Findings from Studies of Poverty Impacts of Road Projects

A Case Study from the 2007 Sector Assistance Program Evaluation of Asian Development Bank Assistance for Roads and Railways in the People’s Republic of China

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Tyrrell Duncan

Operations Evaluation Department

Asian Development Bank
Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
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<tr>
<td>GDP</td>
<td>gross domestic product</td>
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<tr>
<td>IFPRI</td>
<td>International Food Policy Research Institute</td>
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<tr>
<td>NTHS</td>
<td>National Trunk Highway System</td>
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<tr>
<td>PRC</td>
<td>People’s Republic of China</td>
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Note

In this report, “$” refers to US dollars.
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1. This study reviews the available evidence from the People’s Republic of China (PRC) and other studies of relevance regarding documentation of poverty reduction impacts of physical infrastructure and, in particular, road development. The main technical assistance (TA) projects that this overview draws from are (i) Socioeconomic Assessment of Road Projects¹; (ii) Evaluating Poverty Impacts of Transport Projects² and; (iii) Assessing the Impact of Transport and Energy Infrastructure on Poverty Reduction³. The study also draws from other literatures: (i) PRC: China Expressway Retrospective Study⁴; (ii) Pathways Out of Poverty and Effectiveness of Poverty Targeting⁵; and (iii) State of the Art Study—The Long-term Effects of Assistance to the Power Sector⁶.

I. Infrastructure as an Engine of Growth and Poverty Reduction?

2. Before addressing the focal challenges of documenting the economic, social development, and poverty reduction impacts of road projects, it is useful to briefly outline the impacts of major infrastructure investments in general. Recent reviews have shown that the impacts of one type of infrastructure (e.g., roads) on economic development, poverty reduction indicators, and other welfare measures can be significantly enhanced by coordinated investments in complementary infrastructure (e.g., telecommunications and power). Furthermore, it is becoming increasingly clear that unless the initial infrastructure investments (e.g., a new or rehabilitated road) is properly operated and maintained, the poverty and development benefits will soon vanish (footnote 5).

3. Such empirical research has taken place mostly during the last two decades. The first such studies caused substantial academic debate for methodological reasons. J.M. Antle⁷ used aggregate agricultural production data for 1965 from 47 developing and 19 developed countries and included infrastructure to explain differences in agricultural productivity across countries. Not surprisingly, he found that infrastructure (in that study

defined in gross domestic product [GDP] terms per unit of land) had a strong positive impact on agricultural productivity in all categories of countries. Antle followed this up with a similar study on India\(^8\) and came to the same conclusion.

4. The econometric methods adopted for these studies, however, suffered from severe shortcomings in design, and therefore did not really answer the fundamental question of impacts. For one, the data used were such that one might equally likely have estimated the impact of output on public infrastructure capital. Secondly, it is possible that, due to common trends in infrastructure and output, the correlation between output and capital stock was driven by a common time trends, and not by any underlying relationship between the two variables.

5. However, later studies have done much methodologically and empirically to improve our understanding of such impacts and the direction of cause and effect. R. Ahmed and M. Hossain\(^9\) measured the aggregate effects of village-level infrastructure (measured as a composite index) on a number of welfare and level-of-development indicators in Bangladesh and found that infrastructure development increased agricultural production by as much as 32%, and increased household incomes by 33%. In addition, they found such investments to be pro-poor since the landless and smallholder farmers garnered a larger share of incomes from better infrastructure.

6. H. Binswanger et. al\(^10\) did a similar impact analysis in India but disaggregated for each type of infrastructure and found that the availability of electricity tended to increase farmers' investments in irrigation pumps, investments in roads paved the way for bank expansion in rural areas, and all public infrastructure works created greater fertilizer demand.

7. Starting in 1999, S. Fan, et. al. started a series of International Food Policy Research Institute studies that included India\(^11\) and PRC.\(^12\) These included infrastructure as a component of public spending on agricultural research and development, irrigation, rural infrastructure such as roads and electricity, and rural development. By analyzing state-level data, they estimated the impact of different public expenditures on poverty reduction (Table 1) and found—in the case of India—that government expenditures on roads had the largest impact on poverty reduction, as well as having a significant impact on productivity growth. This finding on the relative

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impacts and roles of different types of infrastructure corresponds closely to what G. Foley\textsuperscript{13} reported in his review of the partial impacts of electrification.

8. For the PRC, Fan et. (footnote 12) has conducted significant and useful statistical research comparing how different types of investment affect economic growth and poverty reduction by region. More recently, Fan et. al (2005) compared the economic impact of investment in expressways with investment in local roads. The 2002 study highlights the hierarchy of beneficial impacts of different infrastructure and industry sectors on the poor. The relative ranking of public investment in terms of GDP return on investment and direct impact on poverty rank roads no lower than third after agricultural research and development, and education.

