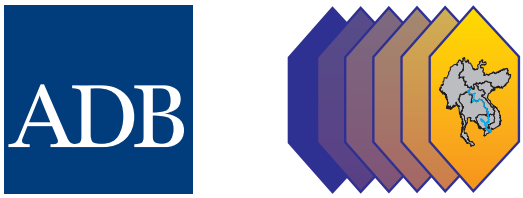
Assessing Impact in the Greater Mekong Subregion

An Analysis of Regional Cooperation Projects



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Asian Development Bank

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Abbreviations

ADB	–	Asian Development Bank
GDP	–	gross domestic product
GMS	–	Greater Mekong Subregion
HS	–	Harmonized System (of tariff nomenclature)
KAP	–	knowledge, attitude, and practices
km	–	kilometer
Lao PDR	–	Lao People's Democratic Republic
NSEC	–	North–South Economic Corridor
PRC	–	People's Republic of China

I. Background of the Study

The Greater Mekong Subregion (GMS) consists of Cambodia, the People's Republic of China (PRC, specifically Yunnan Province and Guangxi Zhuang Autonomous Region), the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam. In 1992, with the assistance of the Asian Development Bank (ADB), the GMS countries launched the GMS Economic Cooperation Program to strengthen economic links between them. The initial emphasis of cooperation was on building trust and confidence through activities and programs aimed at promoting physical connectivity among the member countries. To further this goal, the GMS countries adopted the Strategic Framework, 2002–2012, which outlined a comprehensive subregional development agenda, and underscored the need to supplement infrastructure links with cooperation on policies and programs to promote equitable and environmentally sustainable growth. Taking into account the challenges and opportunities that lie ahead for the GMS and the 20 years of achievements of the GMS Program, leaders of the GMS countries adopted a new strategic framework at the Fourth GMS Summit in 2011 to guide the program through 2012–2022.

Cooperation among the GMS countries has intensified in recent years. By the end of 2013, the program had mobilized $16.6 billion in investment projects and $330.8 million in technical assistance, of which ADB's support amounted to $6.0 billion for investments and $115.1 million for technical assistance. The GMS countries have identified a number of priority sectors for cooperation under the program, including transport, telecommunications, energy, the environment, tourism, trade facilitation, human resources development, and agriculture. So far, however, the majority of the funds for investment projects under the program have gone primarily to transport and, to a lesser extent, energy. Nevertheless, as physical connectivity has improved and the scope for cooperation has broadened, investment projects are gradually becoming more diverse. The share of transport projects in total investment declined from 90% in 1992–2001 to 72% in 2013, while that for energy increased from 10% to 19% during the same period. As evidence of diversification, two projects for controlling communicable diseases and developing sustainable tourism have also been initiated since 2002.[1]

1 Asian Development Bank Greater Mekong Subregion. ADB-Assisted Loan/Grant Project (as of 31 December 2013). Unpublished.

This study summarizes a recent major initiative to assess the initial impact of ADB-supported projects under the GMS Program. As part of this exercise, a range of representative projects in the road transport, health, and tourism sectors were selected for detailed analysis, and research institutes in the respective countries working with international consultants assessed their socioeconomic impact.

The projects selected and their countries of location are in Table 1. The GMS Northern Economic Corridor Project, the GMS Communicable Diseases Control Project, and the GMS Mekong Tourism Development Project had each been in operation for about 3 years at the time of the impact evaluations. The evaluations had no pre-project baseline data and simply looked at the situation for project participants and similar nonparticipants at a point in time. The Southern Coastal Corridor was not in operation at the time of the evaluations.

All projects selected can be considered regional cooperation projects because, although they may be located in a single country, they are expected to generate net benefits across more than one country in the region. Regional cooperation projects, by definition, are expected to create positive externalities within the region, so that through cooperation of the participating countries net benefits will be higher than they would be if the projects were conducted by the countries individually. This can arise for road projects, for example, where cross-border trade facilitation that accompanies the construction of a road on both sides of the border allows a higher growth of trade and thus traffic. Similarly, cooperation between neighbors in developing tourist circuits—through, for example, single-visa arrangements or shared tour operations—can create a larger number of tourist visits in each country than would occur in the absence of such cooperation. Cooperation in health will be particularly important in relation to the control of infectious diseases, because without an integrated approach to disease control, efforts in one country can be undermined by the transmission of the disease from a neighboring country.

To assess the impact on households, data were collected by conducting surveys in the areas affected by the projects, as well as in comparison areas with similar characteristics. Broad socioeconomic impacts were considered, and information was gathered on monetary and nonmonetary measures of welfare, including data on income and expenditure, as well as indicators of health status and access to education and health facilities.

Table 1 Projects Examined

Project	Countries
Transport: Greater Mekong Subregion Northern Economic Corridor Project	Yunnan Province, People's Republic of China; the Lao People's Democratic Republic; Thailand
Health: Greater Mekong Subregion Regional Communicable Diseases Control Project (Dengue)	Cambodia, the Lao People's Democratic Republic, Viet Nam
Tourism: Greater Mekong Subregion Mekong Tourism Development Project	The Lao People's Democratic Republic

Sources: Asian Development Bank.

A. Impact Methodology

Impact is the difference between the outcome with a project or a policy intervention and the situation in the absence of the project or intervention. The outcome with the project can be observed, but the hypothetical or counterfactual outcome without it cannot and so must be estimated. The difficulty of impact evaluation is therefore the accurate estimation of the without-project scenario. This is normally done by comparing a treatment group exposed to a project or intervention to a similar control group that has not been exposed to the project or intervention. However, the estimation of an appropriate counterfactual is complicated by various potential biases; for example, a project may be located in an area of greater economic potential (placement bias) or more dynamic individuals may decide to join the project (selection bias). In both instances, the treatment group is likely to outperform the control group regardless of any effect created by the project.

The best approach for removing such biases is the random selection of individuals, households, or locations for inclusion in the treatment and control groups. If membership of each group is determined randomly, then all have an equal probability of inclusion in one group or the other and participation in a project or intervention becomes the only differentiating factor.[2] Nonetheless, random assignment is costly and complicated to implement, because it requires the close cooperation of the body implementing the project or intervention. It must be applied before the start of a project or program, and there are both practical and ethical issues involved in deliberately excluding some individuals or households. Furthermore, in theory, where it is impossible to rule out an external or spillover effect between the treatment and control groups, there is the risk of a bias in the data (contamination bias). Thus, if the income of the control group is reduced by competition from the treatment group, for example, the impact of the project, defined as the observed difference in incomes between the two groups, will be overstated.

B. Propensity Score Matching

Many rigorous impact evaluations apply an alternative approach to randomization that requires matching participants in a project or program with nonparticipants that have similar measurable characteristics. If done rigorously, the counterfactual is the mean outcome for the control group of similar nonparticipants, and the difference between the mean outcome for the treatment and control groups provides the measure of project impact. This approach will only be strictly valid, however, where the matching is accurate enough to ensure that the control group is statistically equivalent to the treatment group, so that the only difference is that the treatment group has access to the project or intervention.

Given that the matching of households or individuals requires a comparison of covariates (observable characteristics) and in practice there are many such variables, it is important to combine differences in covariates into a single index or score. This is the approach of propensity score matching, which allows the matching problem to be reduced to a single dimension. Propensity score matching is the main empirical approach to

2 The merits of randomization or experimental design have been debated extensively in recent years, e.g., Banerjee et al. (2009), de Mel et al. (2009), and Mackenzie (2009). Ravallion (2003) contrasts propensity score matching with randomization.

impact evaluation applied in the cases examined in this study.[3] The propensity score is defined as the probability that a unit (individual or household) in the combined sample of participants and nonparticipants (treated or untreated) participates in the project or program under study given a set of measurable characteristics. If units are matched by their propensity scores, then there should be an equal probability of each—both treated and untreated—participating in the project, which is the same result as obtained by random assignment. Where all measurable characteristics are controlled for, the matched treated and untreated units will have the same underlying distribution of characteristics (or values of covariates), and thus we can assume that without the project or intervention the outcomes for the two groups would have been the same.[4]

Estimation of the propensity score is normally by the estimation of a logit or probit function, where for treated units the dependent variable D takes a value of unity and for untreated control units a value of zero. So

$$D = f(X) + e$$

where X is a vector covering all measurable characteristics or covariates that may influence both treatment status and outcomes from a project or intervention and e is an error term.

