ASIAN DEVELOPMENT BANK

THE MEKONG REGION:
ECONOMIC AND SOCIAL IMPACT OF PROJECTS

June 2005

ABBREVIATIONS

ACMECS	—	Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy
ADB	—	Asian Development Bank
AFTA	—	ASEAN Free Trade Area
AIDS	—	acquired immunodeficiency syndrome
ASEAN	—	Association of Southeast Asian Nations
BOP	—	balance of payments
BoT	—	Bank of Thailand
BTA	—	Bilateral Trade Agreement
CEPT	—	Common Effective Preferential Tariff
CPI		Consumer Price Index
DFID		Department for International Development
FDI	—	foreign direct investment
FTA	—	Free Trade Area
FY	—	fiscal year
GDP	—	gross domestic product
GMS	—	Greater Mekong Subregion
HIV	—	human immunodeficiency virus
IMF	—	International Monetary Fund
LECS	—	Lao Expenditure and Consumption Survey
MDGs		Millennium Development Goals
MFA	—	Multi-Fiber Agreement
MFIs	—	multilateral financial institutions
MFN	—	Most Favored Nation
MREO	—	Mekong Region Economic Overview
NESDB	—	National Economic and Social Development Board
NPV	—	net present value
NT	—	National Treatment
NTR	—	Normal Trade Relations
NEM		New Economic Mechanism
PRC		People’s Republic of China
SARS	—	Severe Acute Respiratory Syndrome
SE		standard error
UNDP	—	United Nations Development Program
WTO	—	World Trade Organization

NOTE

In this report, "$" refers to US dollars.

CONTENTS

EXECUTIVE SUMMARY

The inaugural issue of *The Mekong Region: An Economic Overview* was published in March 2004[1] and had as its theme debt sustainability in the less developed countries of the Mekong subregion. In this the second issue, the focus is on the economic and social impacts of projects.

We begin by reviewing recent economic performance, both at the regional and the individual country levels, focusing on major macroeconomic developments.

Recent Economic Performance

The Greater Mekong Subregion (GMS) is one of the fastest-growing subregions in the world. Gross domestic product (GDP) growth in all six economies was robust in 2004, ranging from 6% in Cambodia to 7.5% in Viet Nam. Between 2003 and 2004, growth was higher in all countries except Thailand, where it fell only marginally. The GNP-weighted average growth for GMS in 2003 was 7.8%, the highest in the 2000s.

Mainly as a result of higher world oil prices, inflation picked up in all countries except the Lao People's Democratic Republic (Lao PDR) in 2004. All GMS economies except Thailand continued to run fiscal deficits during 2004, although these deficits narrowed in all countries compared to 2003. All countries except Thailand continued to run current account deficits in 2004. Apart from Viet Nam where the deficit narrowed quite appreciably, the situation in other countries was little changed in 2004.

Analytical Framework for Assessing Economic and Social Impacts of Projects

Next, we present an analytical framework to assess the economic and social impacts of infrastructure projects. It is well established that infrastructure projects are capable of generating substantial benefits for poor people, but how do they do so? This chapter looks at the channels through which these benefits are realized. In poor countries, public infrastructure tends to be particularly inadequate and its absence harms the poor, along with other members of the society.

Public institutions generally participate in some way in the provision of public infrastructure. This necessity arises from economies of scale in the provision of these goods and because they tend to be public or partially public goods. The first feature implies that when they are provided on an exclusively private basis, *monopolies* tend to result. The second feature implies that when goods of this kind are provided by the private sector, they are normally *inadequately provided* because of the difficulty of capturing the benefits privately. Because private sector investors are unable to capture the benefits that the investments generate, they may invest little or nothing in forms of infrastructure that generate large social returns. Rural roads provide a good example.

Three channels through which infrastructure benefits the poor are examined. First, it raises household incomes by raising the productivity of the resources owned by the household. For example, production infrastructure like irrigation does this by providing inputs that are directly complementary with the resources owned by the household. Transport infrastructure like

[1] The full report (ADB 2004a) can also be downloaded from the ADB website at the following address: http://www.adb.org/Documents/Reports/MREO/default.asp.

roads does it by reducing transport costs to and from markets. This raises the net returns farm households can obtain for their goods and reduces the cost of the inputs they need to purchase. Transport infrastructure may also facilitate direct employment of household members outside the household, thus raising the return to their labor directly.

The distributional element of these increases in incomes depends on the distribution of resource ownership among households and on the magnitude of the productivity improvements that occur in each of these resources. In the important case of transport infrastructure, empirical evidence suggests that the effects tend to be distributionally neutral. This means that all major income groups are affected similarly. Transport infrastructure thus tends to reduce absolute poverty, without significant effects on inequality. Within regions, infrastructure projects are not a particularly good candidate for poverty targeting because all major income groups tend to benefit. Between regions, there is greater scope for targeting, by directing the benefits towards poorer regions. Poorer regions can benefit from this practice, provided the infrastructure they receive is actually productive, given their circumstances.

The second channel of effects is through access to public services such as education and health facilities. The infrastructure reduces the cost of reaching these facilities, in the case of roads, or improved information about them, in the case of communications facilities. The possibility of benefits of this kind depends on the coexistence of educational and health facilities within reach of the household. The final source of benefit is that infrastructure improves access to final consumer goods and, by reducing transport costs, makes them more affordable. Electricity infrastructure makes it possible for the household to use a wide range of consumer goods otherwise unavailable to them.

The negative effects of providing infrastructure can be important; unfortunately, the Mekong countries provide examples of some such effects. As road access to remote areas improves, negative environmental outcomes such as deforestation, caused by increased commercial logging and/or land clearing for agriculture, may increase. The flow of drugs may increase, although the capacity of governments to suppress the production of drugs may be improved. Trafficking in women and children may be facilitated. Finally, the spread of HIV/AIDS[2] may increase. These potential negative effects raise the importance of governance. Achieving the demonstrated social benefits from improving infrastructure while avoiding or at least minimizing the negative effects is a challenge to governance throughout the Mekong subregion.

With the aid of this analytical framework, we turned next to a case study of these effects in operation in the context of rural areas of the Lao PDR.

In the Lao PDR, rural roads are widely recognized to be a major developmental problem and improving them will obviously generate benefits. But demonstrating and quantifying effects on indicators relevant for the Millennium Development Goals (MDGs), such as poverty incidence, educational participation, and health standards are another matter.

Economic and Social Impacts of Rural Roads in the Lao PDR: A Case Study

The case study uses household level data from the Lao Expenditure and Consumption Survey (LECS) relating to 1997–1998 and 2002–2003. These data suggest that rural areas of the Lao PDR account for 87% of all poor people in that country. Reducing poverty in the Lao PDR primarily means, reducing rural poverty. But what works and what does not work in

[2] Human immunodeficiency virus/acquired immunodeficiency syndrome.

achieving the goal of poverty reduction? This case study is directed to that question. The case study looks at three dimensions of poverty, broadly conceived: consumption poverty, meaning expenditure on privately purchased goods and services; educational opportunity; and health standards. Consumption poverty measures only the availability of goods and services that people can purchase with their own funds and makes no allowance for the availability of goods and services provided at a collective level, principally by the government. For this reason, including such collectively provided goods as educational and health services is a useful broadening of the concept of poverty reduction.

The results of this analysis suggest that for poverty reduction, the important form of road improvement is the conversion of dry season access roads into all season access. This is in fact the principal form of road improvement that occurred in the Lao PDR between 1997–1998 and 2002–2003. Over this same period, poverty incidence declined from 42.5% to 37.6% of the rural population. The results of this analysis suggest that about one fourth of this amount of poverty reduction can be directly attributed to the conversion of roads that are accessible only in the dry season into roads that are accessible in all seasons. The principal form of road improvement that occurred in the Lao PDR has therefore been consistent with the goal of maximizing the rate of poverty reduction.

The data for the Lao PDR also indicate that improvement of roads has effects on educational participation and health standards. Whereas effects of poverty incidence are strongest for the upgrading of dry season access roads to all weather roads, educational and health benefits derive mainly from provision of dry season access to households, which previously had no road access (meaning, they were accessible only by walking). Over the 5-year period examined in this case study, very little road improvement of this kind actually occurred in the Lao PDR. The results suggest that educational and health benefits would be derived by providing dry season road access to the 20% of rural households that presently lack it.

In summary, it is fair to conclude that the case study provides evidence that road improvement in rural areas can contribute to lowering poverty incidence, improving educational participation of primary school-age children, and reducing rates of illness. In the developing Mekong subregion, these findings have particular relevance and give added weight to national and regional investment programs, particularly those targeting the rural poor.

I. INTRODUCTION

1. The inaugural issue of *The Mekong Region: An Economic Overview* was published in March 2004 and had as its theme debt sustainability in the less developed countries of the Mekong subregion (Asian Development Bank [ADB] 2004a)[3]. In this the second issue, the focus is on the economic and social impacts of projects.

2. The report is organized as follows:

(i) We begin by reviewing recent economic performance, both at the regional and the individual country levels, focusing on major macroeconomic developments.

(ii) Next, we present an analytical framework to assess the economic and social impacts of infrastructure projects. We focus on the transmission mechanisms associated with such interventions or the ways in which infrastructure projects can be expected to impact upon the economic and social well-being of affected populations.

(iii) Drawing upon this framework, we proceed to a case study on rural roads in the Lao People's Democratic Republic (Lao PDR). We provide quantitative evidence of the impact that infrastructure investment in the form of rural road development can have on economic and social indicators such as poverty incidence, educational participation rates of primary school aged children, and health conditions such as rates of illness.

(iv) A final section summarizes the major points.

II. RECENT ECONOMIC PERFORMANCE

A. Regional Overview[4]

3. The Greater Mekong Subregion (GMS) is one of the fastest-growing subregions in the world. With the exception of Thailand, which was directly affected by the Asian financial crisis, growth has remained about 4% or higher in all of the economies for the past decade. Gross domestic product (GDP) growth in all six economies was robust in 2004, ranging from 6% in Cambodia to 7.5% in Viet Nam (Table 1, Figure 1) between 2003 and 2004. Growth was higher in all countries except Thailand, where it fell only marginally.

4. The GNP-weighted average growth for GMS in 2003 was 7.8%, the highest in the 2000s.

5. Mainly as a result of higher world oil prices, inflation picked up in all countries, except the Lao PDR, in 2004 (Table 2, Figure 2). Although still quite high, inflation in the Lao PDR fell quite sharply from 15.8% in 2003 to 10.6% in 2004. The sharpest increase in inflation occurred in Viet Nam, where it more than doubled from 3.2% in 2003 to 7.7% in 2004.

[3] The full report can be downloaded from the ADB website at the following address: http://www.adb.org/Documents/Reports/MREO/default.asp.

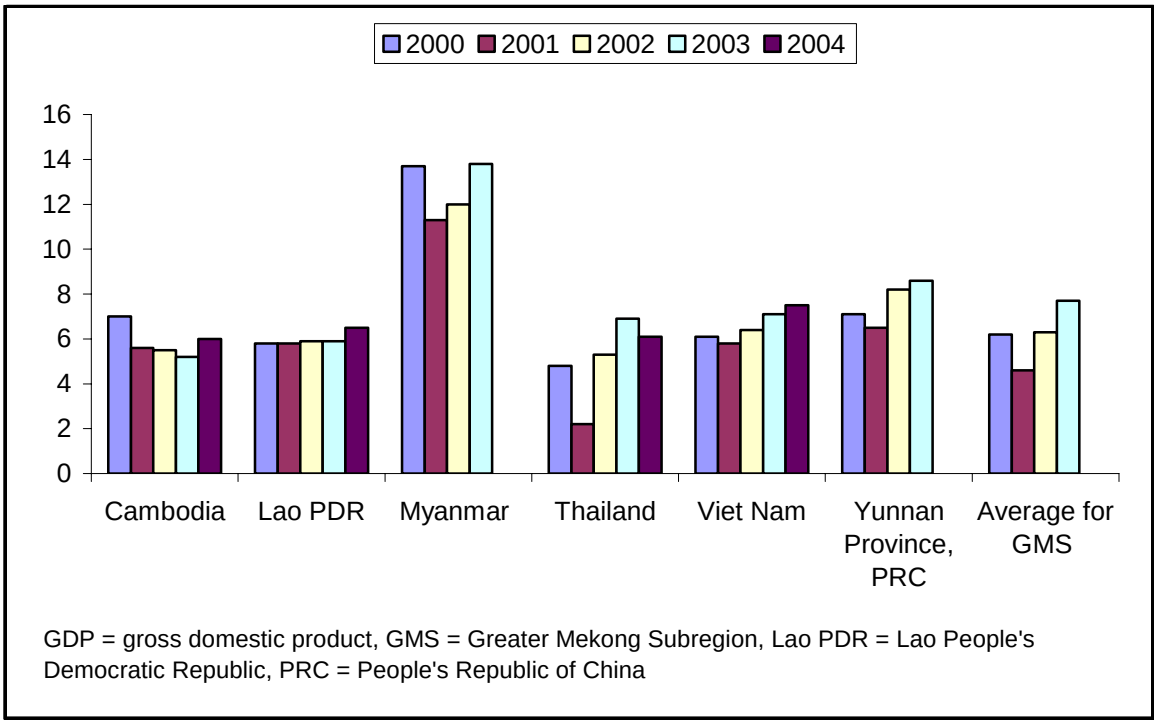
[4] Due to lack of data, we are unable to provide a detailed economic assessment of Yunnan Province and Guangxi Zhuang Autonomous Region of the People's Republic of China (PRC).

Table 1: GDP Growth, 2000–2004
(%)

Country	2000	2001	2002	2003	2004
Cambodia	7.0	5.6	5.5	5.2	6.0
Lao PDR	5.8	5.8	5.9	5.9	6.5
Myanmar [a]	13.7	11.3	12.0	13.8	—
Thailand	4.8	2.2	5.3	6.9	6.2
Viet Nam	6.1	5.8	6.4	7.1	7.5
Yunnan Province, PRC	7.1	6.5	8.2	8.6	—
Average for GMS [b]	6.2	4.6	6.6	7.8	—

— = not available.
GDP = gross domestic product, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PPP = purchasing power parity, PRC = People's Republic of China.
[a] Fiscal year data (April to March).
[b] Weighted average based on PPP GDP shares.
Sources: Asian Development Bank. *Asian Development Outlook 2005*. Manila; Central Statistical Organization, Union of Myanmar; Committee for Planning and Investment, Lao PDR; General Statistics Office, Viet Nam; National Economic and Social Development Board, Thailand; National Institute of Statistics, Cambodia; National Statistical Center, Lao PDR; WDI Online (http://devdata.worldbank.org/dataonline, downloaded 15 May 2005), The World Bank Group; and *Yunnan Statistical Yearbook 2004*, China Statistics Press.