Table 1: Impact of Public Investment in Poverty Reduction

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of Poor Reduced per CNY10,000</th>
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<tbody>
<tr>
<td></td>
<td>Public Investment by Province</td>
</tr>
<tr>
<td></td>
<td>Coastal</td>
</tr>
<tr>
<td>Agricultural Research and Development</td>
<td>1.99</td>
</tr>
<tr>
<td>Irrigation</td>
<td>0.55</td>
</tr>
<tr>
<td>Roads</td>
<td>0.83</td>
</tr>
<tr>
<td>Education</td>
<td>2.73</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.76</td>
</tr>
<tr>
<td>Telephone</td>
<td>0.60</td>
</tr>
<tr>
<td>Poverty Loan</td>
<td>0.88</td>
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</table>


9. It is also worth noting that this multisector comparative econometric analysis concludes strongly that for all expenditure categories, poverty reduction per yuan spent is many times higher in Western provinces than elsewhere in the PRC.

10. Dong\textsuperscript{14} found a strong output response by the PRC farm households to a change in public expenditures when analyzing the effects of village-sponsored infrastructure and social services.

11. S. Chowdhury and M. Torero,\textsuperscript{15} in one of the most carefully structured econometric studies of infrastructure impacts so far, established on the basis of Bangladeshi household data that households living in a village connected to a paved road earn a higher proportion of their income, on average, from nonfarm activities compared with households living in villages not connected to paved roads. Similarly, the

\textsuperscript{13} Foley, G. 1999. Rural Energy in Developing Countries. Final report of a study commissioned by Norad.


availability of electricity or public telephones may also boost the prevalence of nonfarm activities. Other types of infrastructure have no significant effects on their own, but positive complementary effects result when more than one form of infrastructure is available; e.g., electricity only has a positive effect when combined with access to roads or telephones. This is consistent with other results from the Bangladesh study, as well as the findings reviewed by G. Foley (footnote 13).

12. Economic growth is endogenous. This means that growth levels are driven by the public expenditures—including infrastructure investments—but at the same time, public expenditures are driven by economic growth. In a recent study, Lumbila\textsuperscript{16} showed that countries with more developed infrastructure see a disproportionately greater impact of infrastructure on foreign direct investment, domestic investment, and growth.

13. At the same time, countries with underdeveloped infrastructure see no statistically significant impact of infrastructure investment on growth. In other words, not only can a lack of infrastructure be an impediment to more investment, but it can also be one of the dimensions of the so-called "poverty trap," whereby a critical mass of infrastructure is needed to convince investors to make the decisions leading to sustained growth. This suggests that there are critical and interlinked infrastructure threshold levels that have to be reached before one can trace the growth and poverty reduction impacts of infrastructure investments. For example, most African countries have yet to reach such infrastructure threshold levels, and understanding this helps to explain why it has been difficult to detect any significant correlation between infrastructure provision and growth in Africa. Institutional capacity constraints and infrastructure market distortions raise those threshold levels even further.

14. In sum, most papers that have attempted to seriously model the role of infrastructure in economic growth have found strong indications of its importance. A comprehensive review based on national macroeconomic data for the 1960–1997 period clearly shows that adding and/or improving infrastructure is linked to higher growth rates, and that there are only exceptional cases where this correlation is not observed.\textsuperscript{17}

15. The clear message from this research is that there will be no growth and no significant poverty reduction without major infrastructure improvements. This observation has led to counterfactual growth impact studies of what is the macroeconomic cost of not


investing in infrastructure. Esfahani and Ramirez\textsuperscript{18} estimated that had Africa had East Asia’s growth rate in telephones per capita (5% in Africa versus 10% in East Asia) and in electricity generation (2% in Africa versus 6% in East Asia), Africa’s per capita growth rate would have been almost 1% higher. Others did a similar country-by-country counterfactual comparison for 21 African countries with South Korea as the comparator. That study showed that the average per capita growth rate would have been slightly more than 1% higher.\textsuperscript{19}

16. These findings are in line with the diverse body of international empirical evidence, which points to public infrastructure having a significant positive impact on output and on the poverty-related outcome variables studied. For example, it has been estimated that increasing infrastructure investments by three to four percentage points of GDP increases poverty reduction effects (i.e., reduce poverty) by 0.6–1% annually.\textsuperscript{20} However, such studies on developing economies are limited, mainly because there is a lack of comparable data on infrastructure stocks and outcome variables covering a sufficiently long timeframe.

