countries; on the other hand, many in the international development community viewed assistance for infrastructure with considerable skepticism on three grounds (DFID 2002). First, though important for economic growth, infrastructure investment had little relevance to poverty reduction. Second, actual benefits from infrastructure were significantly less than anticipated. Third, weak governance and institutions gave way to corruption, distorted public investment choices, and neglected maintenance, thereby lowering infrastructure's contribution to economic growth and diverting benefits intended for the poor. Nevertheless, there is now wider recognition, including in the international donor community, that if governance and institutional frameworks are strengthened, the linkage between infrastructure and reduction of poverty can be become stronger.

Currently, almost 70% of infrastructure investment in developing countries is financed by governments or public utilities from their own resources or from nonconcessional borrowings, 3% from aid, and the balance from the private sector (DFID 2002). In a similar vein, ADB has invested (as of end 2000) a total of \$15.9 billion in its developing member countries' (DMCs) transport sectors, covering roads and road transport, ports and shipping, airports and civil aviation, and railways (ADB 2001). Of this amount, roads accounted for \$11.2 billion, or 13% of ADB's total loan portfolio.

Governments in many developing countries face severe budgetary constraints. Accordingly, it is important to assess the relative contributions of physical infrastructure investments to poverty reduction. This brief proposes an analytical framework and reviews recent literature and econometric results on the link between physical infrastructure and poverty reduction, with particular reference to the rural sector where the vast majority of the poor reside. The discussion focuses on three types of infrastructure—roads, irrigation, and electricity.