Figure 1: GDP Growth, 2000–2004, %



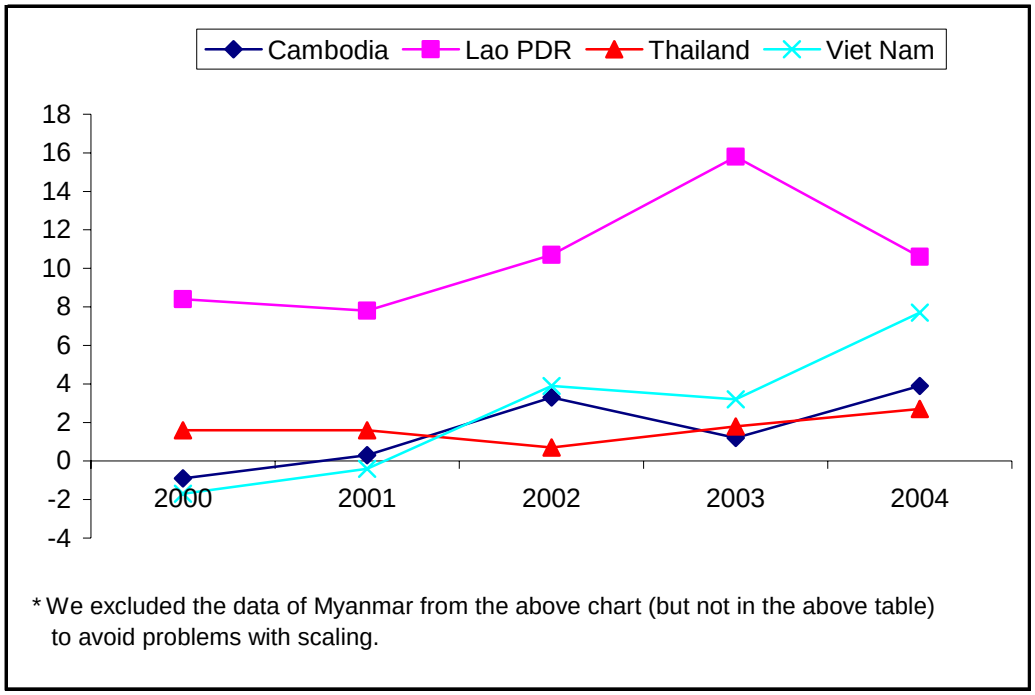
GDP = gross domestic product, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China

Table 2: Inflation Rate (Consumer Price Index)
2000–2004, (%)

Country	2000	2001	2002	2003	2004
Cambodia	(0.9)	0.3	3.3	1.2	3.9
Lao PDR	8.4	7.8	10.7	15.8	10.6
Myanmar	(0.2)	21.2	57.0	36.6	—
Thailand	1.6	1.6	0.7	1.8	2.7
Viet Nam	(1.7)	(0.4)	3.9	3.2	7.7

— = not available.
Lao PDR = Lao People's Democratic Republic.
Sources: Asian Development Bank. *Asian Development Outlook 2005.* Manila; Bank of Thailand; Bureau of Trade and Economic Indices, Ministry of Commerce, Thailand; Central Statistical Organization, Union of Myanmar; General Statistics Office, Viet Nam; National Institute of Statistics, Cambodia; and National Statistical Center, Lao PDR.

Figure 2: Inflation Rate (Consumer Price Index) *
2000–2004, %



* We excluded the data of Myanmar from the above chart (but not in the above table) to avoid problems with scaling.

6. All GMS economies except Thailand continued to run fiscal deficits during 2004, although these deficits narrowed in all countries compared to 2003 (Table 3, Figure 3). The Lao PDR has historically had the highest deficit of the Mekong countries, but it fell quite sharply from 7.8% of GDP in 2003 to 4.8% in 2004. Cambodia now has the largest budget deficit in the subregion at 6.4% of GDP. Thailand posted its second consecutive surplus since the Asian financial crisis, although it narrowed somewhat from 0.6% to 0.3% of GDP. Despite the across-the-board narrowing of budget deficits in the subregion, difficulties in raising government revenues continue to affect the fiscal position in the Lao PDR, Cambodia, and Myanmar.

7. All countries except Thailand continued to run current account deficits in 2004 (Table 4, Figure 4). Apart from Viet Nam, where the deficit narrowed quite appreciably from 6.9% of GDP in 2003 to 5.7% in 2004, the situation in other countries was little changed in 2004.

B. Cambodia

8. After having trended down consistently since 1999, GDP growth bounced back at an estimated rate of 6% in 2004, up from 5.2% in 2003. The industrial sector contributed strongly with growth of 16.9%, as did the services sector with growth of 7%. Much of the growth in industrial output was due to a strong performance from exports of textiles, clothing, and footwear, but the phaseout of the Multi-Fiber Agreement (MFA) suggests that growth in 2005 and beyond will have to be driven by other sectors.

9. Cambodia's fiscal problems continued in 2004. For the first 11 months, government revenues and expenditures came in at 88% and 76%, respectively, of the target for the period. However, compared with the period a year earlier, revenues strengthened by 15% due mainly to a 25% rise in tax collection.

10. Annual average inflation rose steadily to 3.9% in December 2004 from 1.2% in December 2003 as a result of higher transportation costs due to rising world oil prices and drought-related food price increases.

11. The trade deficit increased to an estimated $495 million for the period January–November 2004 from $398.8 million a year earlier. Imports grew by 22.4% to $2.2 billion while exports grew by 21.8% to $1.7 billion in the first 9 months of 2004.The current account deficit (excluding official transfers) during the first 9 months of 2004 widened to $431.7 million from $323.8 million in the same period of the previous year. The deficit was more than matched by higher inflows of official loans and grants and an increase in foreign direct investment (FDI) inflows.

12. The riel remained relatively stable in 2004 at around 4000 to the dollar. Foreign exchange reserves rose to $752.3 million at the end of September 2004 from $672 million 12 months earlier, sufficient to cover more than 3 months of imports.

C. Lao PDR

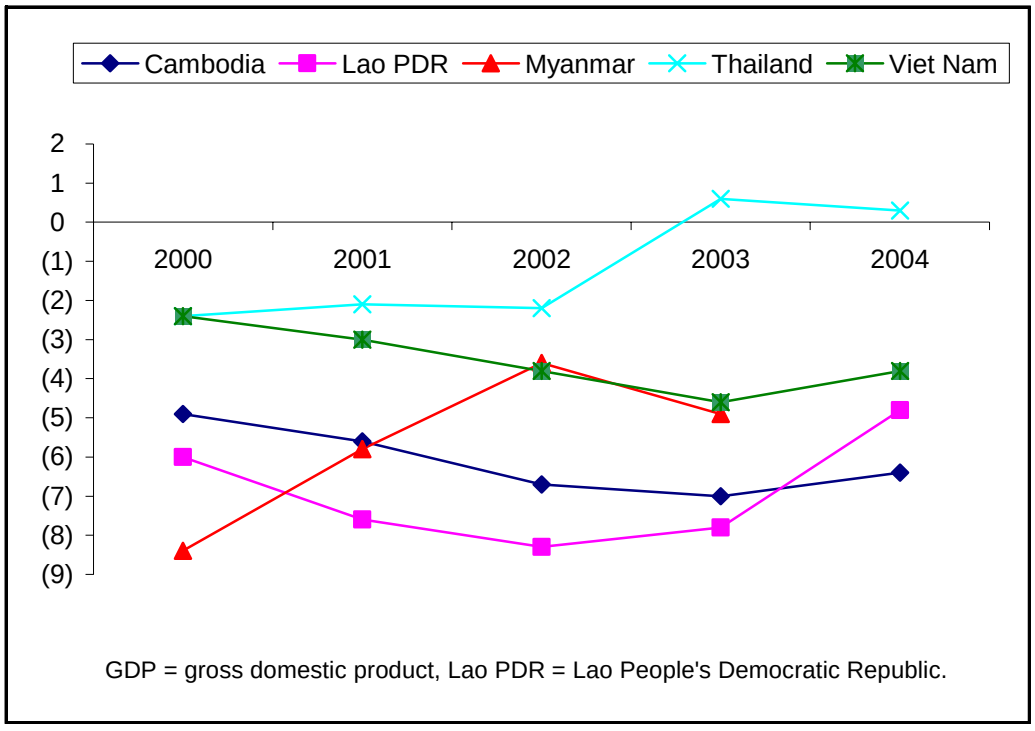
13. In 2004, the Lao PDR's GDP growth was impressive at 6.5%, up from 5.9% in 2003. Although growth in the dominant agricultural sector was relatively modest at 3.5%, other sectors grew strongly. Mining and hydropower were the main contributors to the industrial sector's expansion of 11.4%. The services sectors, following a strong rebound in tourism after the end of the regional severe acute respiratory syndrome (SARS) outbreak, also grew sharply at 7.3%.

Table 3: Fiscal Balance/GDP [a]
2000–2004, (%)

Country	2000	2001	2002	2003	2004
Cambodia	(4.9)	(5.6)	(6.7)	(7.0)	(6.4)
Lao PDR	(6.0)	(7.6)	(8.3)	(7.8)	(4.8)
Myanmar [b]	(8.4)	(5.8)	(3.6)	(4.9)	—
Thailand [c]	(2.4)	(2.1)	(2.2)	0.6	0.3
Viet Nam	(2.4)	(3.0)	(3.8)	(4.6)	(3.8)

— = not available.
GDP = gross domestic product; Lao PDR = Lao People's Democratic Republic.
[a] Excluding grants
[b] Fiscal year data (April to March).
[c] Fiscal year data (October to September) and includes budgetary and nonbudgetary balances.
Sources: Asian Development Bank. *Asian Development Outlook 2005.* Manila; Bank of the Lao PDR; Bank of Thailand (BoT); Central Statistical Organization, Union of Myanmar; General Statistics Office, Viet Nam; International Monetary Fund (IMF); Ministry of Economy and Finance, Cambodia; Ministry of Finance, Lao PDR; National Bank of Cambodia; National Economic and Social Development Board, Thailand; National Institute of Statistics, Cambodia; National Statistical Center, Lao PDR; and State Bank of Viet Nam.

Figure3: Fiscal Balance/GDP
2000–2004, %



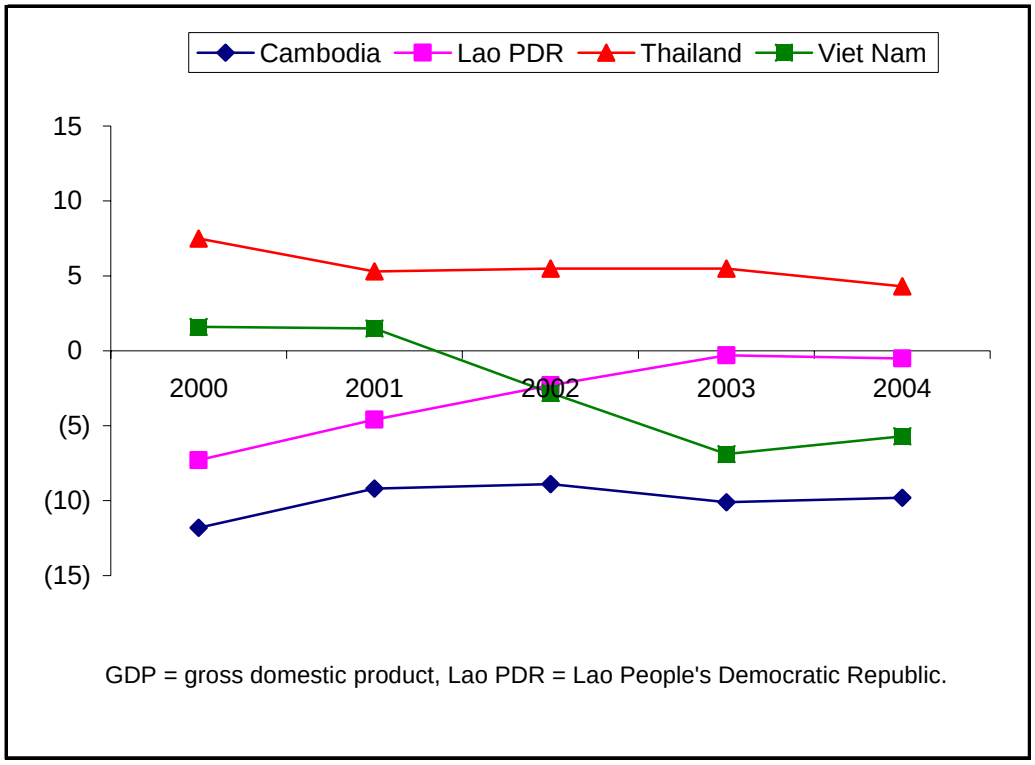
GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic.

Table 4: Current Account Balance/GDP*
2000–2004, (%)

Country	2000	2001	2002	2003	2004
Cambodia	(11.8)	(9.2)	(8.9)	(10.1)	(9.8)
Lao PDR	(7.3)	(4.6)	(2.3)	(0.3)	(0.5)
Thailand	7.5	5.3	5.5	5.5	4.3
Viet Nam	1.6	1.5	(2.8)	(6.9)	(5.7)

GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic.
* Excluding official transfers.
Sources: Asian Development Bank. *Asian Development Outlook 2005*. Manila; Bank of the Lao PDR; Bank of Thailand; General Statistics Office, Viet Nam; Ministry of Economy and Finance, Cambodia; Ministry of Finance, Lao PDR; National Bank of Cambodia; National Economic and Social Development Board, Thailand; National Institute of Statistics, Cambodia; National Statistical Center, Lao PDR; and State Bank of Viet Nam.

Figure 4: Current Account Balance/GDP
2000–2004, %



GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic.

14. Concerns relating to fiscal sustainability increased in 2004. The fiscal deficit increased to 9.2% of GDP from 7.8% in 2003. Although revenue collection (excluding grants) as a share of GDP improved slightly from 11.0% in 2003 to 11.5% in 2004, government expenditure rose quite significantly from 18.8% to 20.7%.

15. Despite increases in oil prices, inflation declined from 15.5% in 2003 to an estimated 10.5% in 2004. This was due mainly to relatively stable food prices, which account for almost half of the consumer price index (CPI) basket. Also worth noting is that, for the first time since 2002, the monthly inflation fell to single digits (9.2%) in August 2004, and fell further to 8.7% by year-end.

16. Export increased quite sharply in 2004, rising by 22.5%, while imports increased by 16.2%. Despite a narrowing of the trade deficit, the current account deficit increased from 0.3% of GDP in 2003 to 2.0% in 2004.

17. The exchange rate remained broadly stable in 2004.

D. Myanmar

18. Data on Myanmar are sparse, and concerns have been raised over their reliability. Independent estimates suggest that economic growth for fiscal year (FY) 2003 (endeding 31 March 2004) was a lot lower than the official estimate of 13.8%. Furthermore, growth rates of essential inputs (power, fertilizer, etc.) do not lend support to such high GDP growth rates.

19. The overall fiscal deficit increased from 3.6% of GDP in FY2002 to 4.9% in FY2003. Both government spending and tax revenues increased sharply, by 52%, in FY2003.

20. According to official estimates, inflation came off its very high levels during the year. After reaching 53% in March 2003, inflation is reported to have fallen to 2.3% in June 2004 before increasing to about 7% in October 2004.

21. FDI has been falling consistently over the past 5 years. Between FY2002 and FY2003, FDI fell by a further 33%.

E. Thailand

22. GDP growth in 2004 remained robust at 6.2%, albeit lower than the 6.8% achieved in 2003. A number of factors account for the minor growth deceleration, including the outbreak of the avian flu, increasing oil prices, the long drought, and the sociopolitical unrest in the southern provinces.

23. For FY2003/04 (ending September 2004), both revenues and expenditures increased by about 17%. The government cash balance registered a surplus of Baht 17.2 billion, or about 0.3% of GDP, slightly down from the 0.6% surplus recorded in FY2003.

24. Headline inflation came in at 2.7% in 2004, significantly higher than 1.8% in 2003. This was due largely to higher prices of farm and oil products. Core inflation, which excludes raw food and energy, was still low at 0.4%, but higher than 0.2% in 2003.

25. Thailand's external performance remained strong in 2004. Merchandise exports increased by 23% while merchandise imports grew by 27%. The trade surplus narrowed somewhat from $3.8 billion in 2003 to $1.7 billion in 2004. Consequently, the current account surplus also narrowed from 5.6% in 2003 to 3.6% in 2004.

26. The baht strengthened from around 41.5 to the dollar in 2003 to about 40 in 2004. It has been trading below 40 in 2005. Gross international reserves increased to $49.8 billion in November 2004 from $42.1 billion at end-2003.