17. Recent studies of the “engines of growth” show convincingly that during the 1970–1990 period, more than 50% of the variation in growth per capita was explained by institutional variables.\textsuperscript{21} Perhaps the most important finding was that any support to infrastructure in poorly governed countries will require a strong commitment to bring about the necessary institutional changes. In this context, it is important to take into account that while construction works may take a long time to complete, it takes much more time to undo faulty institutional arrangements. Solid institutional arrangements are thus vital to ensuring the long-term viability of any infrastructure investment. This link between infrastructure impacts and institutional reform has often been underestimated in the past.

II. Impacts of Transport Infrastructure Projects on Poverty Reduction

18. The recent multi-country (PRC, India, and Thailand) ADB study \textit{Assessing the Impact of Transport and Energy Infrastructure on Poverty Reduction}, not only takes into consideration its primary field studies commissioned in the three countries, but also reviews empirical findings from literature and research on the topic worldwide, and on that basis reaches the following key conclusions of relevance to this review:


19. Transport infrastructure investments have benefited the poor as well as the nonpoor. There is insufficient evidence to reject the hypothesis that the nonpoor benefit more than the poor from public goods transport investments. Poor people welcome the reduced transport costs that result from competition in the transport industry. Reduced transport costs mean reduced costs of inputs to both their farm and nonfarm activities, reduced prices and increased selection of consumer goods, and reduced sensitivity to transport costs and time when marketing their own produce. Poor people near the poverty line are mobile and express demand for transport services. They share equally in the qualitative benefits of improved access to health, education, social and community services, increased safety and security, and access to information.

20. However, transport improvements are less likely—in the short run—to benefit the poorest of the poor. The poorest of the poor tend to be chronically poor for reasons that are not linked to the availability of transport services. This group constitutes a rather small portion of the poor in the PRC. Their mobility is so limited beyond their household, that the challenges of meeting their demands for a better life will be more effectively met by non-transport measures.

21. For the chronic poor, village road improvements may produce net negative effects on welfare. Such people include those who are essentially captive to their household or village (e.g., due to physical handicaps), and those whose livelihoods depend on activities that may be displaced by the transport improvements. In addition, the less productive among the local producers may suffer, since they will be exposed to competition from outside suppliers. Expanding the scope of road improvement projects to include components that target these vulnerable groups could facilitate the process of decision-making toward a project acceptable to all affected parties.

22. Transport improvements are, frankly speaking, not a cost-effective way to address problems facing the chronic poor. Project experience from several countries suggests clearly that households that do not report benefits from transport improvements fit the socioeconomic profile of chronic poor, typically suffering from disabilities, chronic disease, low education levels, and high dependency ratios. Nonetheless, short-term transport benefits may materialize for such households in the form of improved access to education, health care, and social services, which may then pave the way for better income opportunities in the future.

23. Transport planning for poverty reduction must take into account that poverty is not so much a village as a household phenomenon. There are poor households in well-off communities, and well-off households in poor and disadvantaged communities. Experience shows that bringing transport to a community initially creates benefits for the relatively rich households, while enabling some of the poorer ones to
move out of poverty. The extent to which transport investments bring economic benefits to a household depends on the assets the household can mobilize to take advantage of the improved opportunity. Consequently, even though everyone benefits from the new or improved roads, the perception may still be one of growing social inequity.

24. *An important observation in this context is that the poor who do not move out of poverty immediately can also benefit significantly.* They may not travel or transport goods themselves, but they will nevertheless benefit from improved access to jobs, consumer goods, and inputs to whatever they are engaged in producing. Measuring poverty reduction by looking at the number or percentage of people being lifted above an official poverty line can thus be rather misleading.

25. *Transport creates opportunities to increase the productivity of the poor.* Consistently, transport improvements are seen as having the most significant impacts on the incomes of the poor in communities where they are not captive and indebted to middlemen and monopolistic transport service operators. And even in such places, improved access to markets and employment could reduce such intra-community dependencies. Increased opportunities for employment in nonfarm enterprises appears to be the dominating effect; this also applies to landless poor, so long as they do not have a chronic physical handicap.

26. *The provision of a road alone does not determine who benefits and the extent of those benefits. Equally important is the quality and reliability of the services provided.* Since competition in transport services in the PRC tends to be stiff, it is likely that improved transport infrastructure and transport services will benefit the users (including the poor) in the form of lower prices, increased frequency of service, and shorter travel times. This again impacts positively on the local investment climate and the preparedness of community households to take more risks and invest in equipment and new production lines (including higher value and perishable crops) that could enhance incomes considerably.