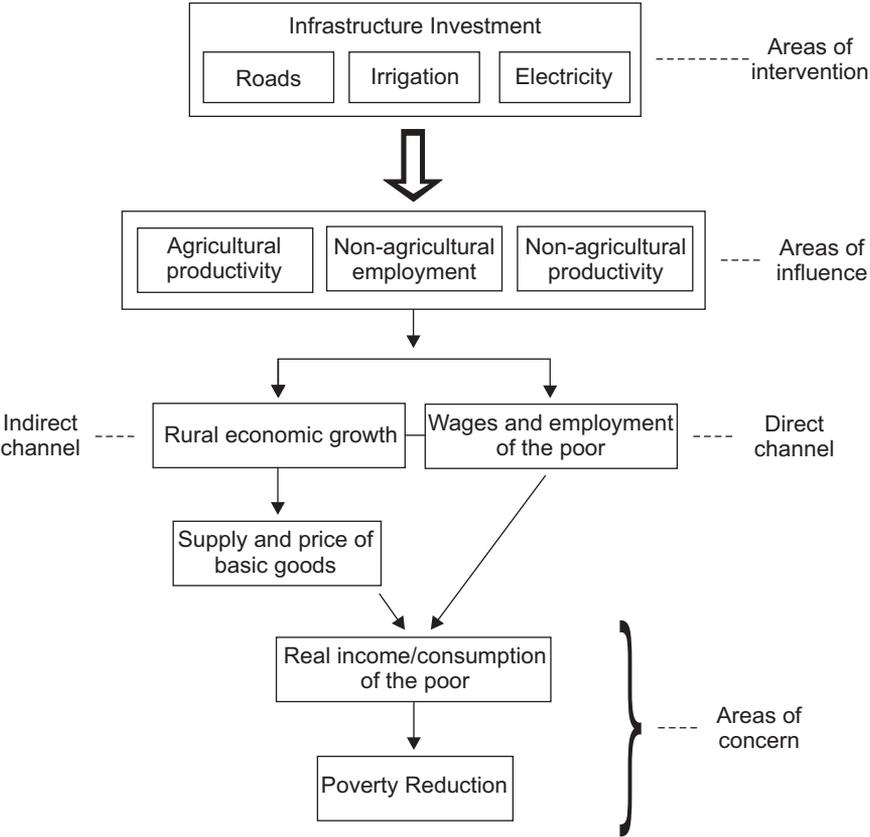
### **Analytical Framework**

Typically, the incidence of rural poverty is inversely related to the size of landholdings, decreasing from landless to submarginal, marginal to small, then to large farmers. Hence, the sources of income vary among these groups, with the share of wage income being the highest among the landless, submarginal, and marginal farmers; and the share of crop income increasing progressively from submarginal to large farmers. Wage income depends on agricultural productivity and employment, as well as on nonagricultural employment and productivity. Crop income is largely determined by agricultural productivity. Agricultural and nonagricultural productivity contribute to economic growth, particularly in the rural sector. Landless laborers and submarginal farmers are net buyers of food while the other groups of farmers are net sellers of food. When agricultural prices rise, the former groups' real income drops while it increases for the latter. Implicitly, the terms of trade between agriculture and nonagriculture is also an important determinant of poverty incidence. In this simple analytical framework, the main determinants of rural poverty include agricultural productivity, nonagricultural employment, and nonagricultural productivity.

Figure 1 summarizes the links from infrastructure investments (areas of intervention) through these determinants (areas of influence) to the poor's wages and employment (direct channel), on the one hand, and rural economic growth (indirect channel) that influences the supply and prices of basic goods, on the other. The final links are to real income/consumption of the poor and, consequently, poverty reduction (area of concern). The various links can be illustrated with an example. For example, a road investment could result in an increase in agricultural productivity, nonfarm employment and productivity, directly raising the wages and

employment of the poor and, hence, their economic welfare. This is the (direct) income distribution effect. In addition, higher productivity and expanded employment lead to higher economic growth, affecting the supply and prices of goods and, thus, the poor's well-being. This is the (indirect) growth effect. Similar links can arise from irrigation and electricity investments.

**Figure 1. Simple Analytical Framework Depicting the Links between Infrastructure and Poverty Reduction**



## Empirical Evidence

Econometric studies available generally do not trace in detail the links described above. Nonetheless, they provide useful assessments of the more important links, indicating their quantitative and statistical significance. These measures are typically represented as elasticities denoting the responsiveness of a variable to a determinant. The few available studies covered in the review offer examples from Asian countries. While differences in econometric model specifications, data, and definitions call for caution in the interpretation of results across countries, they do lend helpful insights into the connection between physical infrastructure and poverty reduction. The framework proposed above could be used in designing future empirical work that aim to trace more carefully and systematically the links of interest.

### Roads

A number of studies point to a significant impact of roads on poverty reduction through economic growth. Kwon (2000), analyzing Indonesian data, estimates a growth elasticity with respect to poverty incidence of  $-0.33$  for good-road provinces and  $-0.09$  for bad-road provinces. This implies that poverty incidence falls by 0.33% and 0.09%, respectively, for every 1% growth in provincial GDP. Provincial roads also appear to directly improve the wages and employment of the poor, such that a 1% increase in road investment is associated with a 0.3% drop in poverty incidence over five years.

Another study on Indonesia, using more disaggregative district-level (*kotamadya/kabupaten*) data, also reveals a significant effect of roads on the average incomes of the poor via growth, an estimated elasticity of 0.05 (Balisacan, Pernia, and Asra 2002).<sup>1</sup>

A parallel research on the Philippines, using provincial data, reveals that roads, particularly when complemented by schooling investment, exert significant indirect and direct impacts on the welfare of the poor (Balisacan and Pernia 2002). The elasticities suggest that

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<sup>1</sup> Current income is proxied by current consumption expenditure that is deemed a better indicator of welfare (or permanent income) and is easier to measure in developing countries where the poor are often self-employed and engaged in agriculture with fluctuating incomes. Typically, the elasticity for income/consumption expenditure is much smaller than that for poverty incidence.

a 1% increase in road access coupled with schooling results in a 0.32% rise, via growth, in the mean incomes of the poor. Similarly, a 1% improvement in roads with schooling is directly associated with a 0.11% increase in the poor's incomes.