F. Viet Nam

27. With GDP growth reaching 7.5% in 2004, Viet Nam is one of the fastest-growing countries in the world. As in previous years, strong consumption and investment spending, coupled with robust export performance, underpinned this performance. Strong growth is expected to continue in 2005, remaining higher than 7%

28. Strong economic growth and higher world oil prices provided a boost to government revenues, exceeding the government's target by 14.5%. Expenditures, however, also exceeded the budgeted target by 10.9%, partly as a result of avian flu-related expenditures. The overall fiscal deficit was estimated at 3.8%, below the Government's target of 5%.

29. Buoyant world oil prices as well as the prices of many of Viet Nam's commodity exports lifted export revenues. Total export revenues rose by 30% to reach $26 billion. Higher import prices also increased the total import bill by 26% to about $31 billion, resulting in a trade deficit of about $5 billion. The current account deficit as a share of GDP fell from 6.9% in 2003 to 5.7% in 2004.

30. Inflation rose sharply in 2004, reaching 7.7%, when it was only 3.2% in 2003. Higher fuel and food prices were the main contributors to this sharp increase in inflation. If food prices were excluded, the increase in the CPI would be a much more moderate 3%.

31. FDI commitments increased to almost $4 billion in 2004, almost a third higher than in 2003. Net FDI, on the other hand, increased from $1.2 billion to $1.7 billion.

32. Gross international reserves increased to reach almost $6 billion in 2004, equivalent to about 2.5 months of imports.

III. ECONOMIC AND SOCIAL IMPACT OF PROJECTS: AN ANALYTICAL FRAMEWORK

A. Introduction

33. Developing countries spend roughly a fifth of their total public investment budgets on infrastructure, also referred to as "social overhead capital." This buys facilities for transport, power, sanitation, communication, and water for domestic use, industrial use, and irrigation. Multilateral and bilateral development agencies also invest heavily in public infrastructure projects such as roads, telecommunication facilities, electricity services, and irrigation.[5] These

[5] By first quarter of 2004, ADB had lent $44.4 billion for projects in the infrastructure sector, which includes energy, roads and road transport, ports and shipping, airports and civil aviation, and railways. Of the total, lending for power and roads has been most important and has accounted for 48.1% and 35.5%, respectively. Energy projects totaled $21.4 billion, delivered through 280 projects. Roads accounted for $15.8 billion, involving 177 projects in 28 countries (ADB 2004b).

investments are intended to deliver benefits to households in the form of improved incomes and thus higher levels of consumption of the goods and services that households desire. They are also intended to facilitate access to public services such as educational and health facilities. Social objectives like the Millennium Development Goals (MDGs) are therefore potentially served by these outcomes.

34. It is generally necessary that public institutions participate in some way in providing this form of investment. This necessity arises from two overlapping features shared by these forms of social overhead capital. First, they tend to exhibit economies of scale. This implies that when they are provided on an exclusively private basis, *monopolies* tend to result. Second, they tend to be public or partially public goods. When goods of this kind are provided by the private sector, they are normally *inadequately provided* because of the difficulty of capturing the benefits privately. Much of the benefit spills over to people other than the investor. Because private sector investors are unable to capture the benefits that the investments generate, they may invest little or nothing in forms of infrastructure—which generate large social returns—such as rural roads, hence, the case for some form of public provision. But purely public provision is often inefficient and the public sector in any case is commonly short of capital for investment. Various forms of public and private partnerships have therefore been used in attempting to achieve the efficiencies and access to capital available from private participation while avoiding the monopolistic pricing and/or inadequate provision that purely private provision tends to produce.

35. There is considerable evidence that public investments in infrastructure indeed deliver substantial benefits to private households.[6] The evidence generally takes the form of statistical studies that show a relationship between the availability of public infrastructure and desired social outcomes. The latter include household incomes, household expenditures on goods and services, and (less commonly) broader social outcomes such as health standards or educational attainment. The existence of evidence of this kind should surprise no one. Although some investments turn out to be unproductive, the overall importance of public infrastructure facilities for public welfare is obvious when natural or man-made disasters destroy these assets. Great hardship invariably results. But how are the benefits from public infrastructure actually attained? What is the transmission mechanisms through which improved infrastructure delivers benefits to private households? That is the focus of this chapter.

36. The discussion in this chapter is partly theoretical, partly a review of past empirical studies. A case study follows in the next chapter that applies some of the concepts discussed in the case of road provision in rural Lao PDR.

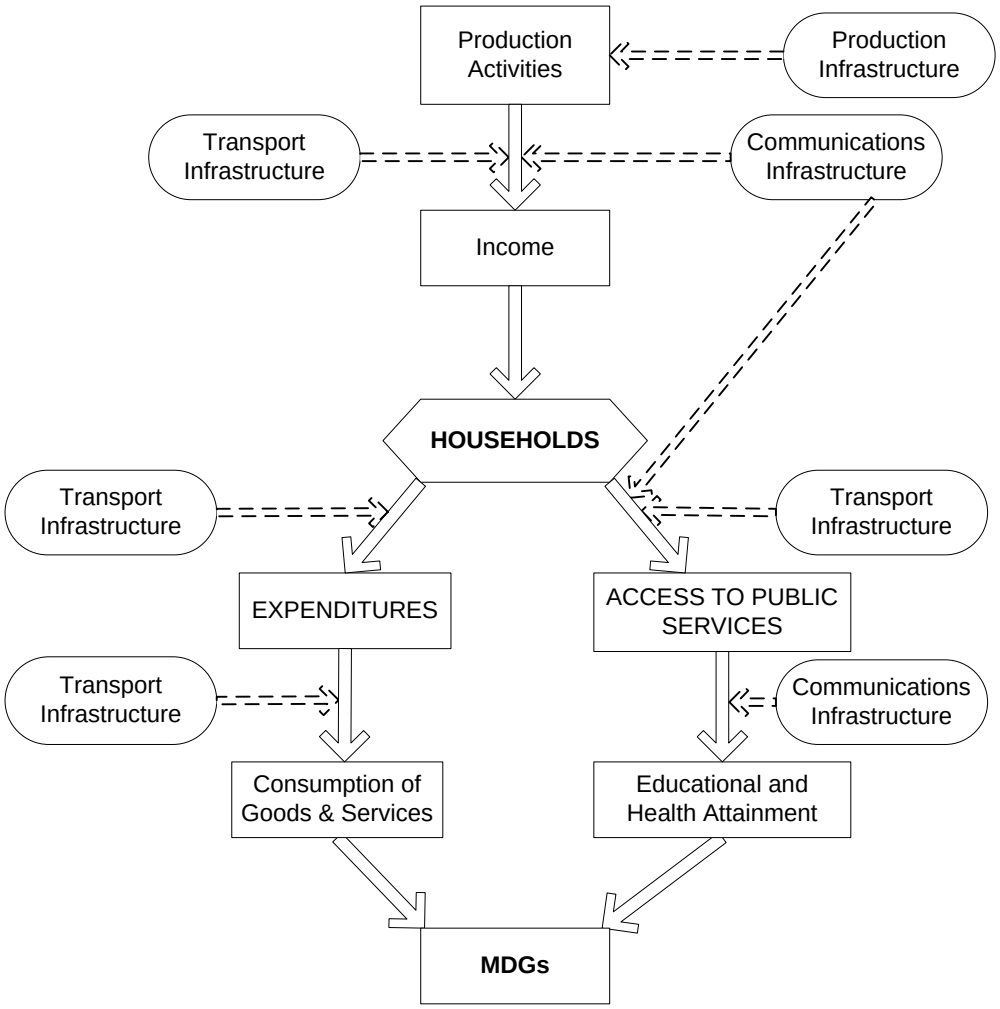
B. From Infrastructure to Welfare: Mechanisms of Transmission

37. A simple analytical framework is developed below for thinking about the channels through which infrastructure development affects welfare at the household level. This framework is summarized in Figure 5. There are three components to the diagram. The upper section focuses on the way infrastructure impacts on household incomes. The lower right section focuses on the way infrastructure influences access to public services, and the lower left section, on the way infrastructure affects household expenditures. Since most, but not all, countries measure poverty incidence by looking at expenditures, the connection between infrastructure and poverty reduction comes through this channel. Each of these three

[6] See, for instance, ADB 2001; 2002a; 2002b; 2004b and 2005, and literature quoted therein.

components of the diagram is reviewed in subsequent sections. First, we summarize the major categories of infrastructure spending.

Figure 5: How Infrastructure Projects Affect Households



38. Four forms of infrastructure are distinguished:

1. Transport Infrastructure

39. New roads, upgraded roads, and the maintenance of existing roads are the principal examples, where “roads” are defined to include associated bridges. The effect of providing or improving roads is to reduce transport costs. The effects can be profound. Reducing transport costs raises the net return producers can obtain for their products and reduces the costs to them of consumer goods and inputs used in production. In a tropical or mountainous environment, existing roads may be impassable altogether during the extended rainy periods of the year. During other times, the poor quality of the roads may still result in transport costs that virtually preclude production for the market. Many countries with previously highly restrictive policies with regard to market activity have undertaken market-friendly reforms that remove

prohibitions on market-oriented economic activity. But the effect of these reforms can be seriously blunted for communities facing very high transport costs, such as those in isolated rural areas. To be effective, the reforms must be accompanied by something more costly than simply removing restrictions on market activity—investment in the transport infrastructure that can make participation in the market feasible. The GMS Program's emphasis on economic corridors is a case in point.

2. Production Infrastructure

40. This includes infrastructure facilities intended to contribute directly to production. Examples include irrigation facilities, electricity facilities servicing private firms, and some communication facilities. The benefits generated take the form of enhanced productivity of land and labor in the areas immediately serviced by the infrastructure, but not elsewhere.

3. Electricity Infrastructure

41. By linking a community to the electricity supply network, cost-reducing technologies and communications facilities are made accessible. The use of electricity-based consumer goods is also made feasible. This form of infrastructure is therefore complementary with private expenditure on electrical consumer and producer goods.

4. Communications Infrastructure

42. Participation in the market requires information and telephone networks facilitate this. New mobile telephone technology, which is capable of bringing communications capabilities to otherwise isolated communities more cheaply than by extending the land line system, partly ameliorates the poor state of the telephone networks in many countries. What is required is to extend the network of transmitters and ensure that competitive conditions prevail in the provision of mobile phone services to prevent the development of private monopolies.

C. New Facilities versus Maintenance

43. In the case of each of the above forms of infrastructure investment, there is often an overemphasis on provision of *new* facilities at the expense of maintaining *existing* infrastructure. If infrastructure investments are not maintained, their value can be lost quickly. Rural roads in tropical areas provide a good example. Conventions of government accounting can be an obstacle in this regard. In public sector accounts, new facilities are called investment or development expenditures, while maintenance tends to be classified as recurrent expenditure. It is much easier to obtain outside assistance for new "development" expenditures. They tend to be more attractive politically within the country as well. But maintenance, along with other forms of "recurrent" expenditure, tends to be left to the resources of the government, which might be insufficient for the purpose.

44. The fungibility of public funds sometimes reduces the force of this point. When an external agency provides funding for new roads, for example, where the public sector would have invested in, funds are freed up for use elsewhere. These alternative uses of funds can include maintenance of existing roads. It follows that even though the external agency provides no direct funding for maintenance, its funding for new investment nevertheless makes resources available for other uses, including maintenance. However, when the recipient government is so short of revenue that little or no spending on new roads would have occurred in the absence of external funding, this argument does not apply. These circumstances of very

limited resources for public investment indeed arise in several Mekong countries and explain the need for donor financing of these key investments.

45. A frequent reality is that new infrastructure facilities are funded even while existing facilities deteriorate to the point where they are unusable for lack of maintenance. For this reason, expenditures on maintenance, rather than construction of new facilities, can be much more cost-effective. From an economic point of view, maintenance of existing roads, dams, electricity networks, and other infrastructure is investment in exactly the same sense as construction of new facilities. It is a sacrifice of current income for the sake of the future productivity of an asset. Maintenance of existing infrastructure deserves the same priority as new investment. But since this form of expenditure has often been neglected in the past because of funding constraints, its marginal value is greater.

D. Infrastructure and Incomes: Distributional Issues

46. The top section of Figure 5 focuses on how infrastructure development affects household incomes. The most obvious channel is that production infrastructure contributes directly to the productivity of privately owned assets. Irrigation projects raise the productivity of land and labor. Electricity supplies make possible the operation of light manufacturing, and communication facilities make it possible to obtain the inputs needed for these activities. Once the output is produced, transport and communications infrastructure facilitate its sale.

47. It is obvious that production infrastructure such as transport, electricity, and communications facilities all contribute to generate household incomes. But how? Since households derive their incomes primarily from ownership of productive assets, including their own labor, land, and capital, public infrastructure must operate on incomes by raising the returns to these factors of production. But different households own very different combinations of labor, land, and capital. The way infrastructure affects the returns to these factors thus has important implications for the distributional impact of these infrastructure investments. A recent study by Jacoby (2000) provides an insightful analysis of the mechanisms involved. The study deals with Nepal, a country with many features similar to the Mekong countries. This case study is discussed in Box 1.

Box 1: Distributional Effects of Rural Roads in Nepal

Jacoby (2000) studies the effects of rural roads in Nepal using household survey data. She examines the relationship between incomes and distance from the market and decomposes this difference into return to land and return to labor. The effect of reduced distance from the market, measured in transport cost, is divided into these two major components. This information is then used to analyze the effects of improved roads at the household level. The economic story underlying this statistical analysis is an assumed production function in which output depends on inputs of land, labor, and purchased inputs like fertilizer. Improved roads reduce the price farmers must pay for inputs like fertilizer and raise the price, net of transport cost, which they receive for their output. Under the assumptions made, the increased value of output made possible by the new roads will result in increased returns to land and labor. But in what proportions?

To the extent that new roads raise the productivity of land, then if land prices are determined similarly to other economic assets, the increased income-earning capacity of land will be capitalized in the form of increased land prices. On the other hand, to the extent that the productivity of labor is increased, the real return to labor will rise. The difference between the two may be quite important. If the main effect is to increase land prices, the beneficiaries will be land owners who are not necessarily the poor. But if the real wages of unskilled labor rise, the beneficiaries will indeed be among the poorest people because their labor is their principle asset. The question posed by Jacoby is therefore the magnitude of these two effects—how this depends on distance from the market, and how this is translated into incomes at the household level. Jacoby's analysis therefore provides a way of studying the distributional impact of infrastructure improvement.

Jacoby's results confirm that road development raises both real land prices and real wages. The net effect is slightly progressive with respect to income, meaning that households with lower real incomes, who tend on average to be furthest from the markets, initially receive the largest proportional income gain from improved roads. However, this progressive element is not particularly strong.

48. Jacoby's results imply that rural road improvement is an effective measure of reducing absolute poverty incidence but not an effective way of reducing income inequality. The benefits tend to be spread widely across the income distribution and the effect on inequality is very small. These general findings are common in the analysis of the distributional impact of public infrastructure. The effects of this form of investment generally do not discriminate strongly in favor of poor groups, relative to others, or vice versa. It is especially important to note that the poor are not excluded from the benefits of infrastructure investment.

E. Infrastructure and Access to Public Services: Benefit Incidence Analysis

49. A common approach to studying how projects affect households at different levels of income is known as *benefit incidence analysis*. Despite its name, this approach does not focus at all on the benefit that households actually derive from the projects. Rather, it studies the *cost* to the government of providing the facilities concerned, and how this cost may be allocated across household groups. These studies are thus best regarded not as analyses of the full

impact of public expenditures but rather as studies of access to public services, indicated on the lower right hand side of Figure 5.