The propensity score is the probability of treatment for each unit given their values of X. Once scores are estimated, they must be matched for treated and untreated units.[5] This can be on a one-to-one basis as pair matching, for example taking the closest value (nearest-neighbor matching) or matching a treated unit against a weighted score of a group of untreated units (e.g., kernel matching or radius matching). Some of the cases in this study use nearest-neighbor matching, but others also apply kernel matching.

Once scores have been estimated and the matching process conducted, the project or program impact is found by averaging the difference in outcomes (however these are defined) between each treated unit and its matched comparator (or comparators where a weighted comparison is used). This difference gives the average treatment effect on the treated. The results for impact need to be tested for their robustness. Standard errors of the estimates provide an indication of the importance of sampling error, and only statistically significant differences in means between the treatment and control groups can be accepted as reliable measures of impact. The steps involved are summarized in the box on page 5.

If matching has been done correctly a rerunning of the original logit or probit analysis should find that the pseudo R^2 should be substantially lower than in the pre-matching analysis, as after matching there should be no significant difference in the distribution of the covariates (or X variables) between both groups.[6] Another important check after matching is to compare the means of the

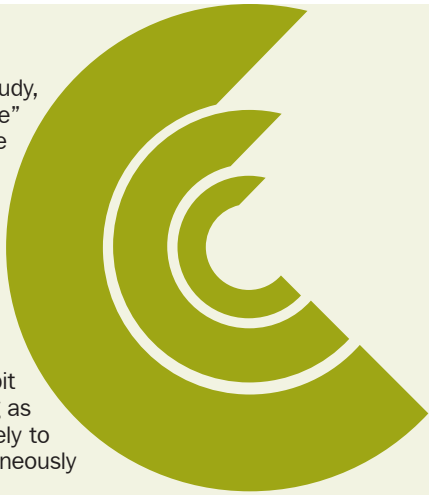
3 Rosenbaum and Rubin (1985) set out the statistical theory involved. Heinrich et al. (2010) provide an excellent introduction to the approach.

4 Theoretically, for propensity score matching to work, two conditions must be met: (i) all differences between units must be measurable, so all covariates in a vector X must be known; and (ii) for each possible value in the vector X there must be a positive probability of finding both a treated and untreated unit so all combinations of characteristics can be matched. See Heinrich et al. (2010, 15–16).

5 The STATA software combined with a specialist program such as psmatch2 is a common way of applying propensity score matching (Heinrich et al. 2010, 28).

6 See Caliendo and Kopeining (2005: 16).

Simple Steps in Propensity Score Matching



Propensity score matching is a technique for matching units (in this study, households) on the basis of a set of observable characteristics, so that only "close" units in terms of observable characteristics are matched. The approach can be disaggregated into a set of steps.

Step 1: There need to be representative sample surveys of both participants and nonparticipants in a project. The larger the sample of eligible nonparticipants the better, as it will allow better matching. The two surveys should be directly comparable in terms of questions, timing, interview techniques used, and data collected.

Step 2: The data from the two samples should be pooled and a logit or probit model estimated that explains the likelihood of program participation, including as many as possible of the explanatory variables from the survey data that are likely to influence participation. As many independent variables as possible that simultaneously influence both the participation decision and outcomes should be included.

Step 3: The logit or probit model creates predicted values of the probability of participation for each unit, termed "propensity scores." There will be propensity scores for each unit sampled—both participant and nonparticipant.

Step 4: Some of the nonparticipant samples may have to be excluded at the outset because their scores are outside the range found for the participant sample. It is important to ensure that the range of scores for the treatment or participant sample corresponds closely to the range for the control or nonparticipant sample. Observations in the nonparticipant group whose propensity score is smaller than the minimum and larger than the maximum within the range for the participants are considered as "off-support" and should be discarded from the analysis.

Step 5: Each individual unit in the treatment sample must be matched against a unit (or units) in the nonparticipant sample on the basis of the closeness of their propensity scores, normally measured as the absolute difference in scores. The simplest approach is to compare a treatment unit with the nearest single control unit ("nearest-neighbor" matching), but it is also possible to match against an average of control units.

Step 6: As a check on the matching process, values of all independent variables used in the logit or probit analysis at step 2 should be compared before and after matching to check for any remaining differences. The difference in the means of all variables for the participant and nonparticipant groups can be calculated, and their statistical significance found.

Step 7: Different outcome indicators (monetary and nonmonetary) can be compared between treated and closely matched control units. For each separate indicator the mean for all participants can be compared with the mean for the matched nonparticipants to give the average treatment effect on the treated from the project.

Source: Compiled by the author.

covariates (or X variables) between the treated units and their matched comparators (termed a balancing test). After matching, for the model to work there should be no statistically significant difference between the means of the covariates for the treated and matched units.[7] If significant differences remain, the specification of the model needs to be revised. One can also test jointly for the equality of means for all of the covariates between the treatment and control groups rather than for

7 In addition, in order to assess matching quality, the standardized bias of each independent variable in the logistic regression before and after matching can be calculated. This is defined as the difference in sample means for the treatment and control groups as a percentage of the square root of the average of the standard deviation for both groups. As a rule of thumb, most empirical work accepts a mean standardized bias of below 5% as an indication of an adequate match for the variables covered (see Caliendo and Kopeining 2005: 15).

each covariate separately. If the hypothesis of joint equality of means in the matched sample is rejected, this means the propensity score model is inadequate to achieve balance and it needs to be respecified.

Similarly, there needs to be a reasonable overlap between the propensity scores of the treated and untreated units to ensure that matching is possible. If some units of the treatment group have characteristics that are very different from those of the comparison group, then it will not be possible to construct a counterfactual for them. As a simple check, visual inspection of the density of the scores for the treated and untreated groups before and after matching can be carried out. Minimum and maximum scores can be used to establish the degree of overlap (or area of common support). Outlier observations (off-support observations) will need to be removed and the resulting smaller samples should show a similar distribution after matching has been carried out.

A refinement of the propensity score approach can allow for unobserved differences between treated and untreated units that may influence participation and outcomes, and cannot be reflected in vector X. Such differences (such as motivation determining self-selection into a project or program) can be controlled for, provided the unobservable differences can be assumed to be constant over time. Under this assumption, a difference in differences or double-difference approach can be applied with propensity score matching, provided that baseline data at the start of a project or program are available. Now treated and untreated units are matched at the start on the basis of propensity scores. To derive impact, the difference between outcome post-treatment and pre-treatment for the treated group is compared with net outcome over the same period for the matched untreated group. This difference reveals the project's impact, assuming unobservable differences between the groups have not changed and there are no transitory shocks in the pretreatment period that affect the two groups differently. None of the evaluation cases in this study had initial baseline data to draw on, and hence this refinement was not applied. In an effort to address this problem, some of the surveys asked for recall information on how conditions had changed over a number of past years. Statistically significant differences in this recall data between matched households in the two groups can provide partial support for project impact. In addition, as part of this study, baseline data for matched units have been compiled for projects that had not yet started operations to allow a rigorous analysis of impact from these projects in the future.

C. Conclusions

The projects examined are from a range of sectors and have diverse effects. The approach adopted in the case studies specified project outcomes in various ways—in both monetary and nonmonetary terms—and tried to assess the extent to which there has been a significant project impact. These results are important both in the context of the individual projects and in the wider discussion about the impact of regional cooperation in the GMS and elsewhere. This study is an effort to fill this gap by collecting primary household-level data and applying a rigorous technique from the evaluation literature.

II. Transport

Economic transport corridors linking member countries of the GMS are a critical element of the strategy of maximizing the benefits of regional cooperation and closer integration. Three separate impact analyses looked at the North–South Economic Corridor (NSEC) from the expected benefit of road projects connecting the Yunnan Province in the People's Republic of China (PRC), Lao People's Democratic Republic (Lao PDR), and Thailand. Two different routes along the north–south axis are involved in the North–South Economic Corridor initiative:

- the Kunming–Chiang Rai–Bangkok route via the Lao PDR and Myanmar; and
- the Kunming–Ha Noi–Haiphong route, which connects to the existing Highway No. 1 running from northern to southern Viet Nam.

Only the first route—Bangkok–Kunming via the Lao PDR—was evaluated in this study. The project includes the upgrading of existing roads in Yunnan Province, the PRC and in Thailand, as well as the restoration of a missing section in the Lao PDR to allow traffic to transit through the country.