A study by Fan et al. (2002), using provincial data, examines the effects of different types of government expenditures on growth and rural poverty in People's Republic of China (PRC). They find that roads significantly reduce poverty incidence through agricultural productivity and nonfarm employment. The estimated elasticities with respect to road density are 0.08 for agricultural GDP per worker, 0.10 for nonagricultural employment, and 0.15 for wages of nonagricultural workers in rural areas. Among government infrastructure projects, rural roads are found to have the largest impact on poverty incidence: for every 10,000 yuan invested on rural roads, 3.2 poor persons are estimated to be lifted out of poverty.

A related research shows that road density has a significant positive effect on the consumption expenditure of rural farm households in poor regions of the PRC (Jalan and Ravallion 2002). For every 1% increase in kilometers of roads per capita, household consumption rises by 0.08 percent.

Research on Viet Nam reveals that poor households living in rural communes with paved roads have a 67% higher probability of escaping poverty than those in communes without paved roads (Glewwe et al. 2000). Likewise, an evaluation of a World Bank-funded rural road rehabilitation project in Viet Nam finds that the strongest positive impact was for the poorest households (Van de Walle and Cratty 2002). In particular, the time savings to reach habitual places of destination were highly significant for the poorest 40% of households.

A study on Nepal finds that providing extensive rural road networks results in substantial benefits, with the poor capturing an appreciable share (Jacoby 1998). However, the poor's share is often not large enough to significantly reduce income inequality as the benefits from road extension could be greater for landholdings of the rich. Thus, the distribution of benefits from road extension may be ambiguous. The relevant question to ask is whether the benefits of a hypothetical road project are sufficiently large and distributed progressively enough to reduce overall income inequality, with benefits accruing more to the poor than the nonpoor.

Qualitative research employing interviews and focus group discussions lends additional insights. One such study in two provinces of the Central Highlands of Viet Nam notes that the benefits of rural roads are generally perceived as largely social rather than economic in nature (Songco 2002). While the rural poor appreciate road improvements, they clamor for other types of interventions, such as credit and health services. Nonetheless, rural roads are generally regarded as instrumental in creating opportunity, facilitating empowerment, and enhancing security (ADB 2002, World Bank 2002).

## **Irrigation**

There is evidence showing that irrigation significantly contributes to farm productivity and wages, reducing poverty and income inequality (the latter implying that the poor benefit more than the nonpoor). Research in India, Philippines, Thailand, and Viet Nam suggests that poverty is substantially lower in irrigated areas compared with unirrigated areas (Bhattarai et al. 2002). The authors emphasize that the relative success of an irrigation project in poverty alleviation largely depends upon the magnitude of the project's multiplier effects, including employment multiplier effects and interlinkages in the economy's different sectors.

For instance, an irrigation multiplier, estimated for irrigated areas in the New South Wales region of Australia, shows that a dollar worth of output generated in irrigated agriculture creates more than five dollars worth of value added to the regional economy (Bhattarai et al. 2002). In the same vein, a dollar worth of output in irrigated farms generates a total employment value of 4.75 dollars. Further, the authors report that farm income in irrigated areas is 77% higher than that in unirrigated areas in Bihar, India.

In the PRC, Fan, Zhang and Zhang (2002) find that irrigation directly contributes to the growth of the agricultural sector, leading to poverty reduction. The estimated elasticity is 0.41, implying that a 1% increase in irrigation is associated with a 0.41% rise in agricultural output per worker, resulting in a 1.13% drop in poverty incidence.

In the Philippines, irrigation is also found to have a significant pro-poor bias (Balisacan and Pernia 2002). It is land quality, not farm size per se, that influences the incomes of the poor. Irrigation directly affects the poor's farm productivity (wages) and employment apart

from its indirect effect via overall income growth. The direct effect is reflected in an elasticity of 0.31, meaning that a 1% increase in irrigation leads to a 0.31% rise in the poor's incomes.

In Viet Nam, Van de Walle (1998) finds that targeting irrigation expansion to households with small per capita landholdings leads to the most progressive distribution of gains, benefiting the poor the most. The increase in crop income is about 4.5% of household expenditure for the poorest compared with only 0.1% rise for the richest group.