50. There are three components to such studies.

(i) Unit costs. The first step is to determine the unit (average) costs of delivering the infrastructure concerned. In the case of roads, for example, this means the cost per kilometer of a particular kind of road in a particular kind of terrain.

(ii) Participation rates. The second step is to assess the degree to which households in different income (or expenditure) categories receive the services of these publicly provided facilities. This is by far the most demanding of the three steps. This step is greatly facilitated when available household income and expenditure surveys include questions on access to infrastructure services.

(iii) Assignment of costs to income groups (or expenditure groups). The third and least demanding of the three steps uses the results of steps (i) and (ii) to assign the value of the government services provided to income groups, focusing on the poor in particular. The calculation of the value of services delivered is important only when aggregating across different kinds of expenditures, say, roads and electricity services.

51. While the assumptions of benefit incidence analysis studies are limiting, these studies provide insights into how access to public services and infrastructure varies across the income distribution. Infrastructure facilities are themselves of direct value to households and access to them is therefore of interest. They may also facilitate access to other public facilities, such as those promoting education, health, cultural activities, and civic participation. Benefit incidence analyses address each of these issues.

52. Benefit incidence analysis is not especially new. Two World Bank studies, by Meerman (1979) on Malaysia and Selowsky (1979) on Colombia, were early influential applications of the methodology. These studies look at a wider set of public expenditures than just infrastructure, but each considers public infrastructure specifically. A frequent finding is that infrastructure has little distributional impact. All broad social groups obtain access to these facilities, regardless of incomes.

53. A partial exception to these findings was a study of expenditure incidence for Thailand, by Sussangkarn and Patmasiriwat (1999) (Box 2). This study found that the distributional impact of transport infrastructure was directly related to income. The authors suggest that in a middle income country like Thailand improved road infrastructure generates additional benefits mainly to those households possessing private automobiles. Improved roads shorten travel time for them, but do less for those reliant on public transport. Obviously, those owning cars tend to be better off. The situation in poorer countries, like several other Mekong countries, is very different. When roads, especially rural roads, are very bad those using public transport benefit from road improvement as well.

54. While these studies are capable of generating useful information on access to the facilities funded by public spending, they do not necessarily identify the reasons for these effects. For example, suppose it is found that poorer groups obtain little benefit from irrigation investment. The details of the study may provide clues as to why this is happening, but in itself the finding itself does not tell us what needs to be done to address any problem that the findings

might reveal. The reason may lie in the distribution of land ownership, the placement of irrigation schemes, or exclusion of some groups from irrigation associations. It should not be assumed that all forms of infrastructure investment should necessarily benefit the poor. But if benefit incidence studies can help find the reasons why the poor do not benefit, and these reasons are capable of being corrected, these findings can be of great value.

Box 2: Benefit Incidence in Thailand: Transportation Infrastructure

An especially comprehensive and ambitious study of the distributional incidence of both government expenditures and taxes was recently conducted for Thailand by the Thailand Development Research Institute (Sussangkarn and Patmasitiwat [S-P] 1999). The most interesting feature of the study is its comprehensiveness: it attempts to apply a similar framework to describe the distributional effects of both government expenditures and taxes. In the case of expenditures, it applies the standard benefit incidence analysis methods to study the impact of education, public health, agriculture, and transportation infrastructure spending. Some of their results, which relate to 1994, are summarized below.

Thailand: Results of Regressions of Expenditure Benefit against Household Income

Types of expenditures	Coefficient	Significance level: p - value	Elasticity with respect to income
Total	0.048	0.000	0.41
Education	0.014	0.008	0.33
Health care	0.000	0.011	0.02
Agriculture	-0.002	0.009	-0.09
Transportation infrastructure	0.035	0.000	1.09

Source: Warr (2003), based on data in Chalongphob Sussangkarn and Direk Patmasitiwat (1999).

Except for agricultural and health expenditures, groups with higher incomes tended to receive higher benefits from public spending. In the case of agricultural and health expenditures, the estimated benefits were independent of incomes. For education expenditures, the elasticity of benefit received with respect to income was less than unity, meaning that as incomes rise, say, by 10%, the benefit received rises by less than 10%. For transportation infrastructure, the elasticity was about 1. The benefits received rise roughly in proportion to income.

These results need to be interpreted in conjunction with the S-P study's corresponding estimates of the distributional burden of taxes, which of course pay for the above expenditures. The implied estimate of the elasticity of tax burden with respect to income was 1.05, almost the same as the above elasticity of benefit from transport infrastructure with respect to income. Combining these two sets of estimates, the net effect of raising taxes to finance transport infrastructure spending is similar across households of different incomes; the net effect of raising taxes to finance these infrastructure investments neither favors nor discriminates against the poor, relative to other income groups.

F. Infrastructure and Expenditures: Effects on the Poor

55. Most countries measure poverty incidence by means of household expenditures. Infrastructure investments affect poverty through two central channels. First, they affect incomes, as discussed above. Second, they affect the prices of goods the poor purchase and thus the real value of the goods and services that can be purchased from a given level of income. Of these two channels, the first is generally, but not always, the more important.

56. A focus on poverty leads naturally to efforts to ensure that investment does indeed reach the poor. The World Bank's 1994 assessment, contained in its *1994 World Development Report*, is seemingly pessimistic about the prospects for doing this: "Although the relationship between infrastructure and poverty is pivotal, infrastructure is nevertheless a blunt instrument for intervening directly on behalf of the poor" (p. 80). What this seemingly self-contradictory statement means is that infrastructure development in itself does not necessarily produce benefits that are targeted towards the poor, relative to other groups. Indeed, this is the finding of most of the empirical studies reviewed here. For instance, one of the main conclusions reached by ADB (2005) is that "the evidence is not sufficient to reject the null hypothesis that the poor and the nonpoor benefit proportionately".

57. The benefits of public infrastructure provision are generally widely spread across the income distribution. But their value to all major groups, including the poor, may be so large, especially in the poorest countries, that significant effects on poverty can be achieved from this form of investment. Furthermore, so long as the benefits are not skewed away from the poor, the fact that poor people make up a significant proportion of the population implies that they are large recipients of the benefits from such investment.

58. Issues that affect the distributional impact of infrastructure development include the distribution of productive assets within the affected population because this affects the capacity to take advantage of public infrastructure. Other factors include domestically financed projects, the way it is financed, meaning the distributional effects of the taxes which pay for it, and the regional distribution of the infrastructure investments. *Within* regions, the distributional effects of infrastructure development tend to be minor, but there is a big difference between providing improved infrastructure in poorer and richer regions. The main distributional effect is thus *between* regions. Of course, regional targeting is not an end it itself—allocating infrastructure to poorer regions is effective in assisting the people of that region only if it is productive.

1. Targeting the Poor: Two Kinds of Error

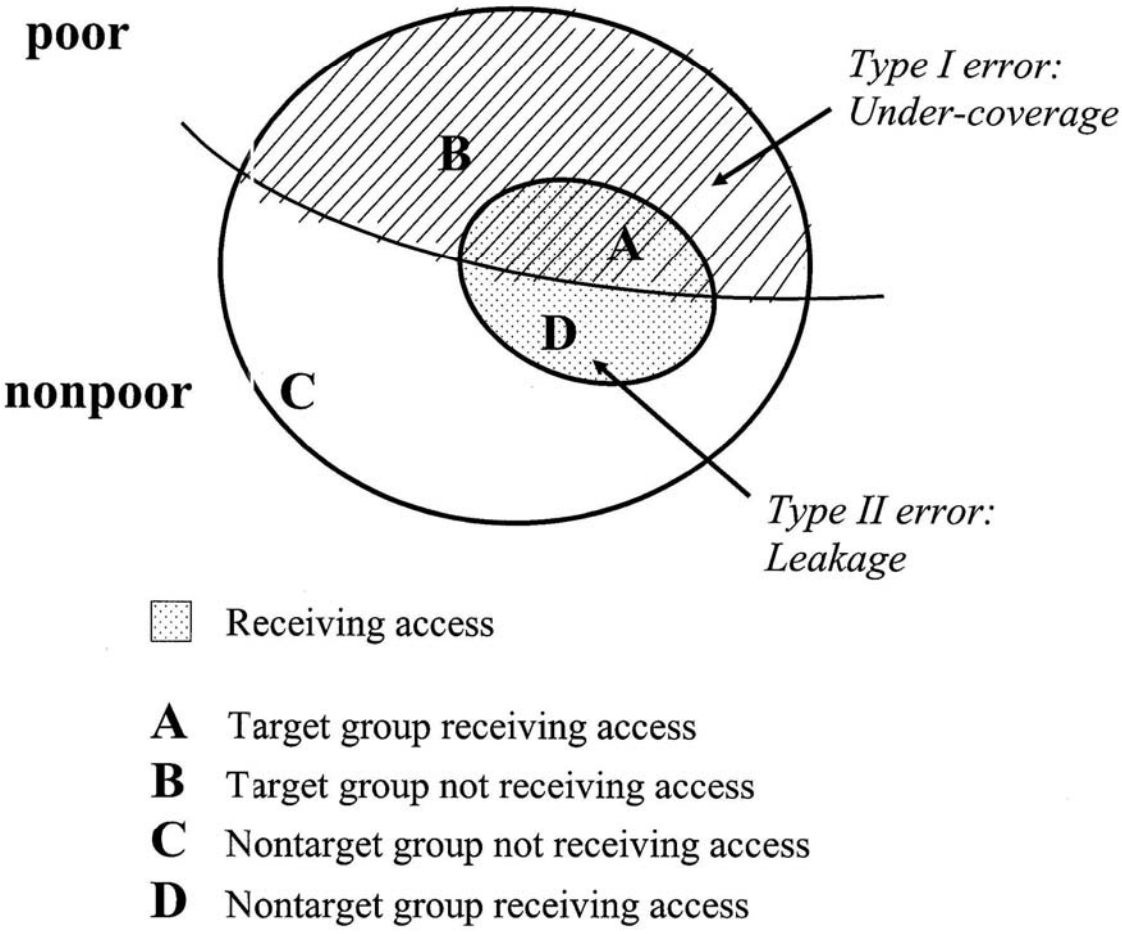
59. The mechanisms available for targeting infrastructure expenditures towards the poor are very imperfect. Suppose the government attempts to direct expenditures to a particular social group, in this case, the poor. Two kinds of errors are possible, as summarized in Figure 6. The areas labeled B and D correspond to these two kinds of error. They are analogous to the Type I and Type II errors of statistical theory.

60. Type I error (Area B: under-coverage) – people who need improved access fail to receive it. Type II error (Area D: leakage) – people who do not need improved access do receive it.

61. There is a trade-off between these two kinds of error. For instance, to minimize Type I error (under-coverage), more widespread provision of improved infrastructure (e.g., roads) throughout the country might be attempted. The consequence is that some areas where infrastructure was

already adequate and did not need the increased expenditure nevertheless receive it. Errors of Type II (leakage) will inevitably result, implying some wastage of public revenues, given the objective of targeting the poor. Conversely, to minimize Type II error, stricter criteria might be applied to assess areas eligible for, say, improved roads, giving preference to poorer areas. Type II errors might be lessened but more errors of Type I (under-coverage) will occur because many poor households might actually be present in areas that are nonpoor on average.

Figure 6: Poverty Targeting: Two Kinds of Error



62. Attitudes to these two kinds of error seem to differ across countries. One hypothesis that seems plausible is that social attitudes to these two kinds of error change systematically as societies become richer. In particular, the willingness to tolerate more Type II error (leakage), to reduce Type I error (under-coverage), seemingly increases as the society becomes wealthier.

63. An interesting study by Cornia and Stewart (1995) recognizes the distinction between these

two kinds of error involved in targeting and applies it to several developing country case studies of the effects of public spending. Their discussion implies that when developing countries give greater emphasis to avoiding Type II errors (leakage) relative to Type I errors (under-coverage), they are somehow misguided or irrational in doing so. But this criticism seemingly misses an important point. Very poor countries typically have great difficulty in raising public revenues, of which the poorer countries of the Mekong subregion are good examples (see Section II, Recent Economic Performance). It seems reasonable that where public revenues are very scarce, and where many worthy expenditures must therefore go unfunded for lack of resources, greater emphasis will be given to avoiding Type II errors in all public expenditures than to avoiding Type I errors. Since the former imply the waste of these scarce public revenues, they occur at the cost of other, more productive forms of expenditure. When revenue is wasted in one area, something else goes unfunded; that is, when public revenues are very scarce, incurring Type II errors (leakage) in one form of expenditure necessarily implies incurring Type I errors (under-coverage) elsewhere. Avoiding leakage, where possible, makes sense, especially in poor countries.

64. When looking at the results of a benefit incidence analysis, the statistical implications of Type I and Type II errors are similar. If infrastructure programs are targeted, say, by incomes per person, and if these errors were very small, there would be a strong negative relationship between the benefits received per person from these expenditures and incomes per person. The larger the errors, whether of Type I or of Type II, the weaker will be this negative relationship. Practical problems in implementing targeted expenditure programs can lead to large errors of both the Type I and Type II kind (Ravallion 2003 and Weiss 2005).

65. In a study of poverty-related expenditures identified by Thailand's Bureau of the Budget, Warr and Sarntisart (2005) used data on the allocation of these expenditures among Thailand's 76 provinces. Infrastructure was one of six such categories of poverty-related expenditures.[7] Thailand's provinces vary widely in income per person and in official estimates of poverty incidence. The authors studied the relationship between the provincial allocation of these expenditures per person and poverty incidence at the provincial level. They also examined the relationship between provincial expenditures per person and income per person. They hypothesized that if being 'poverty related' meant that these expenditures were targeted towards the poor, then a positive relationship between infrastructure expenditure per person and poverty incidence should exist—that is, provinces with higher poverty incidence should have more expenditure per person. Similarly, a negative relationship should exist between provincial spending on infrastructure per person and provincial income per person.

66. The results indicated that the relationship between provincial spending per person and poverty had the predicted sign, but the estimated coefficient was not significantly different from zero. Similarly, the estimated coefficient for income per person had the expected negative sign but was again not significant. Spending at the provincial level on infrastructure was not significantly related to poverty incidence or to income per person. While these results do not indicate the presence of significant poverty targeting, they do contradict the claim sometimes expressed that richer areas are favored in the allocation of infrastructure spending. No such effect was found. The effect that was significant was that of population size. Smaller provinces receive more spending per person.

[7] The others are Poor and Low Income People Projects; Agriculture and Natural Resources Projects; Health and Social Welfare Projects; Education and Training Projects; and others. Between 2000 and 2002, total expenditures on Infrastructure Projects were about 21% of total expenditures on these six poverty-related categories.