Any evaluation of road projects using the propensity score matching or other approaches must recognize that road placement is not random. Given that road projects may be placed in areas with different levels of economic potential, to avoid placement bias it will be critically important to ensure that the control area is as similar as possible in all ways to the treatment area, and that the only difference is that the treatment area has an improved road. All three country cases do this on the basis of judgment and specialist advice. Although much effort is made to identify appropriate control areas, the element of judgment opens this approach to bias and there is a suspicion that some of the results (particularly for the Lao PDR) may have been distorted because of this. No baseline pre-project data were available, so a double-difference analysis that would have at least partially addressed this bias could not be carried out.

A. The Lao People's Democratic Republic

The analysis for the Lao PDR focused on the 228-kilometer (km) stretch of the R3 road from

Houay Xay in Bokeo Province to Boten in Loung Namtha Province. The project reconstructed and upgraded the existing road to a sealed two-lane highway. It was started in late 2003 and was finished by the end of 2006. At the time of the household survey, it had been in operation for about 3 years. It was expected to provide income for the Lao PDR through road charges for vehicles and passengers. It was also anticipated to have a substantial impact on the development of Louang Namtha and Bokeo provinces through the creation of market opportunities for local businesses, for example in tourism, and through links with external markets to promote the development of commercial rather than subsistence agriculture. It was also expected to lower the cost of delivery for goods supplied from outside the project area.

Households living in villages along the project road (R3) were expected to be the group most affected by the project. Therefore, the treatment area was defined as all villages located within a 5 km radius of the project, which covered three districts: Luang Namtha and Viengphouka in Luang Namtha Province, and Houaxay in Bokeo Province.

The identification of the comparison or control group was based on field visits and consultations with key informants in the study area. Route 17-17B was judged to be the most comparable to R3 in terms of its pre-project condition. Therefore, households living along this route were used to form the control group, which was defined as households living in villages with a proximity of 5 km from route 17-17B.

Both R3 and 17-17B link with border areas, as route 17-17B is also used for cross-border trade linking the PRC, Myanmar, and Thailand via the Mekong River. To reflect differences in cross-border effects in the two areas, households located 5 km from the roads and within 10 km of the border crossings were identified in both the treatment and control groups. These subsamples were used to assess separately the cross-border or connectivity component of the project.

A total of 750 sample households were surveyed: 400 from the treatment group and 350 from the control group. A two-stage sampling method was used to first select villages and then randomly select 10 households in each village.[8] A household questionnaire was used to collect information from the sampled households. Where possible, the questionnaire asked for quantitative data over two periods, before and after the project, in a simple recall method. Where available, aggregate secondary data, such as the Lao Expenditure and Consumption Surveys in 2002–2003 and 2007–2008, were used to supplement the analysis.

Table 2 gives the mean results by outcome variables in the control and treatment areas before and after matching.

B. Matching Results

The treatment and control groups displayed significant differences both before and after matching. The initial relatively large difference

8 There are only a few villages located in the project area within 10 km of the border, and therefore a simple random selection method was used to select villages in this category. Most of villages in the project area are located along the R3 route and the systematic sample selection technique was used to obtain a sample distributed geographically over the domain. However, villages in this area are of different sizes in terms of either the number of households or of population, so the probability proportionate to size method was used in combination with the systematic selection approach to determine the sample.

Table 2 Income and Expenditure: After Matching, North–South Economic Corridor, the Lao People's Democratic Republic

Variable	Mean for the Whole Sample			Mean for Border Area	Mean for Nonborder
	Treatment (n = 353)	Control (n = 326)	Difference	Difference (n = 230)	Difference (n = 520)
Household annual income (KN million)	38.70	23.2	15.50[a]	16.4[a]	15.50[a]
Household annual expenditure (KN million)	28.50	15.5	13.00[a]	5.0	11.20[a]
Share of food in total consumption	46.47	38.5	7.97[a]	6.6[a]	8.76[a]
Percentage of poor households	39.60	47.8	(8.20)[b]	(0.6)	(10.00)[a]

( ) = negative, KN = kip.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
Source: Consultant's survey.

in income per capita before matching—with the treatment area having an average income of nearly double that in the control area, and the lower levels of poverty, where the headcount was 12 percentage points lower—cast doubt on the suitability of the control area as comparator in the absence of baseline data. A few of the mean characteristics of the sampled households in the treatment and control groups remained statistically significant after matching, suggesting that the sample balancing was imperfect. However, the pseudo R^2 fell from 0.24 before matching to 0.08 after matching. The mean absolute standardized bias was reduced from 33.1% to 10.9%, although after matching this was relatively high compared with the other studies.

With matching, a household living in the project area earned about 67% more on average each year than a comparable household in the nonproject area, and the percentage of poor households by the national poverty-line classification was 8 percentage points lower in the treatment area (Table 3). These differences were statistically significant at the 1% level.[9]

Changes in occupation over the last 5 years were used as an indication of employment benefits. Overall, most households in both treatment and control areas still considered farming as their main occupation; however, the shift away from agriculture was more significant in the treatment area. The percentage of households that changed their main occupation from agriculture over the past 5 years was twice as great in the treatment area compared to the control area, and the difference is statistically significant (Table 3). There is also a modest and significant difference in the percentage of households that identified themselves as working in tourism-related activities.

This employment shift was matched by a higher share of households stating their perception of an improvement in living standards over the last 5 years, which was 3 percentage points higher than in the nonproject area. Although this difference

9 The national income poverty line in 2009 for the Lao PDR of KN192,000/person/month was used.

Table 3 Employment Opportunities: After Matching, North–South Economic Corridor, the Lao People's Democratic Republic

Variable	Mean for the Whole Sample			Mean for Border Area	Mean for Nonborder
	Treatment (n = 353)	Control (n = 326)	Difference	Difference (n = 230)	Difference (n = 520)
Percentage of households who consider farming as their main occupation	73.00	76.0	(3.00)	(7.9)[a]	(8.5)[b]
Percentage of household who have shifted from agriculture to non-agriculture over the last 5 years	13.00	5.7	7.30[a]	4.3[c]	8.3[a]
Percentage of households who consider trading as their main occupation	7.73	7.5	0.02	6.0[a]	3.2[a]
Percentage of households who consider transport provision as their main occupation	1.78	0.7	1.08	0.7	1.1
Percentage of households who consider tourism services as their main occupation	1.78	0.0	1.78[b]	1.8[b]	1.8[b]
Percentage of household operating a family business	36.00	31.0	5.00	10.7[a]	8.7[b]

( ) = negative.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
[c] 10% level of statistical significance.
Source: Consultant's survey.

with the control group was not statistically significant, this perception by households was supported by significant differences in some physical indicators including better housing quality, and the use of more types of energy and better sanitation practices (Table 4). There were also significant differences in asset ownership with the treatment households having more motorcycles, electrical goods, and cattle (Table 5).

Improvement in access to services is the most direct impact expected from the road project. From the survey, there was a clear and significant reduction in the time used by households to access various services in the project area. On average, households in the treatment area served by the project spent significantly less time travelling to various places compared with the treatment group (Table 6). The recall method was used to ask households about the situation 5 years ago. While there was virtually no change in time involved for the control households to access various services, households in the treatment area reported a significant improvement. However, it is noteworthy that households in the control area made significantly more use of various services, for example taking micro loans, visiting a bank, and selling rice in a market, even though better road access would be expected to create more use of these services in the treatment group (Table 7).

A focus on control and treatment groups in the border and nonborder areas separately (Tables 2–7 border-area column) suggested a very similar pattern to the overall sample, although notably the difference in poverty level between the treatment and control groups was not significant in the border areas and, associated with this, average total household expenditure was also not significantly different between the two groups in the border areas (Table 2). The differences in employment shifts out of agriculture relative to the control group were

Table 4 Livelihood Indicators: After Matching, North–South Economic Corridor, the Lao People's Democratic Republic

Variable	Mean for Whole Sample			Mean for Border Area	Mean for Nonborder Area
	Treatment (n = 353)	Control (n = 326)	Difference	Difference (n = 230)	Difference (n = 520)
Perception of household living standard compared to others in the village (Likert Scale from 1 to 5)	3.140	2.840	0.300[a]	0.300[a]	0.300[a]
Households who perceive improvement in their livelihood over the past 5 years[#]	0.750	0.720	0.030	0.009	(0.012)
Households having tiled roof[#]	0.470	0.380	0.090[b]	0.090[b]	0.070[a]
Households having brick wall[#]	0.185	0.187	(0.002)	0.035	0.029
Households using modern energy (charcoal, LPG, electricity)[#]	0.160	0.070	0.090[a]	0.097[a]	0.076[a]
Households using permanent toilet	0.920	0.860	0.060	0.160[a]	0.090[a]
Households drinking boiled water	0.920	0.900	0.020	0.060[a]	0.000

( ) = negative, LPG = liquefied petroleum gas.
Note: [#] denotes that the variable is a dummy of 1.0 where a household meets the criteria.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
Source: Consultant's survey.