Further, Van de Walle (2000) notes strong complementarities between returns to irrigation and education in Viet Nam. Raising primary schooling of all household heads to five full years (and of other adults by one standard deviation) results in a 36% differential increase in crop income between irrigated and unirrigated farms. The synergistic effect of schooling and irrigation appears to be largest for the poorest.

## **Electricity**

Electricity contributes significantly to the growth of the rural nonfarm sector in the PRC, leading to poverty reduction, an estimated elasticity of 0.42 (Fan et al. 2002). Electricity investment has a strong impact on poverty, such that for every 10,000 yuan spent for electricity development, 2.3 persons are brought out of poverty.

In Indonesia, electricity reflecting access to technology contributes directly increased employment and incomes of the poor, as well as to poverty reduction through growth (Balisacan et al. 2002). In the Philippines, electricity positively influences the incomes of the poor through growth, but direct effects are unclear for the poorest and clearer for the upper quintiles (Balisacan and Pernia 2002). This suggests that some minimum income level and complementary facilities are required to benefit from electricity.

An evaluation of World Bank-assisted rural electrification projects in Asia indicates that in Bangladesh and India rural electrification raises the use of irrigation, thereby significantly reducing poverty incidence (Songco 2002). The beneficiaries also feel an improvement in their lives, a diminution in the sense of powerlessness and instability, and an increase in empowerment.

Electricity improves the poor's access to productive activities, thus lessening their vulnerability to shocks.

However, the evaluation report also notes some negative or neutral impacts. In a number of countries, rural electrification is perceived as having little or no impact on agricultural productivity owing to high connection costs, unclear land use rights, extremely low income levels, restricted credit access, and low potential for agricultural improvements. In Indonesia, many households opt not to connect to available electric power supply. This could be attributed to extremely low incomes and lack of credit opportunities that prevent the poorest from availing of rural electrification.

### **Conclusion**

Rural infrastructure investments can lead to higher farm and nonfarm productivity, employment and income opportunities, and increased availability of wage goods, thereby reducing poverty by raising mean income and consumption. If higher agricultural and nonagricultural productivity and increased employment directly benefit the poor more than the nonpoor, these investments can reduce poverty even faster by improving income distribution as well. The econometric analysis reported in this brief, however, has not addressed the issue of purposively skewing the distribution of public intervention benefits to enhance the poor's access to opportunities. An example would be employment or credit programs targeted to the poor.

However, targeting government interventions to reduce poverty can only be regarded as supplementary to fostering economic growth, which is the more durable approach to sustained poverty reduction and overall improvement in living standards. Public investment in physical infrastructure is needed to raise productivity and achieve long-term growth. Such investment is especially critical in rural areas for at least two reasons: first, because ample potential remains for raising rural productivity and employment, thereby contributing significantly to faster overall economic growth in many developing countries; and, second, because rural areas are home to the majority of the poor in these countries.

The econometric results highlight the importance of country specificities in terms of causes of poverty and effectiveness of

alternative infrastructure investments. In this regard, the cases of the PRC and India provide contrasting examples. Higher agricultural prices are good for the poor in the PRC because poor farmers are net sellers of farm products. The opposite is true in India because landless laborers and submarginal farmers are net buyers. In the case of electricity, its effect in reducing poverty significantly depends on investments already made in the past in the power sector. If a government has already invested heavily in rural electrification, as in India, the marginal returns from additional investments in reducing poverty would be low. The opposite would be the case in the PRC.

Based on the available econometric literature reviewed, roads appear to have strong indirect and direct effects on poverty reduction, and these are even clearer when roads are combined with complementary investments, such as schooling. Irrigation also seems to be a potent intervention for poverty reduction, both directly and indirectly. Less unambiguous is the evidence on electricity's link to the welfare of the poor. This is probably because, among the three infrastructure types, electricity is the least essential and entails the highest private costs for connection and continuing consumption, as well as for the purchase complementary facilities, such as household appliances.

Finally, project design including location of infrastructure investments is critical. Poverty reduction can be hastened if rural roads, irrigation, and rural electrification interventions are made in locations that are pivotal in terms of distributive and multiplier effects favoring the poor.

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