27. *Time savings are of great importance to the poor, especially to time-deprived women. Their time is worth much more than their estimated opportunity cost of labor.* Improved transportation generates time savings that provide for more time spent on the farm, household work, or participation in health care, education and/or community activities, and expands the radius within which they can seek off-farm employment opportunities. The value of such time savings have traditionally been ignored in manuals for project preparation.
### III. Cost-Effective Pathways Out of Rural Poverty in the PRC—the Role of Road Investments

28. Based on fieldwork and extensive interviews in poor areas with distinctly different sociocultural and natural resource characteristics in Sichuan and Yunnan provinces, this Operations Evaluation Department study found, unsurprisingly, that the real impact of infrastructure investment on poverty reduction varies across regions, depending on local conditions in the particular area.

29. In areas with limited natural resources for agricultural expansion (i.e., where the population carrying capacity of soils and water is virtually exhausted), people escape from poverty through the migration of younger family members to the cities or other provinces with better job opportunities. In such areas (e.g., in parts of rural Sichuan Province), the lack of good local infrastructure such as rural roads and expressways does not stop people from migrating out of their villages, as long as they can find better job opportunities in the outside world where they have social connections. It is the ability to migrate that determines the extent to which they are able to escape poverty and contribute with remittances back to their origin.

30. This ability to migrate is due to (i) the many jobs created by the sustained rapid economic growth in the PRC, (ii) the emergence of an integrated labor market nationwide, and (iii) easy access to information about job opportunities arising from having relatives and friends outside the village and province who migrated earlier.

31. There is at best tenuous evidence to suggest that expressways (running through poor provinces) and/or local roads increase the incidence of poor households rising out of poverty. But one must clearly acknowledge that expressways—in particular the National Trunk Highway System—have had a strong indirect impact on poverty reduction because of the critical role they have played in removing bottlenecks to the sustained high rate of economic growth in the PRC. This growth is the underlying factor that creates new jobs in the coastal and central areas of the country, thus making large-scale migration possible. From this perspective, investing in expressways as a means to create a climate for workplace investments that facilitates migration from poor, growth-constrained communities could be an extremely cost-effective poverty reduction method, even if it contains no explicit, geographically placed poverty reduction component.

32. In areas where the natural resource conditions, population densities, and agro-cultural practices combine to suggest a considerable underutilized carrying capacity of the land, the poverty reduction impacts from improved rural roads and reliable year-

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round transport can be significant. For example, in rural areas of Yunnan Province with high potential for developing commercial crops, improved rural-road access enabled poor households to rise from poverty by growing and marketing such crops.

33. In these areas, the improved rural-road network meant that commercial firms were more willing to sign contracts with farmers to purchase their produce. Such firms have a choice between locations, and communities that lack good road access usually end up losers because doing business in these communities means higher transport costs, higher travel times, and more uncertain access.

IV. Where to Improve Roads to Achieve Cost-Effective Poverty Reduction

34. The answer to this question is complex and elusive. S. Fan et. al (footnote 11) sought answers to the question by subdividing in the PRC GDP and poverty impacts by region. The eastern coastal area of the PRC is more urbanized and has better access to coastal shipping. Trading has always been a strong characteristic of the coastal provinces. Conversely, the central and western provinces have traditionally been difficult to access. The analysis showed the highest GDP impact of roads was in the central provinces, which logically benefited the most from the improved accessibility afforded by the new toll road system.

35. The direct impact of roads on poverty reduction is also impressive and shows that the Government’s consistent policy of improving access to a strong hierarchy of roads remains a viable and necessary development strategy. What is less clear is what role the toll-road system fills in that strategy. As the focus of attention shifts to the western provinces, rightly, the residual obligation to continue the development of the system in the eastern and central provinces will fall increasingly on the private sector.

36. Their more recent research (footnote 13) targeted the difference between funding expressways and funding local roads. It assessed the differential impact of that investment on both rural- and non-rural GDP, disaggregated by geographic areas of the PRC. It found that the GDP return from investment in rural roads was significantly higher than the equivalent investment in higher-standard roads. As noted in the report:

For the country as a whole, the marginal benefit-cost ratio for high-quality roads was 1.45 in 2001. The southwest region has the highest return, followed by the central region, which are two relatively poor regions in PRC. The lowest returns occurred in the northwest and the south. The returns to low-quality roads are much higher. The average return to low-

quality roads was 6.37 yuan for each yuan invested in PRC in 2001. This is more than four times larger than the return to investment in high-quality roads. The southeast region has the highest return, followed by the south and southwest, whereas the lowest return occurs in the northwest.