Table 5 Asset and Livestock Ownership: After Matching, North–South Economic Corridor, the Lao People's Democratic Republic

Variable	Mean for Whole Sample			Mean for Border Area	Mean for Nonborder Area
	Treatment (n = 353)	Control (n = 326)	Difference	Difference (n = 230)	Difference (n = 520)
Number of cars per household	0.098	0.068	0.03	0.040	0.04[a]
Number of motorcycles per household	1.160	0.990	0.17[b]	0.300[a]	0.24[a]
Number of bicycles per household	0.700	0.620	0.08	0.146[b]	0.15[a]
Number of TVs per household	0.880	0.770	0.11[c]	0.150[a]	0.29[b]
Number of radios per household	0.640	0.650	(0.01)	0.190[a]	0.12[c]
Number of VCDs per household	0.330	0.210	0.12[a]	0.060	0.05
Number of fans per household	1.250	0.650	0.60[a]	0.650[a]	0.65[a]
Number of cattle per household	2.520	0.720	1.80[a]	1.500[a]	1.60[a]
Number of poultry per household	21.630	23.910	(2.27)	0.950	(1.80)

( ) = negative.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
[c] 10% level of statistical significance.
Source: Consultant's survey.

Table 6 Time to Access Various Services: After Matching, North–South Economic Corridor, the Lao People's Democratic Republic (minutes)

Variable	Mean for Whole Sample			Mean for Border Area	Mean for Nonborder Area
	Treatment (n = 353)	Control (n = 326)	Difference	Difference (n = 230)	Difference (n = 520)
School	10 *52*	16 *16*	(6)[a]	(4.8)[a]	(5.0)[a]
Hospital	24 *200*	108 *122*	(84)[a]	(82)[a]	(132.0)[c]
Market	29 *48*	184 *185*	(155)[a]	(150)[a]	(127.0)[a]
Bank	18 *366*	24 *20*	(6)[a]	(7)[a]	(13.4)[c]

( ) = negative.
Note: Numbers in *italics* refer to the situation 5 years ago.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
[c] 10% level of statistical significance.
Source: Consultant's survey.

Table 7 Service Access or Usage: After Matching, North–South Economic Corridor, the Lao People's Democratic Republic

Variable	Mean for Whole Sample			Mean for Border Area	Mean for Nonborder Area
	Treatment (n = 353)	Control (n = 326)	Difference	Difference (n = 230)	Difference (n = 520)
Share of households selling goods in a provincial market#	0.13	0.18	(0.05)[c]	(0.070)[a]	(0.050)[c]
Share of households selling goods along the road#	0.09	0.10	(0.01)[a]	(0.030)	0.005
Share of households selling goods in the village#	0.29	0.45	(0.16)	(0.100)[a]	(0.150)[a]
Share of rice sales in total rice production#	0.10	0.32	(0.22)[a]	(0.220)[a]	(0.210)[a]
Share of vegetable sales in total vegetable production#	0.18	0.17	0.01	(0.010)	0.020
Share of fruit sales in total fruit production#	0.054	0.068	(0.014)	(0.011)	(0.003)
Share of households accessing microfinance#	0.15 *0.07*	0.23 *0.13*	(0.08)[a]	(0.074)[b]	(0.08)[a]
Share of households accessing a bank#	0.26 *0.16*	0.36 *0.14*	(0.1)[a]	(0.090)[a]	(0.08)[b]

( ) = negative.
Notes: Numbers in *italics* refer to the situation 5 years ago. # denotes that the variable is a dummy of 1.0 where that a household has used the service.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
[c] 10% level of statistical significance.
Source: Consultant's survey.

both larger and statistically much stronger in the nonborder areas. This could be interpreted to mean that road upgrading and the time savings involved have been more important than cross-border trade effects in causing structural change.

The analysis for the Lao PDR can be no more than suggestive given the lack of baseline data; but households with access to the improved R3 road on average appear to be better-off than similar matched households with access to a lower-quality road, and appear to have experienced a significantly greater shift in employment activity and time-saving relative to the situation 5 years ago. However, even after matching, some significant differences remained in the mean value of independent variables reflecting household characteristics. This suggests that the balancing conditions were not addressed in a wholly satisfactory manner, and thus casts doubt on how far access to the road project per se can be said to have caused the higher income and improved social conditions found in the project area.

C. Yunnan Province, People's Republic of China

Located on the southwest border of the PRC, Yunnan Province is adjacent to the Lao PDR, Myanmar, and Viet Nam. The construction of the North–South Economic Corridor (NSEC) has opened the land route from Yunnan Province to Southeast Asia, and offered the landlocked province a route to major external markets. The potential area affected by the project is very large, but for practical purposes the evaluation was restricted to the border counties of Mengla and Funing. These areas are close to the road section completed in 2008, so the household survey in 2010 using recall data was more likely to capture impact than a similar survey on road sections completed earlier. As noted earlier, selection of appropriate treatment and comparison groups is of crucial importance to an evaluation. The treatment group should be within the project's area of influence, while the control group should consist of households at a similar level of socioeconomic development to the treatment group and with access to a road like the NSEC section in its condition before upgrading. This case study aimed to distinguish between the upgrading effect and the international connectivity effect of the project, and the choice of control area reflected the international connectivity effect.

The Yunnan Province section of the Shantou–Kunming component of National Highway 323 was chosen as the control road. It is the most important link connecting Yunnan Province with the east coast of the PRC, and constitutes a local gateway from Yunnan Province to the rest of the country. The NSEC, on the other hand, provides an international link with Thailand and Southeast Asia. Both road sections were completed in 2008 to a similar standard, thus controlling for the upgrading effect. The treatment–control comparison was therefore between two similar roads with the key difference between them arising from the nature of the connectivity they offer—the NSEC offering an international link and the National Highway 323 offering a national one.

Mengla County (the treatment area) is situated in Xishuangbanna Dai Autonomous Prefecture at the southern end of Yunnan Province, and shares borders with the Lao PDR and Myanmar. A total of 426 households were sampled from 14 villages in this area. Funing County (the control area) is located in southeast Yunnan Province, and belongs to the Wenshan Zhuang and Miao Autonomous Prefecture. A total of 318 households were sampled from 13 villages. Households were chosen randomly from the selected villages.

Table 8 Income Comparison, North–South Economic Corridor, Yunnan Province

Variable	Sample	Treated	Controls	Difference	Standard Error	T-stat
Log of total income	Unmatched	9.739980	8.995257	0.744724	0.073020	10.20
	Matched	9.335077	9.329565	0.005511	0.225117	0.02

Source: Consultant's survey.

The socioeconomic data generated from the household survey was analyzed using propensity score matching and matched means for a set of comparable households were generated.[10] In this case study, the primary outcome variable of interest was income; however, no significant difference in mean income was evident between the treatment and comparison samples after matching. Table 8 reports the comparison for income. One interpretation of the absence of any evidence of impact is that international connectivity through the NSEC has had no differential impact relative to the domestic connectivity of a similar route within PRC. The most likely explanation for the absence of any project effect relates to the lack of implementation of the GMS Cross-Border Trade Agreement and the fact that the comparison area is linked with the highly dynamic domestic market in the PRC with no national borders to create trade costs. If a control area reflecting an unimproved road had been selected—as in the Lao PDR—a positive effect might have been observed.

D. Thailand

The components of the NSEC Project in Thailand that were studied related to the upgrading of the project road, which was previously an unpaved seasonal road with only a single lane along some stretches. It covers 228 kilometers (km) of national route 3 from Houayxay in Bokeo Province, which borders Thailand, to Boten in Louang Namtha Province, which borders the PRC. This route is referred to as R3E in the NSEC flagship initiative. The project road was upgraded to a paved two-lane highway. In addition, new bridges were constructed, existing bridges were widened, the ferry facilities across the Mekong River were upgraded, and a new bypass was constructed around the town of Louang Namtha.