G. The Interaction between Infrastructure and Other Factors

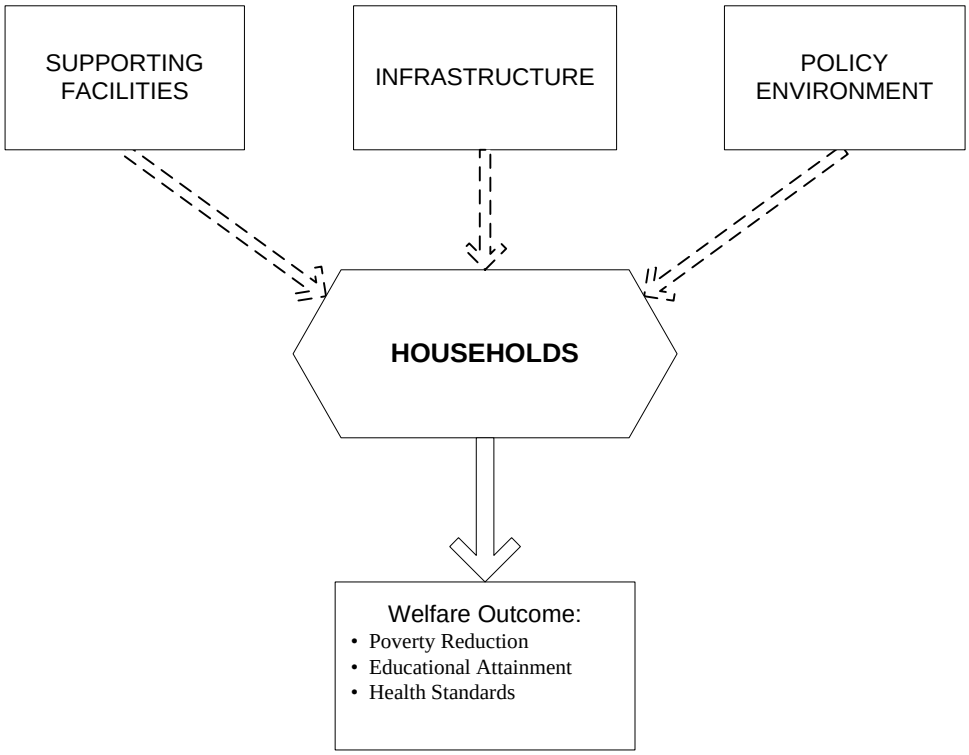
67. Studies of the return to infrastructure projects have a consistent feature. They tend to indicate implausibly large estimates of the rate of return to infrastructure investments. Several examples are cited in World Bank (1994). Rates of return of 20% per annum are common and some studies indicate rates of return as high as 60% (World Bank 1994, p. 15). These rates of return are simply not plausible. A clue to the possible source of these puzzling results is provided by the case study of rural roads in the Lao PDR below. When the relationship between road development and incomes or expenditure is studied directly, a very strong relationship is found, implying very high rates of return, and this is typical of the findings found in the literature. But when allowance is made for other variables, which also differ between households that have access to improved roads and those that do not, this very strong relationship weakens considerably.

68. These "other" variables are factors that tend to enhance the value of roads. For example, the presence of local market places, schools, and health facilities within a reasonable distance makes a big difference to the benefits in income, education, and health terms which result from improved roads. The road is much more useful if it makes it possible to reach facilities that are actually present, but would otherwise be more difficult to utilize. If these facilities are not present within a reasonable distance, the value of the road is much less. The presence of these other variables tends to be correlated with the existence of improved roads. So looking in isolation at the relationship between improved roads and the benefits seemingly derived is misleading. It misses the contribution of the other supporting infrastructure that is correlated with the roads and wrongly attributes all the benefits derived to the road itself. When multiple regression methods are employed to allow for the contribution of these other factors, this bias is removed.

69. Figure 7 illustrates this crucial point. The return to improved infrastructure, *by itself*, might not be high. The potential benefits depend on the coexistence of other things: supporting facilities such as local schools, health clinics, and market facilities, along with a policy environment that recognizes the importance of health and education systems, reflected in adequate resources for local teachers and health professionals, and that permits the effective functioning of markets. In an area like the GMS, the functioning of markets applies to international, as well as domestic, markets.

70. For example, for the poor farmers of northern Lao PDR, the crucial form of market access is to the northeast provinces of Thailand. These are much closer geographically than the urban markets of the Vientiane region of central Lao PDR. Improving roads within northern Lao PDR without improving border access to the markets of northeastern Thailand would not be helpful. Conversely, improving border access without improving the road system of northern Lao PDR would assist Lao farmers within easy reach of the Thai border-crossing points but exclude the great mass of Lao farmers of this area who are not close to the border and for whom road access is currently very limited.

Figure 7: The Interaction between Infrastructure, Supporting Facilities, and Policy



71. The key point is that improving infrastructure is an important part of the development effort but if this is all that is done, the returns might not be high. Other factors must also be present—supporting facilities and an appropriate policy environment. These factors interact and when addressed together, the returns can be very high indeed. This finding lends support to the GMS Program's emphasis on the development of "economic corridors" and not simply "transport corridors."

H. Conclusions

72. This chapter focuses on the mechanisms through which infrastructure investments benefit households. It emphasizes three channels. First, it raises household incomes by raising the productivity of the resources owned by the household. For example, production infrastructure like irrigation does this by providing inputs that are directly complementary with the resources owned by the household. Transport infrastructure like roads does it by reducing transport costs to and from markets. This raises the net returns farm households can obtain for their goods and reduces the cost to them of the inputs they need to purchase. Transport infrastructure may also facilitate direct employment of household members outside the household, thus raising the return to their labor directly.

73. The distributional element of these increases in incomes depends on the distribution of resource ownership among households and on the magnitude of the productivity improvements that occur in these resources. In the important case of transport infrastructure, empirical evidence suggests that the effects tend to be distributionally neutral. This means that all major

income groups are affected similarly. Transport infrastructure thus tends to reduce absolute poverty, without significant effects on inequality. Within regions, infrastructure projects are not a particularly good candidate for poverty targeting because all major income groups tend to benefit. Between regions, there is greater scope for targeting by directing the benefits towards poorer regions. Poorer regions can benefit from this practice, provided the infrastructure they receive is actually productive, given their circumstances. The focus of both the GMS Program and the more recent Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS) Program on poor regions and isolated border areas reflects this approach.

74. The second channel of effects is through access to public services such as education and health facilities. The infrastructure reduces the cost of reaching these facilities, in the case of roads, or improved information about them, in the case of communications facilities. The possibility of benefits of this kind depend on the coexistence of educational and health facilities within reach of the household. The final source of benefit is that infrastructure improves access to final consumer goods and, by reducing transport costs, makes them more affordable. Electricity infrastructure makes it possible for the household to use a wide range of consumer goods otherwise unavailable to them.

75. In identifying the economic and social impact of projects, we have focused on the positive ones. Negative effects of infrastructure provision can be important and, unfortunately the Mekong countries provide examples of some such effects. As road access to remote areas improves, negative environmental outcomes such as deforestation, caused by increased commercial logging and/or land clearing for agriculture, may increase. The flow of drugs may increase, although the capacity of governments to suppress the production of drugs may be improved. Trafficking in women and children may be facilitated, and this is becoming an increasingly concerning problem in this subregion. Finally, the spread of HIV/AIDS may increase.[8] These potential negative effects raise the importance of governance. Achieving the demonstrated social benefits for improving infrastructure while avoiding or at least minimizing the negative effects is a challenge to governance throughout the Mekong subregion and one that is an increasing feature of the GMS Program.

IV. ECONOMIC AND SOCIAL IMPACT OF PROJECTS: ROAD DEVELOPMENT IN THE LAO PDR

A. Introduction

76. How do development projects affect the welfare of the population? This question is fundamental to the operation of many public agencies, including multilateral development agencies such as ADB. The tools of analysis employed to study such questions are various and all have limitations. The basic problem is that the social sciences generally lack the possibilities for controlled experimentation that have been so successful in the natural sciences for identifying causal relationships. This fact necessitates the use of imperfect substitutes for properly controlled experiments as a way of determining the way that interventions like public sector projects impact on social and economic variables of interest.

77. We wish to determine the way that project interventions affect the achievement of basic social objectives such as the MDGs adopted internationally as central goals of development. These goals include poverty reduction and improvements in basic education, health, gender

[8] These negative impacts are noted but not analyzed here. Some of these negative impacts are analyzed in more detail in ADB (2005).

equity, environmental quality, and other objectives central to the agenda of development. If the activities of development institutions are to promote the achievement of these goals, we need to know how project interventions affect them. That is not easy.

78. One approach is to use socioeconomic surveys to study the statistical relationship between the level of poverty incidence and the implementation of public projects of various types. The existence or nonexistence of the project is treated as an exogenous (independent) variable and the impact variables (poverty, education, health, and others) are treated as the endogenous (dependent) variables. The relationships between the former and the latter may be studied with and without the project, in the case of cross-sectional data, or before and after the project, in the case of time series data. The fact that the 'experiments' concerned are not properly controlled is relevant, however. Suppose that areas with high levels of income per person were chosen by the government or other implementing institution for the location of a particular kind of project. If the study found that low levels of poverty incidence were statistically associated with the existence of the project, this would not necessarily indicate that the project reduced poverty. It might simply reveal the way the government decided about the location of the project. In that case, a better approach would be to study the changes in the variables concerned over time, using the change from one survey period to another. As with the cross-sectional approach, however, the problem is that many variables change over time, and not just the existence or nonexistence of the project. The changes that occur over time might not be due to the project at all, but to some other variable that also changed over time.

79. Another approach is to use computerized models of the economy to study the way economic changes, such as the existence or nonexistence of a particular kind of project, affect variables of interest. The advantage of this approach is that it makes true experiments possible. The models facilitate the changing of one variable at a time and the determination of the effects this change produces, holding everything else constant. The obvious disadvantage of this approach is that the results are only as good as the models that are used. It is often difficult for nonspecialists to assess the quality of the models underlying the results and hence the value of the results themselves. But all such models rest heavily on assumptions about the qualitative functioning of the economy and the quantitative relationships between variables of interest. These assumptions are always open to doubt and dispute, producing uncertainty about the reliability of the results that emerge from them.

80. This chapter reports on a case study using the socioeconomic surveys approach. The case study examines the effect of improved roads in rural areas of the Lao PDR. An earlier report (Warr 2005) examined the effect of improved roads on consumption expenditures and measures of poverty incidence based on consumption. The present analysis updates these results and also reports new results on the effect of improved roads on two other MDGs—improved health and education.

B. Summary Data on Roads, Poverty, Education, and Health

1. Background

81. Since the late 1980s, a program of market-oriented economic reforms, known as the new economic mechanism, has shifted the Lao PDR economy away from the rigidly socialist pattern instituted immediately after the declaration of the Lao PDR in 1975. Since the reforms, overall economic growth has been good. From 1991 to 2002, annual growth of GDP averaged 6.2% per annum, or around 3.8% per person. The agricultural sector dominates in employment, with 80% of the workforce, and it contributes about 50% of GDP, down from just over 60% in

1990. The Lao PDR receives substantial external support. In 2002/03, external donors contributed 61% of the government's capital budget, representing 39% of total public expenditure, and 7.6% of GDP. From 1992 to 2003, estimates of poverty incidence in the Lao PDR declined from 46 to 33.5% of the population.

82. The reform process has been highly successful, but it is hardly surprising that many problems remain. One of the most serious, evident to any visitor to rural areas of the Lao PDR, is the poor state of rural roads. Many villages have no road access at all, meaning that vehicles cannot reach them. They are accessible only by walking. Others have access only during the dry season, meaning that during the extended rainy season of the year, vehicle access to their village is impossible. Poor roads severely impede the capacity to participate in the market economy. Reforms may remove prohibitions on participating in the market economy, but this may be of little help if roads are bad enough that market participation is prevented by high transport costs. Better rural roads will likely improve living conditions in rural areas, but can this effect be demonstrated? That is the focus of this case study. It asks whether improving rural roads is an effective instrument for reducing poverty and for improving health and educational outcomes for the rural population.

2. Indicators of Socioeconomic Progress in the Lao PDR

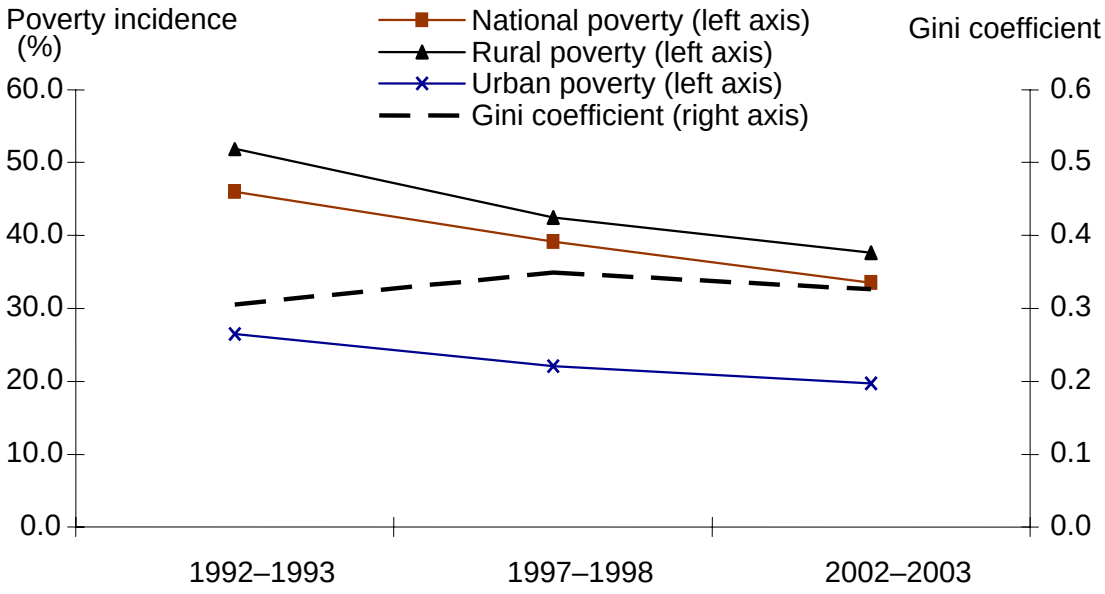
83. The most useful source of socioeconomic data on the Lao population is the Lao Expenditure and Consumption Survey (LECS). This survey has been conducted every 5 years since 1992. The number of households surveyed is around 8,900, about 1.2% of the total number of households in the country, containing around 57,600 individuals.[9] The individual households sampled in each survey are seldom the same and, in any case, households are not identified individually. It is therefore not possible to compare the same households across LECS II and LECS III.

84. Data from the LECS surveys indicate that in 2002–2003, 77% of the Lao population resided in rural areas, but poverty incidence in rural areas (the proportion of the rural population with real expenditures below the poverty line) was almost double that of urban areas (Figure 8). Most tellingly, rural areas accounted for 86.5% of all poor people. Poverty in the Lao PDR is overwhelmingly a rural phenomenon and it follows that poverty reduction is primarily a matter of reducing rural poverty. We now turn to data that may help identify the determinants of poverty in rural areas and the ways it can be addressed, focusing on the contribution of roads.

85. "Distance to main road" is one of the variables listed in LECS, but this variable is known to be of unreliable quality, a point emphasized by LECS data enumerators. The variables "Rural with access to road" and "Rural without access to road" are considered more reliable; these are the data used in the present study. These variables reflect yes/no answers from households and are treated as dummy (0,1) variables in the regression analysis.

[9] A brief description of the survey and its main variables is provided in Appendix 1.

Figure 8: Lao PDR: Poverty incidence and inequality, 1992–1993 to 2002–2003



Source: Richter, van der Weide and Souksavath (2005), using data from the Lao Expenditure and Consumption Survey, National Statistical Center, Vientiane.

86. Table 5, summarizing data assembled by Richter *et al.* (2005), presents results drawn from the three LECS surveys conducted to date. Between the LECS I and LECS II surveys (1992–1993 and 1997–1998, respectively, both the format of the LECS survey and the sampling method used were changed. For this reason, accurate comparison of the results from these two surveys is difficult. The format and sampling method remained the same from LECS II to LECS III, so comparison between these two surveys (1997–1998 and 2002–2003) is more reliable and our discussion will emphasize these two surveys.

87. The LECS surveys make it possible to classify households into three categories of road access—all season access, meaning wet and dry seasons; dry season access only; and no road access. No road access means that the village can be reached only on foot, rather than by vehicles. Of all households in the Lao PDR, 77% were rural in 2002–2003, 43.9% (57% of all rural households) had all season road access, 13.1% (17% of all rural households) had dry season access, leaving 20% of all households (26% of all rural households) without any road access at all. This problem of lack of road access is a particular problem in rural areas of the northern region, which is also the poorest. There, 38% of households lack road access. In some specific areas of the country this problem is even worse. Along the northern border with Vietnam, the proportion is 53%, and along the southern border with Cambodia, 54% of households lack any road access. Because of the particular importance of roads in rural areas of the Lao PDR, we shall focus on this issue.