37. Rural-road upgrading is needed in all provinces as such roads improve access to markets and employment—both of which are more plentiful in the south, particularly in the southeastern provinces where the impact is highest.

38. Furthermore, the 2005 S. Fan model points out that the gross increase in economic activity nationwide is higher with expressways, the cost effectiveness of expenditures on roads is much higher for local roads because they cost much less. The ratio of effectiveness of investment in rural roads in the northern and southwestern provinces is 5 to 10 times greater than the comparative investment in expressways. While this does not in itself argue for less investment in expressways, it does highlight the need to continue to aggressively focus on local roads.24

39. “For high-quality roads, every million yuan invested raises 13 rural poor above the official poverty line. Again, low-quality roads are much more beneficial, raising 161 rural people out of poverty for every million yuan invested. For both high-quality and low-quality roads, the poverty impacts are largest in the southwest and northwest regions when the official poverty line is used. However, when Xi’an and Sheng’s poverty line is used, the number of rural poor helped is much larger: each million yuan invested in high and low quality roads, 50 and 821 rural poor, respectively, are raised above the poverty line. These effects are about four times larger than those estimated using the official poverty line. For high-quality roads, the largest impact is found in the southwest, followed by the northwest and the north. For low-quality roads, the largest impact also occurs in the southwest followed by the north, and then the central and southeast regions.25

40. The above review of empirical experience from ADB- and World Bank-funded projects supplemented by a comprehensive review of independent research (which for

24 Both the 2002 and the following 2005 studies are based on a rigorous analysis of the available PRC statistics using a series of simultaneous equations that include: agricultural GDP per worker, terms of trade (measured as agricultural prices divided by a relevant non-agricultural gross national product deflator), chemical fertilizer use per worker, GDP per worker, rural illiteracy rate, percentage of total cropped area that is irrigated, capital stock per worker, arable land per agricultural worker, nonfarm GDP per worker, capital stock per worker in the rural nonfarm sector, agricultural research stock per worker, rural electricity consumption per agricultural worker, length of high-quality roads per agricultural worker, length of high-quality roads per nonfarm worker, length of high-quality roads per worker, length of high-quality roads per urban worker, length of lower-quality roads per agricultural worker, length of lower-quality roads per nonfarm worker, length of lower-quality roads per worker, length of lower-quality roads per urban worker, percentage of rural population below poverty line, average years of schooling of rural population 15 years and older, number of rural telephone sets per agricultural worker, average years of schooling of general population 15 years and older, urban GDP per worker, gini coefficient of per capita expenditure for urban residents, urban capital stock per worker, percentage of urban population below poverty line, and percentage of urban population in total population.

the most part supports the conclusions and recommendations reached in ADB projects), can perhaps be summarized as follows:

(i) The net economic impact in terms of poverty alleviation from road transport investment improves as the investment moves toward the western provinces in the PRC—by a factor of 10 over investment in the eastern provinces. However, in terms of return to the rural economy, investment in the central provinces has a higher impact than an equivalent investment in the eastern or western provinces. This is likely due to the fact that in the western provinces, the rural economy is largely self-contained at subsistence levels. In addition, historical data does not reflect a high degree of linkage to the national grid.

(ii) More recent work on the same theme using more recent and more comprehensive sets of data shows that the overall economic returns from high-quality roads are highest in the central and southwestern provinces, and from low-quality roads in the southeast, south, and southwest.

(iii) When comparing high-quality and low-quality roads, the difference in the cost of construction compared with the economic return shows much higher returns from low-quality roads in terms of poverty reduction.

(iv) In examining the spillover effect of investment in one province on other provinces, road investment in the central provinces provides both a push and a pull effect on the adjacent western and eastern provinces, and results in the best overall net economic effect. While investment in the eastern and western provinces tends to stay largely in the east and west, investment in the central provinces benefits all regions.

(v) Since expressway investments to build the NTHS have contributed critically to the PRC’s very high sustained economic growth rates—and as a result growth in jobs in the fastest growing provinces and cities—many of the rural poor, who have minimal opportunities to escape poverty at home, have been escaping poverty by migrating. As they do so, they provide important cash contributions to their families back home. From this perspective, expressway construction and establishment of the NTHS have been very important growth stimulants, and quite likely a highly effective indirect means of poverty reduction.

(vi) The strong poverty reduction effects of local roads also must be acknowledged. However, poverty reduction cost-effectiveness by means of rural roads is not a universal solution. Before prioritizing such investments in a localized area, one must carefully establish the underlying causes of the observed poverty, and from such understanding determine if and when—and in what context—rural roads investment is the best way to proceed.
determine if and when—and in what context—rural roads investment (upgrading and/or new roads) is the best way to proceed.