The NSEC is expected to promote trade, investment, and passenger traffic, especially between Thailand and Yunnan Province, which in turn is expected to translate into socioeconomic impacts along the route. The impact on producers was deemed likely to be particularly strong in the border areas near the project road. For the evaluation, the treatment area selected for study covered the border district of Chiang Kong in Chiang Rai Province to reflect any localized cross-border impacts, as well as three districts in Chiang Rai Province. These were Chiang Khong, a rural area along the road close to the border; Mueang Chiang Rai, the capital district of the province and an important business center; and Chiang Saen, which is situated on the alternative trade route to the PRC via the Lao PDR, close to the Mekong River. Chiang Saen was selected because it is likely to be adversely affected by any trade diversion in favor of the project route. The control areas chosen were two districts in Chiang Rai Province—Wiang Chai, a nonborder area relatively distant from Chiang Khong and Chiang Saen; and Phan, which is well away from the border and Mueang Chiang Rai.

10 Given the absence of statistically significant results, full data on the analysis are not reported here.

A total of 1,040 households were sampled, of which 642 were taken from the treatment areas and the rest were from the control areas. For each district studied, the households were stratified into municipal and nonmunicipal areas. Those living in municipal areas were assumed to be fully urbanized across the four districts, while those living in nonmunicipal areas were taken as rural and agricultural. The sample size for each group was allocated in proportion to its share in the total population in the district. Since the nonmunicipal areas are large and consist of many subdistricts, two subdistricts of similar characteristics were selected from the nonmunicipal area of each district. Households were selected randomly at each survey site.

Household data were collected by interviewing each sample household using structured questionnaires that combined information on monetary values for income and consumption with perception questions on how socioeconomic conditions had changed over the 3 years since project completion.

A logit estimation was applied using the explanatory variables gender and age of head of household, age (linear and squared), marital status (linear and squared), education (linear and squared), household size (linear and squared), hometown location, ownership of house, house type squared, and dummy variables for the main types of job and the presence of a student in the household. With matching of similar households in the control and treatment areas, a single-difference method for differences in the outcome variable was applied. The lack of baseline data meant that the double-difference method to allow for unmeasurable characteristics and placement bias could not be applied; however, the questionnaire attempted to partially address this problem by asking households for their perception of changes in socioeconomic conditions over the past 3 years.

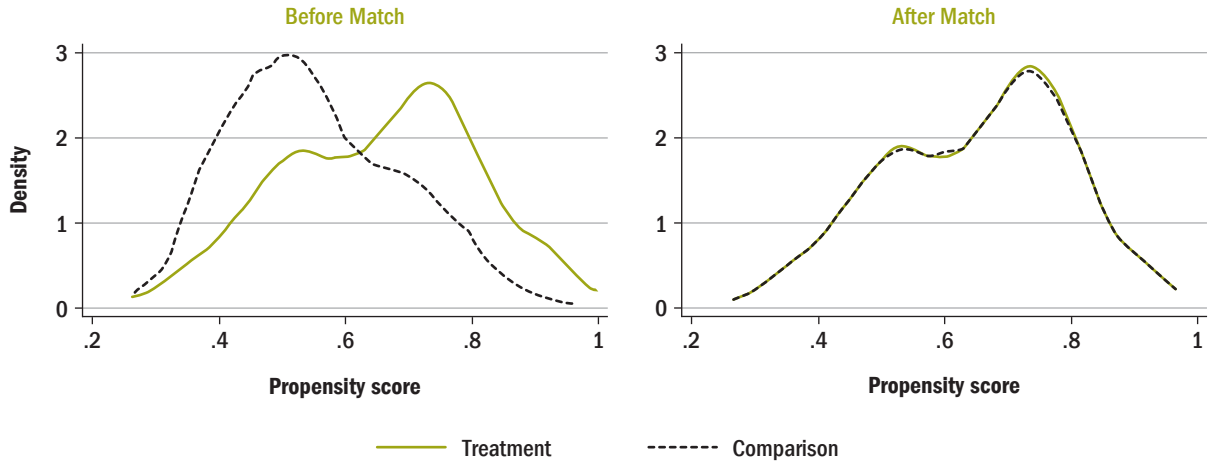
Matching was undertaken for the whole sample as well as for the subgroups in urban, rural, and border areas. The propensity score matching for the full sample indicated no significant difference in household income between treatment and control areas. The mean standardized bias was reduced from 17.3% before matching to 2.2% after matching, and the pseudo R^2 fell from 0.09 to 0.003. Figure 1 shows the distribution of propensity scores before and after matching.

The proportion of households reporting an income increase over a 3-year recall period in both types of area was found to be similar, as was the incidence of debt (Table 9). This strongly implies that the project had had no significant income effect by that time.

The household expenditure data collected as part of the survey included money spent on consumption, investment, education, and healthcare. In the full-sample case, household investments in agriculture were found to be significantly higher for the treatment group, but the statistical significance of this difference was weak. Not surprisingly, it was stronger and more significant for the rural subsample. For other types of expenditure, there was little evidence of any significance difference, with the exception of higher education expenditure in the border areas, and higher savings and insurance in all nonrural areas. These results indicate that in rural areas the road project has been associated with higher investment activity in response to the productive opportunities that have been opened up; while in nonrural areas, access to the road is associated with higher savings (Table 10).

Unexpectedly, non-agricultural investment appears to be negatively related to the project and this

Figure 1 Distribution of Propensity Scores: Whole Sample, North–South Economic Corridor, Thailand



Source: Consultant's survey.

difference is statistically significant in urban areas, where funds appear to have been placed in financial savings rather than being spent on investment goods. Overall, household income and expenditure do not seem to be significantly different between the treatment and control groups after matching, suggesting no project impact in monetary terms up to the time of the survey.

The household perceptions revealed a few significant differences between the control and treatment groups working in both positive and negative directions in terms of project impact, although the reported perceptions did not always match available secondary data on some issues. In relation to education, a statistically significant higher proportion of households in the treatment group felt that school capacity and number of courses had increased over the previous 3 years. In relation to healthcare, in urban areas only, a significantly higher proportion of households in the treatment groups felt hospitals had become

Table 9 Income and Debt: After Matching, North–South Economic Corridor, Thailand

Outcome Variable	Difference between Treatment and Control			
	Total Sample	Urban	Rural	Border
Income				
Household income	0.234355	(0.1090992)	0.3527265	0.2305303
	0.2026	*0.3221*	*0.3064*	*0.2051*
Proportion of households with increasing income in the past 3 years	0.0119462	0.1033254	(0.0255866)	(0.0059585)
	0.0568	*0.0891*	*0.0623*	*0.0767*
Proportion of households with debt	0.111443	0.1515669	0.1116224	0.1113277
	0.0567	*0.1116*	*0.0559*	*0.0576*

( ) = negative.
Note: Numbers in *italics* are t ratios.
Source: Consultant's survey.

Table 10 Types of Expenditure: After Matching, North–South Economic Corridor, Thailand

Outcome Variable	Difference between Treatment and Control, Thailand			
	Total Sample	Urban	Rural	Border
Investment in agricultural sector	0.0987039[c]	0.026359	0.140516[b]	0.0990676
	0.0578	*0.1169*	*0.0640*	*0.0839*
Investment outside agricultural sector	(0.0262482)	(0.0790145)[b]	(0.0128057)	(0.0068344)
	0.0294	*0.0343*	*0.0231*	*0.0317*
Consumption	(0.0042365)	0.0481142	(0.0215068)	(0.0257556)
	0.0471	*0.1973*	*0.0563*	*0.0527*
Education	0.0403233	0.0586789	0.0309686	0.1227467[b]
	0.0555	*0.1096*	*0.0605*	*0.0517*
Healthcare	0.0108163	(0.0209932)	(0.0074016)	0.0340801
	0.0296	*0.0866*	*0.0333*	*0.0276*
Debt repayment	(0.0092568)	(0.0704668)	0.0148844	(0.0142531)
	0.0440	*0.1262*	*0.0563*	*0.0539*
Savings and Insurance	0.0235439	0.102869[a]	0.0059398	0.0610177[b]
	0.0272	*0.0322*	*0.0307*	*0.0284*
Others	0.0069243	0.0119044	(0.0028846)	0.0012616
	0.0067	*0.0132*	*0.0108*	*0.0079*

( ) = negative.
Note: Standard errors are in *italics*.
[a] 1% level of statistical significance
[b] 5% level of statistical significance
[c] 10% level of statistical significance
Source: Consultant's survey.

slower and more crowded, and that the cost of medical treatment had risen over the past 3 years. In relation to a perceived drug problem, in rural areas a significantly higher proportion of households from the treatment group judged that drug-related problems had worsened over the 3-year period. Finally, in relation to the environment, in urban areas there was a statistically weak tendency for a higher proportion of treatment households to judge that environmental problems had worsened.