Table 5: Lao PDR: Socioeconomic Change and Road Access 1997–1998 to 2002–2003

		1997–1998	2002–2003
Population (million)	Lao PDR	5.087	5.519
Population shares (%)	Urban	16.7	23.0
	Rural	83.3	77.0
	With all season road	36.0	43.9
	Without all season road	47.3	33.1
	Dry season access only	26.7	13.1
	No road access	20.6	20.0
Poverty incidence (%)	Lao PDR	39.1	33.5
	Urban	22.1	19.7
	Rural	42.5	37.6
	With all season road	31.7	31.3
	Without all season road	50.8	46.2
Poverty gap (%)	Lao PDR	10.3	8.0
	Urban	4.9	4.1
	Rural	11.4	9.2
	With all season road	7.3	7.1
	Without all season road	14.5	12.0
Gini index of per capita consumption (%)	Lao PDR	34.9	32.6
	Urban	39.7	34.8
	Rural	32.1	30.3
	With all season road	32.1	30.3
	Without all season road	30.9	29.4
Access to electricity (%)	Lao PDR	31.1	47.6
	Urban	91.1	97.1
	Rural	19.0	32.0
	With all season road	35.4	44.0
	Without all season road	6.6	18.1

Source: Richter, van der Weide and Souksavath (2005), using data from Lao Expenditure and Consumption Survey, National Statistical Center, Vientiane.

88. Table 5 shows that the proportion of the Lao PDR's population residing in rural areas who had all season road access increased from 1997–1998 to 2002–2003 from 36% to 44%. This improvement in road access coincided with other dimensions of socioeconomic improvement in rural areas. The headcount measure of poverty incidence in rural areas declined from 42.5% of that population to 37.6%. Some part of this decline might be attributable

to improvement in access to all season roads, but not all of it. Within the population having all season road access, poverty incidence remained almost constant (declining from 31.7% to 31.3%), but it declined significantly within the population lacking any road access (from 50.8% to 46.2%). Events other than the improvement in roads must have been causing the latter change. The question that remains is to what extent, if any, can reduced poverty be attributed to improved roads? We return to this question in the following section.

89. Of course, the head–count measure is only one indicator of absolute poverty, but other indicators show a similar picture. The poverty gap measure, which, unlike the head–count measure, is sensitive to how far a household's consumption per capita falls below the poverty line, is also shown in Table 5 and behaved very similarly to the head–count measure. Measures of inequality, like the Gini coefficient shown in Table 5, are quite different. Measured inequality increased slightly in virtually all areas of the Lao PDR over this decade. Access to electricity improved in all rural areas of the Lao PDR over this decade, including both those with all season road access and those without it.

90. The LECS surveys include data on other socioeconomic outcomes of interest. Table 6 focuses on educational participation. It looks at the proportion of children in the primary school age group 5–12 who attend school. These data relate to LECS III, covering 2002–2003. School attendance is highest among rural households who have all season road access, and lowest among those without road access, among both males and females. The data indicate that the average time taken to reach school is actually higher among those with all season access than those without road access, but this is a consequence of lower participation rates in the latter group. The average time taken to reach school among participants is highest for those without road access. Expenditure on education per student is highest among those households for which road access is best. This reflects higher incomes and greater priority to education among the latter group.

Table 6: Lao PDR: Educational Participation and Road Access, 2002–2003

	All Season Access	Dry Season Access Only	No Road Access	All
School Attendance	80.67	70.48	51.90	69.41
Females (%)	80.00	67.82	47.54	67.06
Males (%)	81.37	72.98	56.27	71.72
Average time traveling to school	8.14	9.02	6.24	7.79
Average expenditure on education (kip per student per month)	111,963	86,973	65,152	96,209

Note: Expenditure on education is measured in kip per student per month.
Source: Author's calculations from the Lao Expenditure and Consumption Survey (LECS) III data, National Statistical Center, Vientiane.

91. Table 7 summarizes data from LECS relating to health. The survey includes questions on the proportion of people who became ill in the past 4 weeks. This proportion is somewhat higher in households with low levels of road access. Moreover, in areas with poor roads, those who did become ill were less likely to seek treatment. In these households, more days were

missed from work than in households with better roads and, not surprisingly, less was spent on transport to hospital.

Table 7: Lao PDR: Health Status and Road Access, 2002–2003

	All Season Access	Dry Season Access Only	No Road Access	All
Proportion of persons who became ill in the last 4 weeks (%)	13.31	13.37	15.63	14.07
Of those ill, those who did not seek treatment (%)	80.69	83.16	89.80	84.35
No treatment because too difficult to get there (%)	11.83	24.83	24.10	18.55
Average days missed due to poor health (days per household, last 4 weeks)	0.58	0.58	0.76	0.64
Average expenditure on transport to hospital (kip per household per year)	102,958	72,460	50,564	85,494

Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

92. Two features of Tables 5 to 7 are especially notable. First, the final row under "Population shares" in Table 5 makes it clear that the change in road access over the 5-year period 1997–1998 to 2002–2003 was heavily concentrated in the provision of wet season road access to households that already had dry season access. The proportion of rural households with "All season access" increased and the proportion with "Dry season access only" declined correspondingly. But the proportion with "No road access" barely changed.

93. Second, turning to Tables 6 and 7, we first compare those households having all season and those having only dry season access. We then compare those households having only dry season access with those having no road access. One clear point emerges. The largest differences in socioeconomic outcomes on education and health are between the second two—those with dry season access only and those with no road access. This point applies to both education and health indicators. Attaining dry season road access, for those with no access at all, coincides with a greater improvement in educational and health outcomes than attaining wet season access for those households enjoying dry season access already.

94. The data reviewed above suggest that improved roads coincided with lower levels of poverty incidence, higher levels of school participation among school-age children, more spending on education at the household level, better standards of health, and better care for those who became ill. However, areas with roads and those without roads differed in many respects, not just the presence or absence of roads. What we cannot tell directly from these data is whether improved road access is *causing* the lower levels of poverty and higher levels of educational and health attainment that coincide with it, or whether some other factors are at work. This is indeed the critical issue, and addressing this issue is what we turn to next.

C. Isolating the Effects of Roads on Poverty[10]

95. Multiple regression is a way of coping with the fact that more than one factor that potentially influences the dependent variable is changing across the sample; that is, the data are not generated by controlled experiments, changing only one independent variable at a time. The problem that this raises is how to sort out the respective causal influences of each independent variable. The LECS surveys make it possible to deal, imperfectly, with this point, by taking note of the variation in many independent variables using multiple regression methods. Results are reported in this section.

96. Does road improvement reduce poverty and, if so, by how much? The LECS survey has data on consumption expenditures at the household level. These were converted into per capita form and deflated by regional consumer price indices available on a monthly basis, taking account of the month in which the survey data were collected. This takes account of both the regional variation in consumer prices and the variation in prices over time. The analysis regresses real household expenditure per capita on the independent variables shown in Table 8, including road access, using dummy variables *D* for dry season access and *W* for wet season access.[11] These regression results are then used to simulate the change in the distribution of real consumption expenditures that results from hypothetical improvements in road access, as explained below. The simulations utilize the estimated regression coefficients and the full original data set, with the hypothetical levels of road access substituted for the levels observed in the data. Levels of poverty incidence are then estimated from these projected levels of real expenditures at the household level.

97. The regression results for LECS III are reported in Table 8. To allow for province-specific effects, provincial dummy variables were used, as shown in the lower part of Table 8. The estimated coefficients had the expected signs, including the education variables and asset ownership variables. The variables “Access dry season” and “Access wet season” each had the expected positive signs, and each was significant at the 1% level of significance. According to these results, there was a high return to having both dry and wet season access in the LECS III data set.

[10] This section draws upon, but also updates, results presented in Warr (2005) reporting research supported by the Asian Development Bank Institute. The updating is based on the official 2002–2003 poverty incidence estimates provided in Richter *et. al* (2005).

[11] Appendix 2 describes these dummy variables in detail.

Table 8: Lao PDR: Real Per Capita Expenditure and Road Access, 2002–2003
Regression Results at Household Level

Dependent variable: Log of real per capita expenditure			
Independent variables:	*Coefficient*	*t-statistic*	*p-value*
(Constant)	10.911	87.710	0.000
Age at last birthday	0.032	7.073	0.000
Age at last birthday squared (household head)	0.000	-6.138	0.000
Primary (1–5 years)	0.140	6.159	0.000
Lower secondary (6–8 years)	0.330	10.439	0.000
Upper secondary (9–11 years)	0.380	6.900	0.000
Higher (vocational training or university/institute)	0.541	9.679	0.000
Paid employment	0.257	4.623	0.000
Farm employment	0.055	1.021	0.307
Not in labor force	0.135	2.098	0.036
Number of adults in household (18 <= Age Adult < 65)	0.060	6.070	0.000
Total number of members in household	-0.115	-23.015	0.000
Total number of cows and buffaloes	0.021	11.543	0.000
Electricity_n	0.194	8.408	0.000
DailyMarket_n	0.084	1.381	0.167
BusStop_n	0.029	0.988	0.323
CleanWater_n	0.061	2.883	0.004
HospitalInVillage	0.350	5.619	0.000
AccessDrySeason_n	0.102	3.403	0.001
AccessWetSeason_n	0.086	2.638	0.008
Prov. 1 – Phongsaly	0.206	2.473	0.013
Prov. 2 – Luang Namtha	-0.354	-4.705	0.000
Prov. 3 – Bokeo	0.020	0.277	0.782
Prov. 4 – Oudomsay	-0.076	-1.010	0.312
Prov. 5 – Sayabouri	-0.060	-0.813	0.416
Prov. 6 – Luang Prabang	0.245	3.499	0.000
Prov. 7 – Huaphanh	0.006	0.089	0.929
Prov. 8 – Xieng Khouang	0.533	7.775	0.000
Prov. 9 – Vientiane Municipality	0.063	0.832	0.405
Prov. 10 – Vientiane	0.315	4.534	0.000
Prov. 11 – Saysomboune	0.126	1.724	0.085
Prov. 12 – Borikhamsay	0.040	0.567	0.571
Prov. 13 – Khammouane	-0.028	-0.413	0.680
Prov. 14 – Savannakhet	-0.269	-3.925	0.000
Prov. 15 – Champasack	-0.380	-4.776	0.000
Prov. 16 – Saravane	0.145	2.115	0.034
Prov. 17 – Sekong	-0.380	-5.007	0.000

Summary diagnostics:
R^2 = 0.318; adj. R^2 = 0.314; s.e. of estimate = 0.729; F = 85.55; significance level: p = 0.000.
Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

98. The significance of this result for poverty incidence is explored in Table 9. The method of analysis is illustrated in Figure 9. The figure shows the projected cumulative distribution of the logarithm of real consumption expenditures per person obtained from the LECS III data set combined with the regression results reported in Table 8. These data were assembled by calculating real consumption expenditures per person for all rural households, taking the natural logarithm and then sorting them from the lowest to the highest. The diagram shows three estimated distributions:

(i) **P1.** The predicted level of real expenditures using the actual values of the dummy variables *D* and *W* as observed in the data as well as actual values of all other independent variables. The difference between this prediction and the actual data is the error of the regression.

(ii) **P2.** The predicted level of real expenditure when all households have the value of *D* = 1 and *W* takes its values in the actual data, along with the actual values of all other independent variables.

(iii) **P3.** The predicted level of real expenditure when D = 1 and W = 1 for all households, along with the actual values of all other independent variables.

99. The difference between P1 and P2 is an estimate of the degree to which real consumption expenditures could be increased if all households had access to roads in the dry season, but wet season access remained as observed in the data. The difference between this and P3 is then the degree to which real expenditures could be increased if all households had access to roads in the dry season and the wet season as well. Clearly, the difference between P1 and P3 indicates the overall potential for increasing real expenditures through road improvement.

Table 9: Lao PDR: Poverty Incidence and Road Access, 2002–2003, Simulation Results — Estimated Poverty Incidence under Alternative Road Conditions

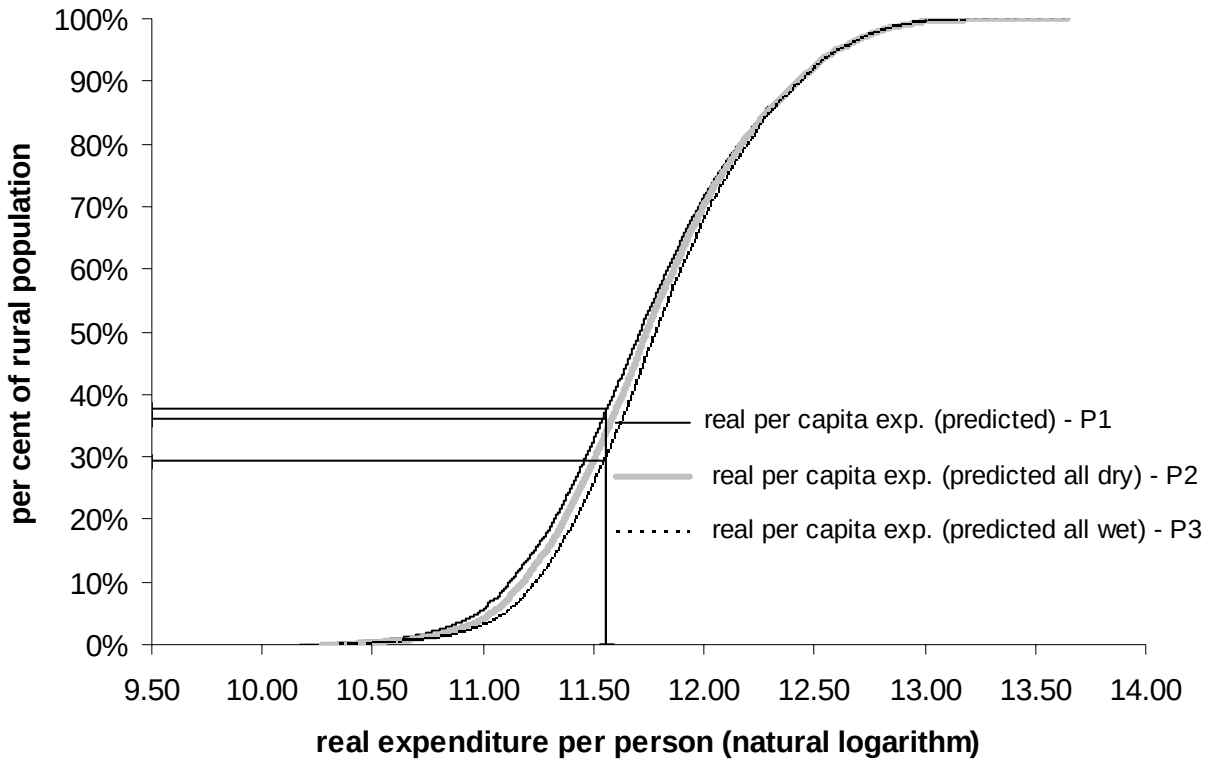
Dry season road access	Wet season road access	Code	Estimated poverty incidence (%)
Observed levels in data	Observed levels in data	P1	37.60
All households with access	Observed levels in data	P2	36.17
All households with access	All households with access	P3	29.36

Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

100. The figure then uses these calculations to project levels of poverty incidence. The results of this exercise are summarized in Table 9. In this exercise the poverty line is selected so that the predicted level of rural poverty incidence (P1 above) replicates the level of rural poverty incidence officially estimated from the LECS III data—37.6%—as shown in Table 5. In Figure 9, this is the uppermost of the three horizontal lines. The difference between the estimated levels of poverty incidence under P1 and P2 is 0.43% of the rural population (poverty incidence under P2 is 36.17%—the middle horizontal line in Figure 9). The difference between P3 and P2 is a

further 6.81% of the rural population (poverty incidence under P3 is 29.36%—the lowest of the three horizontal lines in Figure 9). Combining the two, rural poverty incidence in the Lao PDR could be reduced by 7.24% by providing all-weather roads to all rural people. This number of rural people is equivalent to about 5.6% of the total population of the Lao PDR. This reduction in poverty would be permanent, assuming that the roads were properly maintained.