Overall, the propensity score matching analysis found only a modest impact from the project, principally in terms of higher agricultural investment in rural areas linked with the project and higher financial savings in urban areas. Total household incomes and other nonmonetary measures of welfare did not appear to have been affected in a major way.

As a complement to this analysis of households, trade data for the region were also analyzed in a gravity model to show the impact of lower transport costs on trade flows. Road improvements are expected to reduce trade costs, and these lower costs in turn are expected to lead to higher incomes as a result of the increased exports and imports. The gravity model analysis showed that trade in a

number of products is responsive to lower transport costs, creating the potential for higher incomes through trade; although as yet the cost reductions created by the project appeared to have had only a modest impact on trade (Appendix 1).

E. Conclusions

Road corridor projects linking participating countries are a central plank of the GMS strategy for regional cooperation. Road improvements are expected to lead to higher trade flows, thus stimulating further economic activity, as well as providing better access to a range of services that are important for household welfare. However, the evidence from the three evaluations suggests that project impact has so far been modest. In the Lao PDR, significant major differences were found between households in the project area and those in a comparison area. However, in Yunnan Province, the PRC, no significant differences were found; while in Thailand, differences were found in particular aspects of economic activity rather than in overall measures of welfare, whether monetary or nonmonetary.

It should be considered that only a short period of time had elapsed between project completion and the household surveys (typically about 3 years), and in principle greater responses to the cost reductions and time savings created by the road projects might be expected in the medium term. Furthermore, important aspects of the GMS strategy are not yet in place. In particular, the Cross-Border Trade Facilitation Agreement, which will remove all border controls and thus reduce trade costs, had not been fully implemented at the time of the surveys and important links in the NSEC road corridor, particularly in Thailand, were also incomplete.[11] These expected new developments may require further analysis to measure the impact of projects more accurately.

The observation that a possible reason for the modest impact of the road corridor project is the delay in implementing the GMS Cross-Border Transport Agreement (CBTA) reflects the recognition already reached much earlier by the participating GMS countries that infrastructure connectivity must be supported by necessary software to be able to reap the full benefits. In the case of the road corridors, the key software required is transport and trade facilitation (TTF) measures, such as the CBTA, to enable the free and smooth flow of vehicles, goods, and people across borders. This is why in the new pipeline of GMS cooperative projects, much attention is being given to TTF measures. Indeed, given that most of the physical transport infrastructure along the corridors (including the International Mekong Bridge between the Lao PDR and Thailand along North–South Corridor, which was still under construction at the time of the impact study) is now in place, impact assessments can now focus on the TTF measures that will be applied at the borders between countries. Such assessments will be undertaken, for instance, as part of the this year's midterm review of the Program of Action for TTF in the GMS, as well as in the ongoing time release studies for selected border crossing points in the GMS. Moreover, to help in conducting more accurate impact assessments for transport projects in the future, the collection of pre-implementation baseline data can be made a regular feature of project preparation and development for such projects.

11 For example, the Fourth Mekong Bridge, connecting the Lao PDR and Thailand in Chiang Khong district, was opened on 11 December 2013.

III. Health

The spread of communicable diseases is a serious problem in Cambodia, the Lao People's Democratic Republic (Lao PDR), and Viet Nam. It also has a clear regional dimension, given that disease transmission crosses national boundaries and can be seen as a major negative environmental externality imposed by one country on another. Regional cooperation to address the problem therefore offers the potential for greater health and other related impacts than independent national initiatives, since there is the risk that progress in disease eradication in one country may be undermined by lack of coordination with eradication activities in another.

The evaluation reported here focused on the dengue control program under the Greater Mekong Subregion Regional Communicable Diseases Control Project, spanning the three countries.[12] In the case of dengue control, the project supported three main sets of activities:

- information, education, and communication targeted at the regional population in high-risk areas;
- the distribution of larvicides, guppy fish, and insecticides (including project-supported spraying in some localities) to control the larvae population of dengue-carrying mosquitoes; and
- training in diagnosis and treatment for health workers who are expected to visit households to educate them about dengue and its prevention, and to provide disease surveillance at the local level.

These activities were expected to improve knowledge, attitude, and practices (KAP) in the vulnerable population to encourage those at risk to eliminate mosquito breeding sites, prevent bites, recognize symptoms, and seek prompt treatment with a view to reducing both the incidence of dengue and its impact on morbidity. These improvements in health awareness and practice can be expected to raise household welfare both through the lower monetary cost from a lower incidence of dengue, as well as through the reduction of the pain and suffering associated with infection. The dengue control program was introduced in selected parts of Cambodia, the Lao PDR, and Viet Nam, particularly in areas of high dengue incidence.

12 http://www.adb.org/sites/default/files/projdocs/2005/36672-CAM-RRP.pdf

Dengue fever and its more severe form, dengue hemorrhagic fever, are mosquito-borne viral diseases of global significance. The disease affects more than 100 countries worldwide, with 50 million infections each year. It is also a leading cause of hospitalization and death among children in Southeast Asia and its incidence has increased 30-fold in the past 5 decades. Several epidemiological conditions have accelerated viral transmission by the main vector mosquito, *Aedes aegypti*. These include human population growth, rural–urban migration, and the inadequacy of basic urban infrastructure. Although research into dengue vaccines for public health use is in progress, the only method available for prevention and control is vector control. Early diagnosis and treatment is likely to be particularly important, as is good knowledge of dengue recognition, prevention, and control methods. Dengue vector control requires effective participation of the local community. Although education campaigns have increased people's awareness of dengue, the extent to which this knowledge is put into practice and the degree to which this practice reduces mosquito populations remain unclear.

Ideally, to measure impact, it would be desirable to measure the socioeconomic effects of the program directly using household survey data. This would entail comparing dengue incidence and mortality between a treatment and a comparison area, and exploring differences in related socioeconomic effects. However, this is difficult to do using household survey data, because dengue fever is a relatively rare disease and a very large survey would be needed to ensure sufficient cases were available to allow statistically reliable estimates. Therefore, the major focus of the evaluation in all three countries was on the identification of intermediate measurable outcomes that could be linked with KAP indicators related to dengue.[13] If such outcomes are positively affected by the project, it can be assumed that there will be a positive impact on household welfare through improved socioeconomic outcomes, whether in terms of lower medical costs, higher household productivity, or less pain and suffering.

A household survey was conducted in all three countries in both project or treatment and nonproject control areas in order to estimate the effects of the program on households' KAP. Propensity score matching was used to obtain estimates of the project effects on measures of these concepts that are not biased by initial differences in observed socioeconomic characteristics between the treatment and control household groups. KAP indicators used in the country surveys covered knowledge of

- the danger of dengue,
- how the dengue virus is transmitted,
- the symptoms of dengue fever,
- measures to adopt when there are symptoms of fever,
- the source of dengue,
- the type of mosquito that transmits the dengue virus,
- the time of day when the *Aedes* mosquito bites,
- how to prevent mosquito bites, and
- how to destroy the mosquito larvae and pursue prevention practices.

In addition, in Cambodia and the Lao PDR, province-level (in the Lao PDR) or district-level (in Cambodia) national program data were

13 KAP studies are the standard approach to evaluate the impact of health interventions on diseases such as dengue (Constantianus et al. 2006).

assembled for several years (i.e., cross-section time-series data) and were used to estimate the direct effect of the project on dengue incidence and mortality. This was not done in Viet Nam because the dengue treatment areas were too limited in geographical scope.

Further, calendar data on dengue incidence, morbidity, and case mortality during the past 5 years were collected from households reporting one or more episodes of dengue during the 5-year reference period. These data were used directly to estimate the socioeconomic impact of dengue incidence.

A. Communicable Disease Control in the Lao People's Democratic Republic

Dengue fever has been a serious public health problem in the Lao PDR for more than 25 years and is endemic in Champasak, Luangprabang, Savannakhet, and Xayabouly provinces. Dengue cases occur throughout the year but reach a peak in July–August. Official data show that the highest record of annual deaths due to dengue fever was 295 persons in 1987 while infection rates reached their highest level in 2003 with 17,660 cases. In 2009, there were still 7,768 cases with 19 deaths, mostly in children under 15 years.

The aim of the Greater Mekong Subregion Regional Communicable Diseases Control Project was to raise awareness of prevention methods and symptom identification, as well as to instigate the clearing of mosquito breeding sites though the spraying of insecticides and larvicides (footnote 12). The main focus of the evaluation was to assess the difference in KAP between treatment and control areas in relation to three levels of infection: dengue fever, dengue hemorrhagic fever, and dengue shock syndrome.

A total of 512 households were sampled in two provinces: Champasak (256 households) and Savannakhet (256 households). The selection was made from 8 districts containing 32 villages. Of the 32 villages, 16 were in treatment areas falling under the project influence and the other 16 were from control or nonproject areas. The villages were divided equally between the two provinces. The choice of districts and villages was by purposive selection based on the high incidence of dengue infection.

B. Matching Results

If the project is to alter household welfare through control of this infectious disease, people who have access to the funds and support the project offered in the treatment areas will have better KAP regarding dengue fever than those with similar measurable characteristics who live in areas outside the area of project influence. To estimate the possible difference in outcomes, cross-section survey data were used along with propensity score matching methods for treatment and comparison units. Data on household characteristics were collected in relation to family demography, housing, and assets, together with outcome variables related to knowledge about the disease and of practices for its elimination.

The impact of the project on KAP indicators relating to dengue is in Table 11. The data show whether for different outcome variables, the mean performance of treatment units is statistically different from the mean for control units. Scores are given for the degree of knowledge of the

Table 11 **Knowledge, Attitude, and Practices: After Matching, Communicable Disease Control, the Lao People's Democratic Republic**

Outcome Variables (494 observations)	Nearest-Neighbor Matching				
	Treatment	Control	Difference (ATT)	t-stat	t-stat*
Knowledge of					
Information access	6.4622	2.4529	4.0092	1.04	0.85
Significance of mosquito bites	0.7521	0.5429	0.2092	3.58	2.59[a]
Time of day for bites	0.7311	0.6168	0.1143	1.95	1.54
Symptoms	2.2647	1.6571	0.6076	2.93	2.71[a]
Breeding sites	1.8319	1.6269	0.2050	1.55	1.42
Attitude toward					
Seriousness of dengue	0.8824	0.8849	(0.0025)	(0.06)	(0.06)
Necessity of prevention	0.9160	0.9294	(0.0134)	(0.40)	(0.34)
Practice: prevention					
Spraying inside house	0.2101	0.1723	0.0378	0.88	0.63
Insecticide spraying	0.1429	0.0933	0.0496	1.46	0.61
Use of repellant	0.0210	0.0176	0.0034	0.24	0.18
Use of smoke	0.1597	0.1546	0.0050	0.11	0.11
Use of bed net	0.9328	0.8126	0.1202	3.19	1.68[c]
Window netting	0.0378	0.0235	0.0143	0.74	0.50
Cleaning of house	0.4916	0.4487	0.0429	0.70	0.38
Use of electricity racket	0.1681	0.1143	0.0538	1.40	1.19
Practice: breeding sites					
Removing stagnant water	0.6303	0.5168	0.1134	1.88	1.65[c]
Covering water container	0.3277	0.2824	0.0454	0.78	0.72
Changing water in tank	0.9454	0.8504	0.0950	2.61	2.16[b]
Cutting overgrown trees	0.4958	0.3924	0.1034	1.71	1.91[c]
Use of larvicide	0.5294	0.1185	0.4109	9.47	4.01[a]
Interaction terms					
Knowledge of bites and of prevention	1.6638	1.0058	0.6579	4.53	3.26[a]
Knowledge of severity and of elimination practices	6.8067	4.6042	2.2025	4.19	3.13[a]

( ) = negative, ATT = average treatment effect on the treated.
* Bootstrapped t-statistic with 200 replications.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
[c] 10% level of statistical significance.
Source: Consultant's survey.

respondents. The difference between the means, or the average treatment effect on the treated, shows that the project has a positive impact on most indicators. Only two attitude indicators had a negative sign, and for these the results were insignificant.[14]

While the differences between the treatment and control households are positive for most indicators, only some of these differences are statistically significant. Indicators that are both positive and significant are those for knowledge of dengue transmission through mosquito bites, knowledge of the symptoms of dengue fever, and knowledge of a variety of practices to eliminate the risk of contracting dengue (use of mosquito nets, the elimination of breeding sites by emptying stagnant water, changing water in tanks, cutting overgrown trees or grass, and spraying with larvicide). Two interaction terms—knowledge of the consequences of mosquito bites combined with knowledge of prevention, and knowledge of breeding sites combined with knowledge of the practices for their elimination—were also found to be positively and significantly different for the two groups. The association between knowledge of the consequences of the disease and an increasing use of preventative measures, and between knowledge about the disease and a reduction in breeding sites for vector larvae, has also been reported in other studies.[15]

Improved knowledge and better practices do not necessarily translate into significantly reduced disease incidence and mortality rates. To test the impact of the project on the incidence of dengue and dengue-associated fatality rates, a regression analysis looked at province-level variations in dengue incidence (Appendix 2). Overall, while the results indicate a negative project effect that increases in magnitude during the period of project implementation, they are not statistically significant. Nonetheless, from the matching analysis, there is evidence that in the Lao PDR the project has improved knowledge of and practices toward dengue, even if at a province level the impact on incidence and fatality cannot be identified in a simple regression model.

C. Communicable Disease Control in Cambodia

The household survey for Cambodia was conducted on a sample of 300 households in two districts of Takeo Province, which is the province with the highest recorded incidence of dengue. Random sampling was used to select the communes, villages, and households in the province. Of the 10 districts in Takeo Province, Angkor Borei is the treated district where dengue incidence is the highest. For this reason, it was selected as the treatment area for the study. Kaoch Andaet, a district in Takeo Province that has similar geographic characteristics including a flat plain region, proneness to flooding, and rice-based farming, but which was omitted from the scope of the project, was selected as the control district. The sampling design for the survey was a stratified sample selected in two stages. At the first stage, 5 of 34 villages in Angkor Borei district and 5 of 68 villages in Kaosh Andaet district were selected using the simple random sampling method. At the second stage of sampling, 150 households from the project area and 150 households from the

14 Using nearest-neighbor matching the pseudo R^2 was reduced from 0.223 before to 0.029 after matching. The mean standardized bias was reduced from 21.2% to 2.7%. Kernel matching was also applied with a slightly higher level of bias.

15 B. H. Van Benthen et al. (2002) report this association for an analysis in Northern Thailand.

comparison area were selected from each of the selected villages using systematic random sampling with probability proportional to population size.

The survey aimed to collect information on households' knowledge of symptoms, causes, and prevention measures. Knowledge of symptoms was defined as the respondent mentioning at least three of the following symptoms: fever or sickness, headache, eye-socket pain, bone pain, shock, nausea or vomiting, bleeding, red skin rashes, sleepiness, abdominal pain, cold limbs or body, bloody diarrhea, a dry mouth, poor appetite, or fatigue. A person was taken as having had knowledge of common breeding sites if they could identify at least three of the following as such sites: stagnant water, garbage, overgrown trees or vegetation, unused tires, dirty containers, uncovered jars, or dark places. It was assumed that a person had knowledge of preventive measures if they mentioned at least three of the following: mosquito spray; mosquito mat, coil, or liquid vaporizer; window and door screens; mosquito net; house cleaning; mosquito repellent; cleaning of garbage; covering the body; using smoke; or opening doors and windows for sunlight.

Unlike the other two country cases, the Cambodia study found no significant difference between treatment and control households and between districts with the project intervention and those without.[16] In this case, regression analysis on the household data collected in the survey failed to reveal any significant negative association between knowledge about the condition and the likelihood of infection. On the contrary, the regression results revealed an unexpected positive association, which is likely to be due to reverse causation with infected households seeking out more information on the illness. The province-level analysis found a similar pattern, with dengue incidence higher in areas with more health interventions, although dengue mortality rates were lower in districts that had higher interventions. A possible explanation for the absence of an impact from the propensity score matching is that national media-based education initiatives through television and radio may be affecting households in both the control and the treatment areas and thus overriding any project-specific effect. If this is indeed the case, it casts doubt on the effectiveness of the communicable diseases control project interventions and how successful project workers have been in influencing household behavior.