Figure 9: Lao PDR: Predicted Distribution of Real Expenditures per Person in Rural Areas under Alternative Road Conditions, 2002–2003



Note: Units on the horizontal axis are the natural logarithm of real household consumption expenditures per person expressed in December 1999 prices. “real per capita exp. (predicted)” refers to P1 in the text. “real per capita exp. (predicted all dry)” refers to P2 in the text. “real per capita exp. (predicted)” refers to P3 in the text.
Source: Author’s calculations based on LECS III household survey data from National Statistical Center, Vientiane, and regression results shown in Table 8, above.

101. A surprising feature of these results is that the difference between poverty incidence under P1 and P2 is small. Holding other variables constant, providing dry season access, by itself, does little for poverty reduction. Other conditions also have to be met, particularly educational conditions, the availability of electricity supplies and the presence of productive assets such as buffaloes. Much larger gains, in terms of poverty reduction, are available from upgrading dry season access to all-weather access. As noted in relation to Table 5 above, the investment in road improvement that has taken place has primarily been the provision of all weather roads to households that already had dry season road access. The results above suggest that this was, and continues to be, the best strategy for poverty reduction.

102. Between the dates of LECS II and LECS III, improved access to wet weather roads was provided to 7.9% of the rural population. This may be compared with the 47.3% of the same population that lacked it in 1997–1998. This improvement was therefore about one sixth of the potential increase in wet season access. Our simulation exercise above indicates that providing all-weather access to all rural households would reduce poverty incidence by 7.24%. Interpolating linearly, the reduction in poverty incidence may therefore be estimated at about 1.2% of the rural population. Rural poverty incidence actually declined by 4.9% over this same period (Table 5). Therefore these results imply that about 24%, one quarter, of the reduction in rural poverty incidence that occurred between LECS II and LECS III can be attributed to improved wet season road access.

103. A possible objection to the analysis performed above is that it ignores the possible implications of a phenomenon now known as the “endogenous placement” problem. If improved roads were provided to better off areas, rather than independently of household real consumption, the cross-sectional relationship between better roads and real expenditures might not have the causal interpretation attributed to it in the above discussion.

104. This possibility was tested by assembling data on road improvement that occurred between the dates of LECS II and LECS III. These data were assembled at the district level of which there are 140 in the Lao PDR. The data are not derived from LECS but from independent compilation of data from regional government offices and from the Ministry of Roads in Vientiane. Some judgment is involved in assessing whether roads were or were not ‘all weather’ and whether they were maintained. These judgments reflect the assessments of regional level officers of the Ministry of Roads.

105. The change in average real expenditures per capita between LECS II and LECS III was then related to the improvement or non-improvement of roads as captured in this data set. The results are summarized in Table 10. The base level of real per capita expenditures in LECS II (1997–1998) was significant and with a negative coefficient, meaning that better-off households did less well in proportional terms (the dependent variable is the change in the log of real expenditures) than poorer households. The base level of road access in 1997–1998 was less important in explaining the improvement in average real consumption expenditures at the district level than the change in road access, where the coefficient was significant (at 7% level) and numerically of similar magnitude to the value obtained from the cross-sectional results.

106. A further, more direct, test of the endogenous placement problem was conducted by regressing the change in road access that occurred between LECS II and III on the level of initial real per capita expenditure in LECS II. The regression was done using provincial level observations by taking the means of the district level dummy variables for improved road access for each district within the province and regressing this on the provincial means of the district level real per capita expenditure as recorded in LECS II. If better off areas received preferential treatment in road improvement, a significant and positive coefficient would be expected. The estimated coefficient was negative but insignificant.

Table 10: Lao PDR: Change in Real Expenditure from 1997–1998 to 2002–2003 Regression Results at District Level

Dependent variable: Change in real per capita expenditure			
Independent variables:	*Coefficient*	*t-statistic*	*p-value*
Constant	3.934	4.131	0.000
Real per capita expenditure LECS II	-0.334	-4.210	0.000
Age at last birthday (household head)	0.078	0.390	0.697
Age at last birthday squared (household head)	-0.001	-0.342	0.733
Primary (1–5 years)	0.441	1.535	0.128
Lower secondary (6–8 years)	0.537	1.006	0.317
Upper secondary (9–11 years)	-0.442	-0.478	0.634
Higher (12+ years)	2.536	2.847	0.005
Working_Head1	0.330	0.855	0.395
Farming_Head1	0.389	1.136	0.259
NotLF_Head	0.162	0.471	0.638
Adult (18<= AgeAdult < 65)	0.080	0.425	0.672
Total number of members in the household	-1.241	-2.225	0.028
Total number of members in the household squared	0.075	1.780	0.078
Cows or buffalo, owned and free access, no. of animals	-0.001	-0.030	0.976
Market_n	0.128	0.421	0.675
Transport_n	0.068	0.525	0.600
PipedWater_n	0.095	0.635	0.527
CommunityHealth_n	0.075	0.537	0.593
District has all weather road in 1997	0.021	0.199	0.842
District built road during 1997 and 2002	0.188	1.821	0.071

Summary diagnostics:
R^2 = 0.393; adj. R^2 = 0.155; s.e. of estimate = 0.1322; F = 6.944; significance level: p = 0.000.
Source: Author's calculations from LECS II and LECS III survey data, National Statistical Centre, Vientiane.

107. These results are supportive of the findings of the cross-sectional analysis reported above, confirming that improving road access is a powerful instrument for raising real consumption expenditures of households and thereby reducing poverty.

D. Isolating the Effects of Roads on Education and Health

1. Educational Participation

108. Does improving road access improve educational participation? Table 11 reports the results of regressing educational participation rates of children in the primary school-age group on the same set of independent variables discussed above. Because participation at the household level is a binary variable (0,1) for each child, participation was aggregated to the district level to obtain the average participation rate for the district of children in the relevant age group. The independent variables were similarly aggregated to the district level. As far as road improvement is concerned, the results are not highly significant, but indicate tentatively that providing dry season access raises participation rates (effect significant at the 13% level), but that providing wet season access has no additional impact.

Table 11: Lao PDR: Primary School Participation and Road Access, 2002–2003
Regression Results at District Level

Dependent variable: Share of prime age children in school per district			
Independent variables:	*Coefficient*	*t-statistic*	*p-value*
(Constant)	1.625	1.021075	0.310259
Age at last birthday	-0.063	-0.83256	0.407543
Age at last birthday squared (household head)	0.001	0.908241	0.366445
Primary (1–5 years)	0.093	0.770173	0.443438
Lower secondary (6–8 years)	0.762	3.204874	0.001934
Upper secondary (9–11 years)	-0.183	-0.36678	0.714739
Higher (vocational training or university/institute)	0.436	0.801859	0.42498
Paid employment	0.115	0.396726	0.692613
Farm employment	0.394	1.381979	0.170777
Not in labor force	0.164	0.44677	0.656234
Number of adults in household (18 <= AgeAdult < 65)	0.000	-0.23967	0.811192
Total number of members in household	0.000	-0.22999	0.818677
Total number of cows and buffaloes	-0.004	-0.42221	0.673989
Electricity_n	0.060	0.920383	0.360106
DailyMarket_n	-0.173	-1.1994	0.23387
BusStop_n	0.060	0.808697	0.421058
CleanWater_n	0.126	2.165333	0.033304
HospitalInVillage	-0.071	-0.47954	0.632845
AccessDrySeason_n	0.003	1.531388	0.12957
AccessWetSeason_n	0.000	-0.18556	0.853257
Prov. 1 – Phongsaly	-0.086	-0.56677	0.572439
Prov. 2 – Luang Namtha	-0.213	-1.5322	0.12937
Prov. 3 – Bokeo	-0.328	-2.27442	0.025586
Prov. 4 – Oudomsay	-0.328	-2.21364	0.029665
Prov. 5 – Sayabouri	-0.269	-1.85106	0.067805
Prov. 6 – Luang Prabang	-0.144	-1.10317	0.273219
Prov. 7 – Huaphanh	-0.188	-1.38413	0.170122
Prov. 8 – Xieng Khouang	-0.086	-0.70097	0.485328
Prov. 9 – Vientiane Municipality	-0.172	-1.25098	0.214544
Prov. 10 – Vientiane	0.024	0.180271	0.85739
Prov. 11 – Saysomboune	0.080	0.59332	0.55462
Prov. 12 – Borikhamsay	-0.174	-1.33326	0.186185
Prov. 13 – Khammouane	-0.319	-2.50756	0.014155
Prov. 14 – Savannakhet	-0.331	-2.50378	0.014296
Prov. 15 – Champasack	-0.350	-2.48212	0.015128
Prov. 16 – Saravane	-0.051	-0.43392	0.665498
Prov. 17 – Sekong	-0.142	-1.04733	0.298061

Summary diagnostics:
R^2 = 0.727; adj. 0.605; s.e. of estimate = 0.1493; F = 5.987; significance level: p = 0.000.
Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

109. These results are interesting in that they suggest that road access, by itself, is not the most important determinant of school attendance. More important variables are the education of the head of the household (the variable "Lower secondary") and the availability of clean water. Similar results apply to the school participation of both female children (Table 12) and male

children (Table 13). Over longer periods, improved roads may raise school participation, but these results suggest that in the short term, addressing the availability of clean water is more important than providing improved roads.

Table 12: Lao PDR: Primary School Participation of Females and Road Access 2002–2003, Regression Results at District Level

Dependent variable: Share of prime age female children in school per district

Independent variables:	*Coefficient*	*t-statistic*	*p-value*
(Constant)	2.214	1.044881	0.299186
Age at last birthday	-0.096	-0.94732	0.346294
Age at last birthday squared (household head)	0.001	1.026731	0.307604
Primary (1–5 years)	0.245	1.530683	0.129744
Lower secondary (6–8 years)	0.726	2.294988	0.024321
Upper secondary (9–11 years)	-0.149	-0.22439	0.823015
Higher (vocational training or university/institute)	0.816	1.127259	0.262961
Paid employment	0.083	0.21374	0.831287
Farm employment	0.358	0.943538	0.348212
Not in labor force	0.059	0.120504	0.904382
Number of adults in household (18 <= AgeAdult < 65)	0.000	-0.17342	0.862757
Total number of members in household	0.000	-0.28628	0.775395
Total number of cows and buffaloes	0.000	0.000829	0.999341
Electricity_n	0.100	1.147392	0.254597
DailyMarket_n	-0.196	-1.0177	0.311851
BusStop_n	0.000	0.00159	0.998735
CleanWater_n	0.120	1.554888	0.123872
HospitalInVillage	0.057	0.29301	0.770264
AccessDrySeason_n	0.004	1.610362	0.111209
AccessWetSeason_n	0.000	-0.18224	0.855853
Prov. 1 – Phongsaly	-0.112	-0.55123	0.582996
Prov. 2 – Luang Namtha	-0.253	-1.36541	0.175903
Prov. 3 – Bokeo	-0.331	-1.72518	0.088308
Prov. 4 – Oudomsay	-0.369	-1.87501	0.064395
Prov. 5 – Sayabouri	-0.216	-1.11458	0.268326
Prov. 6 – Luang Prabang	-0.113	-0.65399	0.514973
Prov. 7 – Huaphanh	-0.215	-1.184	0.239876
Prov. 8 – Xieng Khouang	-0.098	-0.5986	0.55111
Prov. 9 – Vientiane Municipality	-0.183	-1.00016	0.320209
Prov. 10 – Vientiane	0.010	0.053769	0.957252
Prov. 11 – Saysomboune	0.074	0.411548	0.681758
Prov. 12 – Borikhamsay	-0.202	-1.16108	0.249018
Prov. 13 – Khammouane	-0.312	-1.83839	0.06967
Prov. 14 – Savannakhet	-0.383	-2.17718	0.032378
Prov. 15 – Champasack	-0.415	-2.21266	0.029736
Prov. 16 – Saravane	-0.080	-0.51117	0.610622
Prov. 17 – Sekong	-0.177	-0.98143	0.329305

Summary diagnostics:
R^2 = 0.664; adj. 0.515; s.e. of estimate = 0.1988; F = 4.452; significance level: p = 0.000.
Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

Table 13: Lao PDR: Primary School Participation of Males and Road Access, 2002–2003
Regression Results at District Level

Dependent variable: Share of prime age male children in school per district			
Independent variables:	*Coefficient*	*t-statistic*	*p-value*
(Constant)	1.053	0.598558	0.551159
Age at last birthday	-0.037	-0.43474	0.664922
Age at last birthday squared (household head)	0.000	0.469283	0.640144
Primary (1–5 years)	0.020	0.146775	0.883679
Lower secondary (6–8 years)	0.798	3.021298	0.003379
Upper secondary (9–11 years)	0.074	0.119113	0.905485
Higher (vocational training or university/institute)	-0.067	-0.10881	0.913623
Paid employment	0.189	0.589999	0.556854
Farm employment	0.489	1.551408	0.124751
Not in labor force	0.466	1.150286	0.253453
Number of adults in household (18 <= AgeAdult < 65)	-0.001	-0.40397	0.687315
Total number of members in household	0.000	0.081828	0.934988
Total number of cows and buffaloes	-0.008	-0.78427	0.435197
Electricity_n	-0.002	-0.02933	0.976671
DailyMarket_n	-0.139	-0.85458	0.395337
BusStop_n	0.121	1.464071	0.147093
CleanWater_n	0.181	2.816381	0.006115
HospitalInVillage	-0.147	-0.88072	0.381108
AccessDrySeason_n	0.002	0.972241	0.333861
AccessWetSeason_n	-0.001	-0.46407	0.643861
Prov. 1 – Phongsaly	-0.050	-0.26673	0.790361
Prov. 2 – Luang Namtha	-0.168	-1.09089	0.278596
Prov. 3 – Bokeo	-0.260	-1.61632	0.109961
Prov. 4 – Oudomsay	-0.288	-1.75541	0.083018
Prov. 5 – Sayabouri	-0.285	-1.76566	0.081268
Prov. 6 – Luang Prabang	-0.137	-0.94678	0.3466
Prov. 7 – Huaphanh	-0.145	-0.95754	0.341179
Prov. 8 – Xieng Khouang	-0.054	-0.39299	0.695374
Prov. 9 – Vientiane Municipality	-0.136	-0.89285	0.374617
Prov. 10 – Vientiane	0.059	0.397258	0.692235
Prov. 11 – Saysomboune	0.100	0.666602	0.506944
Prov. 12 – Borikhamsay	-0.121	-0.83423	0.406637
Prov. 13 – Khammouane	-0.315	-2.23014	0.02854
Prov. 14 – Savannakhet	-0.237	-1.62601	0.107881
Prov. 15 – Champasack	-0.266	-1.70819	0.091479
Prov. 16 – Saravane	-0.021	-0.16497	0.869382
Prov. 17 – Sekong	-0.065	-0.43659	0.663584

Summary diagnostics:
R^2 = 0.645; adj. 0.486; s.e. of estimate = 0.1650; F = 4.042; significance level: p = 0.000.
Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

2. Health Standards

110. Does improving roads contribute to raising health standards? The LECS surveys include questions that are relevant for this issue. Table 14 reports a regression similar to those described above for education, but for which the dependent variable is the share of people in the district who reported having been ill in the last 4 weeks. The results are surprising. They suggest that providing dry season road access has a powerful effect in reducing the rate of illness (significant at the 2% level). How could this work? The mechanism may be that road access, along with the availability of clean water, makes it possible for the household to attain higher levels of hygiene. The ability to obtain treatment for those who become ill may also reduce illness among other members of the household. The education of the head of the household is again important (the variable "Lower secondary"). The results presented in Table 15 are loosely supportive of the effect of dry season road access in raising the likelihood of seeking treatment. However, the level of significance is not strong.

E. Conclusions

111. This chapter summarizes evidence suggesting that road improvement in rural areas can contribute to lowering poverty incidence, improving educational participation of primary school-age children, and reducing rates of illness. This is done in the context of rural areas of the Lao PDR. The Lao PDR rural roads are widely recognized as a major developmental problem. Improving them will obviously generate benefits. But demonstrating and quantifying effects on indicators relevant for the MDGs, such as poverty incidence, educational participation, and health standards, are another matter.

112. *The results of this analysis suggest that for poverty reduction, the important form of road improvement is the conversion of dry season access roads into all season access*. This is in fact the principal form of road improvement that occurred in the Lao PDR between 1997–1998 and 2002–2003. Over this same period, poverty incidence declined from 42.5% to 37.6% of the rural population. The results of this analysis suggest that about one fourth of this amount of poverty reduction can be directly attributed to the conversion of roads that are accessible only in the dry season into roads that are accessible in all seasons.

113. The data for the Lao PDR also indicate that improvement of roads has effects on educational participation and health standards. The results are not as robust, statistically, as those on poverty, but an interesting difference emerges. Whereas effects of poverty incidence are strongest for the upgrading of dry season access roads to all weather roads, educational and health benefits derive mainly from provision of dry season access to households that previously had no road access (meaning that they were accessible only by walking). Over the 5-year period examined in this case study, very little road improvement of this kind actually occurred in the Lao PDR. The results suggest that potentially significant educational and health benefits could be derived by providing dry season road access to the 20% of rural households that presently lack it.

Table 14: Lao PDR: Determinants of incidence of illness, 2002–2003, Regression results at District level

Dependent variable: Share of Ill people per district			
Independent variables:	*Coefficient*	*t-statistic*	*p-value*
(Constant)	-1.640	-2.463	0.015917
Age at last birthday	0.083	2.591	0.011351
Age at last birthday squared (household head)	-0.001	-2.545	0.012822
Primary (1–5 years)	-0.010	-0.186	0.85253
Lower secondary (6–8 years)	0.212	2.076	0.041093
Upper secondary (9–11 years)	-0.150	-0.695	0.488971
Higher (vocational training or university/institute)	-0.523	-2.297	0.024184
Paid employment	0.065	0.517	0.606656
Farm employment	0.088	0.713	0.477671
Not in labor force	0.230	1.450	0.151007
Number of adults in household (18 <= AgeAdult < 65)	-0.014	-0.420	0.675582
Total number of members in household	-0.004	-0.258	0.797167
Total number of cows and buffaloes	-0.005	-1.321	0.190145
Electricity_n	-0.023	-0.846	0.399944
DailyMarket_n	0.048	0.775	0.44077
BusStop_n	0.061	1.687	0.095458
CleanWater_n	-0.036	-1.460	0.148194
HospitalInVillage	-0.062	-0.968	0.335788
AccessDrySeason_n	-0.083	-2.398	0.018775
AccessWetSeason_n	0.020	0.601	0.549419
Prov. 1 – Phongsaly	0.045	0.689	0.492556
Prov. 2 – Luang Namtha	-0.086	-1.386	0.169452
Prov. 3 – Bokeo	0.050	0.825	0.411988
Prov. 4 – Oudomsay	0.000	-0.005	0.995832
Prov. 5 – Sayabouri	0.032	0.524	0.601939
Prov. 6 – Luang Prabang	0.028	0.511	0.610957
Prov. 7 – Huaphanh	-0.015	-0.271	0.787028
Prov. 8 – Xieng Khouang	0.028	0.539	0.591316
Prov. 9 – Vientiane Municipality	-0.014	-0.232	0.816763
Prov. 10 – Vientiane	-0.022	-0.390	0.697807
Prov. 11 – Saysomboune	-0.054	-0.940	0.350116
Prov. 12 – Borikhamsay	-0.064	-1.142	0.25677
Prov. 13 – Khammouane	0.042	0.764	0.446794
Prov. 14 – Savannakhet	0.017	0.305	0.761423
Prov. 15 – Champasack	0.060	0.984	0.327948
Prov. 16 – Saravane	0.142	2.853	0.005502
Prov. 17 – Sekong	-0.006	-0.104	0.91751

Summary diagnostics:
R^2 = 0.602; adj. 0.425; s.e. of estimate = 0.0634; F = 3.399; significance level: p = 0.001.
Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

Table 15: Lao PDR: Determinants of Decision to Seek Treatment when Ill, 2002–2003
Regression Results at District Level

Dependent variable: Share of Ill people not seeking treatment per district			
Independent variables:	**Coefficient**	**t-statistic**	**p-value**
(Constant)	-2.049	-1.09355	0.277392
Age at last birthday	0.147	1.629321	0.107128
Age at last birthday squared (household head)	-0.002	-1.52987	0.129944
Primary (1–5 years)	-0.003	-0.01648	0.986894
Lower secondary (6–8 years)	0.368	1.283208	0.203078
Upper secondary (9–11 years)	0.036	0.05964	0.95259
Higher (vocational training or university/institute)	-1.050	-1.63933	0.105022
Paid employment	-0.712	-2.02015	0.046674
Farm employment	-0.420	-1.21859	0.226536
Not in labor force	0.087	0.19432	0.846412
Number of adults in household (18 <= AgeAdult < 65)	0.084	0.864484	0.389875
Total number of members in household	-0.017	-0.42956	0.66866
Total number of cows and buffaloes	0.002	0.165343	0.869086
Electricity_n	-0.014	-0.18438	0.854173
DailyMarket_n	-0.142	-0.81892	0.415234
BusStop_n	0.026	0.253088	0.800841
CleanWater_n	-0.024	-0.34742	0.729176
HospitalInVillage	-0.098	-0.54537	0.586997
AccessDrySeason_n	-0.117	-1.19857	0.234189
AccessWetSeason_n	0.019	0.202277	0.840207
Prov. 1 – Phongsaly	-0.086	-0.46521	0.643029
Prov. 2 – Luang Namtha	-0.126	-0.72362	0.471386
Prov. 3 – Bokeo	-0.123	-0.72964	0.467715
Prov. 4 – Oudomsay	-0.079	-0.44444	0.65791
Prov. 5 – Sayabouri	-0.005	-0.02856	0.977286
Prov. 6 – Luang Prabang	-0.045	-0.2873	0.774614
Prov. 7 – Huaphanh	-0.046	-0.28493	0.776423
Prov. 8 – Xieng Khouang	-0.088	-0.59638	0.552585
Prov. 9 – Vientiane Municipality	-0.272	-1.60803	0.11172
Prov. 10 – Vientiane	-0.123	-0.76405	0.44706
Prov. 11 – Saysomboune	-0.335	-2.07507	0.041154
Prov. 12 – Borikhamsay	-0.242	-1.52749	0.130535
Prov. 13 – Khammouane	-0.141	-0.90417	0.368586
Prov. 14 – Savannakhet	0.049	0.30741	0.75932
Prov. 15 – Champasack	-0.107	-0.62751	0.532088
Prov. 16 – Saravane	0.041	0.291945	0.771075
Prov. 17 – Sekong	0.018	0.112688	0.910557

Summary diagnostics:
R^2 = 0.656; adj. 0.431; s.e. of estimate = 0.1774; F = 1.701; significance level: p = 0.025.
Source: Author's calculations from LECS III survey data, National Statistical Centre, Vientiane.

V. SUMMARY AND CONCLUSIONS

114. The theme of the second issue of *The Mekong Region: An Economic Overview* is the Economic and Social Impacts of Infrastructure Projects.

115. We began by reviewing recent economic performance of the Mekong countries as well as of the subregion as a whole. The GMS is one of the fastest-growing subregions in the world. GDP growth in all six economies was robust in 2004, ranging from 6% in Cambodia to 7.5% in Viet Nam. Between 2003 and 2004, growth was higher in all countries except Thailand, where it fell only marginally.

116. Mainly as a result of higher world oil prices in 2004, inflation picked up in all countries except the Lao PDR. All GMS countries except Thailand continued to run fiscal deficits during 2004, although these deficits narrowed in all countries compared to 2003. All countries except Thailand continued to run current account deficits in 2004. Apart from Viet Nam, where the deficit narrowed quite appreciably, the situation in other countries was little changed in 2004.

117. To assess the economic and social impacts of infrastructure projects, we developed an analytical framework that focuses on the transmission mechanisms associated with such interventions. This framework identifies the ways in which infrastructure projects can be expected to impact upon the economic and social well-being of affected populations.

118. Three channels are examined though which infrastructure benefits the poor. First, it raises household incomes by raising the productivity of the resources owned by the household. For instance, transport infrastructure like roads reduces transport costs to and from markets. This raises the net returns farm households can obtain for their goods and reduces the cost to them of the inputs they need to purchase. Transport infrastructure may also facilitate direct employment of household members outside the household, thus raising the return to their labor directly.

119. The second channel of effects operates through access to public services such as education and health facilities. The infrastructure reduces the cost of reaching these facilities, in the case of roads, or improved information about them, in the case of communications facilities.

120. The final source of benefit is that infrastructure improves access to final consumer goods and by reducing transport costs, makes them more affordable. Electricity infrastructure makes it possible for the household to use a wide range of consumer goods otherwise unavailable to them.

121. Negative effects of infrastructure provision can be important and, unfortunately, the Mekong countries provide examples of some such effects. As road access to remote areas improves, negative environmental outcomes such as deforestation, caused by increased commercial logging and/or land clearing for agriculture, may increase. The flow of drugs may increase, and trafficking in women and children may be facilitated. Finally, the spread of HIV/AIDS may increase. Increased road access and usage can also result in increased accidents although improving the condition of existing roads may improve road safety. These potential negative effects raise the importance of governance. Achieving the demonstrated social benefits from improving infrastructure while avoiding or at least minimizing the negative effects is a challenge to governance throughout the Mekong subregion.

122. With the aid of this analytical framework, we turned next to a case study of these effects in operation in the context of rural areas of the Lao PDR.

123. The case study uses household level data from the Lao Expenditure and Consumption Survey relating to the years 1997–1998 and 2002–2003. These data suggest that rural areas of the Lao PDR account for 87% of all poor people in that country. Reducing poverty in the Lao PDR means, primarily, reducing rural poverty. But what works and what does not work in achieving the goal of poverty reduction? This case study is directed to that question. The case study looks at three dimensions of poverty, broadly conceived: consumption poverty, meaning expenditure on private purchases of goods and services; educational opportunity; and health standards. Consumption poverty measures only the availability of goods and services that people can purchase with their own funds and makes no allowance for the availability of goods and services provided at a collective level, principally by the government. For this reason, including such collectively provided goods as educational and health services is a useful broadening of the concept of poverty reduction.

124. The results of this analysis suggest that for poverty reduction, the important form of road improvement is the conversion of dry season access roads into all season access. This is in fact the principal form of road improvement that occurred in the Lao PDR between 1997–1998 and 2002–2003. Over this same period, poverty incidence declined from 42.5% to 37.6% of the rural population. The results of this analysis suggest that about one fourth of this amount of poverty reduction can be directly attributed to the conversion of roads that are accessible only in the dry season into roads that are accessible in all seasons. The principal form of road improvement that occurred in the Lao PDR has therefore been consistent with the goal of maximizing the rate of poverty reduction.

125. The data for the Lao PDR also indicate that improvement of roads has effects on educational participation and health standards. Whereas effects of poverty incidence are strongest for the upgrading of dry season access roads to all weather roads, educational and health benefits derive mainly from provision of dry season access to households that previously had no road access, meaning that they were accessible only by walking. Over the 5-year period examined in this case study, very little road improvement of this kind actually occurred in the Lao PDR. The results suggest that educational and health benefits would be derived by providing dry season road access to the 20% of rural households that presently lack it.

126. In summary, it is fair to conclude that the case study provides evidence that road improvement in rural areas can contribute to lowering poverty incidence, improving educational participation of primary school-age children, and reducing rates of illness. Given that the vast majority of the Mekong subregion remains rural, these findings have particular relevance and give added weight to national and regional investment programs, particularly those targeting the rural poor.

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THE LECS SURVEY, 2002–2003

The 2002–2003 survey of households in the Lao PDR (LECS III) covered 8,092 households containing 49,790 individuals with the data collection extending from March 2002 to February 2003. Of these households 6,488 were rural and the remaining 1,604 were urban. In addition to data on expenditures, the LECS data include the following relevant variables (section codes of LECS in parentheses):

Province
District
Village

Characteristics of household
Number of adults
Number of members
Household consumption expenditure per person
Household income per person

Household ownership of assets
Irrigated land (B)
Dry land (B)
Rice husking machine (B)
Number of cows or buffaloes

Characteristics of household head
Age
Male (B)
Years of schooling
Unemployed (B)
Paid employee (B)
Employer (B)
Self-employed (B)
Farmer (B)
Unpaid family worker (B)
Outside labor force (B)

Educational characteristics of children in primary age group
Whether enrolled in school during past 12 months – C 5 (B)
If not, why not – C 6
Household expenditure on that child's education – C 11
Distance from home to school attended – C 14
Time taken to travel to school – C 15

Health of household members
Whether treatment sought during last 4 weeks – D 7 (B)
Type of facility – D 9
Transport cost incurred in accessing the facility during the last 4 weeks – D 13

Village characteristics
Electricity network (B)
Permanent market (B)
Scheduled passenger transport (B)
Distance to main road
Primary school (B)
Piped water or protected well (B)
Pharmacy (B)
Medical practitioner (B)
Trained nurse (B)
Community health worker (B)
Immunization program (B)
Urban (B)
Rural with access to road (B)
Rural without access to road (B)

THE TREATMENT OF DUMMY VARIABLES

The treatment of the dummy variables for dry season access to roads and wet season access needs explanation. We used dummy variables *D* and *W*, where *D* takes the value 0 if the household reports no dry season access and 1 if it reports road access. Then, *W* is defined similarly for wet season access. There was no household for which *D* was zero and *W* was 1. With respect to road access there were therefore three categories of households:

(i) no road access at all: $D = 0$, $W = 0$,
(ii) access in dry season but not wet season: $D = 1$, $W = 0$,
(iii) access in both seasons: $D = 1$, $W = 1$.

The number of households belonging to each of these categories are summarized in Table 6. In LECS II, 31% of households belonged to category (i) and this barely changed in LECS III. These are the most isolated households of the country and according to these data, little progress was made in providing them with road access over this period. In category (ii) – dry season access but not wet season access, the proportion declined from 28% in LECS II to 16% in LECS III. Thus the number of households that had wet season access as well as dry season access increased between these two surveys by 12% of all households. In LECS III, 52% of all household had year-round road access.

The estimated regression equation handled this combination of outcomes through an interaction term. The right hand side variables thus included the terms

$$\alpha D + \beta D.W$$

where α and β are estimated coefficients. In case (i) above, *D* and *D.W* are both 0. In case (ii), $D = 1$ and $D.W = 0$. In case (iii), *D* and *D.W* are both 1. The effect of dry season access alone is given by α and (noting that whenever $W = 1$, $D = 1$ also) the combined effect of dry and wet season access is given by $\alpha + \beta$.