D. Communicable Disease Control in Viet Nam

As in the other two country cases, the Viet Nam study examined the effect of the project interventions on KAP through a household survey of a treatment group and a control group using propensity score matching. The treatment group was selected from six communes from three provinces where the program had been introduced—Kien Giang, An Giang, and Tay Ninh. Six control communes were also selected from the same three provinces. From each selected commune, 100 households were chosen randomly, making a total of 1,200 households. The selected treatment and control communes shared similar characteristics in terms of variables such as household size, source of income, and distance from hospitals and schools. The samples are skewed so that 30% of both treatment and control groups are households with at least one member infected with dengue.

16 For this reason detailed results are not reported.

The unmatched samples revealed some unexpected differences because the control group that had not been reached by the project seemed to have more knowledge about dengue symptoms than the treatment group served by the project. For example, one-third of respondents in the control group knew at least four symptoms of dengue, while less than one-fifth of respondents in the treatment group knew more than three symptoms. The difference in knowledge was most serious in Kien Giang Province, where only 12% of respondents in the treatment area knew more than three symptoms, while that figure in the control groups was 38%. Similarly, while most households were aware that the dengue-carrying mosquito (*Aedes albopictus*) breeds in water storage containers, a higher proportion of respondents in the control group knew at least two breeding places (such as ponds, lakes, irrigation canals, and water storage containers) compared with the treatment group (65% versus 52%).

As in the other cases, propensity score matching was used to assess rigorously the impact of the project on KAP in relation to dengue; so after matching participating and nonparticipating households, differences between treatment and control samples in relation to a set of KAP indicators were obtained.

Table 12 gives the definitions of the KAP outcome indicators used and their construction. Two were simple dummies, where respondents were aware of the danger of dengue and its form of transmission. All others were scores based on the sum of correct responses.

Table 12 Knowledge, Attitude, and Practices Indicators: Viet Nam

Code	Meaning	Construction
Danger	Knowing that dengue is dangerous	Danger = 1 if agree that dengue is dangerous, danger = 0 otherwise
Transmit	Knowing that the dengue virus is transmitted	Transmit = 1 if agree otherwise transmit = 0
Howtransmit	Knowing how the dengue virus is transmitted	Sum of right answers for two options: (i) not from people to people, and (ii) from mosquito to people
Usymptoms	Knowing symptoms of dengue fever	Sum of known symptoms of dengue infection
React	Measures to take after symptoms of fever	Sum of correct measures when there are symptoms of fever
Sourcedengue	Understanding the source of dengue	Sum of known sources of dengue infection
Umosquito	Knowing the type of mosquito that transmits the dengue virus	Sum of right answers for two options for the type of mosquito causing the dengue
Utime	Knowing when the *Aedes* mosquito bites	Sum of right answers for the questions relating to the time the *Aedes* mosquito bites
Upreventing	Knowing measures to prevent dengue	Sum of known measures
Ularvae	Knowing where the mosquito larvae breeds	Sum of known places
Aprenvention	Measures used to prevent dengue infection	Sum of used measures

Source: Consultant's survey.

Table 13 Knowledge, Attitude, and Practices: After Matching, Communicable Disease Control, Viet Nam

Variable	Sample	Treatment	Control	Difference	S.E.	T-stat
Danger	Unmatched	0.9631	0.9700	(0.0069)	0.0104	(0.6600)
	Matched	0.9625	0.9683	(0.0058)	0.0128	(0.4500)
Transmit	Unmatched	0.8844	0.8483	0.0361	0.0197	1.8400
	Matched	0.8857	0.8584	0.0273	0.0242	1.1300
Howtransmit	Unmatched	1.8827	1.8283	0.0544	0.0229	2.3800
	Matched	1.8908	1.8024	0.0884	0.0290	3.0500[a]
Usymptoms	Unmatched	2.6817	3.0117	(0.3299)	0.0859	(3.8400)
	Matched	2.6894	3.0932	(0.4038)	0.1114	(3.6200)[a]
React	Unmatched	2.0218	2.2900	(0.2682)	0.0578	(4.6400)
	Matched	2.0222	2.2768	(0.2546)	0.0711	(3.5800)[a]
Sourcedengue	Unmatched	2.8961	2.9250	(0.0289)	0.0172	(1.6800)
	Matched	2.8976	2.9051	(0.0075)	0.0205	(0.3700)
Umosquito	Unmatched	1.8224	1.5933	0.2291	0.0334	6.8700
	Matched	1.8259	1.6287	0.1973	0.0438	4.5100[a]
Utime	Unmatched	0.7370	0.6383	0.0987	0.0436	2.2700
	Matched	0.7406	0.6601	0.0805	0.0529	1.5200
Upreventing	Unmatched	2.0586	2.3150	(0.2564)	0.0553	(4.6300)
	Matched	2.0631	2.2212	(0.1580)	0.0692	(2.2800)[a]
Ularvae	Unmatched	2.3786	2.6650	(0.2864)	0.0692	(4.1400)
	Matched	2.3805	2.6212	(0.2406)	0.0872	(2.7600)[a]
Aprenvention	Unmatched	2.1625	2.0650	0.0975	0.0546	1.7900
	Matched	2.1689	2.0638	0.1051	0.0686	1.5300

( ) = negative, S.E. = standard error.
Note: For indicator definitions, see Table 12.
[a] 1% level of statistical significance.
Source: Consultant's survey.

Table 13 presents the results comparing the difference in means for treatment and control groups, using the nearest-neighbor matching procedure.[17]

Overall, for both groups there is a high level of understanding about the danger and transmission mechanism of dengue. The key issue is whether the project has made any significant difference to KAP.

17 For nearest-neighbor matching trim, 2, i.e., dropping 2% of the treatment observations for which the propensity score of the control observations is the lowest, was used. Matching using the kernel procedure gave similar results. The mean standardized bias was reduced from 13.7% to 2.7%.

The propensity score comparison reveals a mixed picture with the project having a positive impact on some of the outcome variables and a negative effect on others. The mean difference between treatment and control groups is positive and statistically significant for knowledge on how the disease is transmitted and the types of mosquito involved. Thus, households in the treatment area appear to be more knowledgeable on how dengue is transmitted. However, the mean difference is negative and significant for knowledge of prevention practices relating to prevention of bites and destruction of larvae, which implies that, paradoxically, households not reached by the project know more about some aspects of prevention. Also, the difference is again negative and significant for knowledge of symptoms and of how to react to dengue fever. These results cast doubt on the effectiveness of the health workers engaged by the project.

This query over project effectiveness is supported by information from the survey on the frequency of visits to households by the project health workers. The health collaborators are meant to visit households in the project area regularly to remind them of preventative measures and help them kill mosquito larvae. Only 28% of respondents said that the collaborators visited their home more than once a month, while 14% said they only came at a sign of an epidemic. One of the key tasks of health workers is to help households kill mosquito larvae; however, 58% of respondents stated that such help was provided less than once a month, and 20% of households reported receiving such help more frequently than once a month. The project was designed to build pools to nurture guppy fish, which are used to kill mosquito larvae. However, only 32% of the respondents reported that they could get these fish whenever they wished, and 28% reported that they had no access at all to such fish. These results cast doubt on the effectiveness of the project.

E. Conclusions

The analysis of the Greater Mekong Subregion Regional Communicable Diseases Control Project to control dengue in the three case study countries shows different results among the three countries. Positive results in terms of an improvement in KAP relating to the disease were found for the Lao PDR, no significant impact was found for Cambodia, and there were mixed results for Viet Nam. In part, this may be due to the difficulty of obtaining a control group that is completely isolated from health interventions that do not stem directly from the project. In addition, given that television and radio are important sources of health information, it may be that information conveyed in this way is raising knowledge and awareness in locations not reached directly by the health workers engaged by the project. This spillover may be contaminating the data and, in part, may explain the relatively weak project effect, particularly in Cambodia. Further, in Viet Nam, project follow-up through visits to households in affected areas by health workers engaged on the project might have resulted in a positive impact of the project.

The dengue control program is just one element of the Regional Communicable Diseases Control Project, which addressed important gaps in services and funding in preventive disease control activities for emerging diseases (severe acute respiratory syndrome, avian influenza, and malaria), HIV/AIDS, and dengue. More broadly, the project supported the establishment of surveillance and response systems, improvement of community preparedness, and strengthening of laboratory services and regional cooperation in disease control.

A second phase of the Regional Communicable Diseases Control Project, approved in 2010, is underway and it builds on the achievements and lessons learned from the first Second Greater Mekong Subregion Regional Communicable Diseases Control Project. Among other thrusts, the second phase will further enhance regional communicable diseases control systems, by improving regional cooperation capacity, expanding surveillance and response systems, and providing targeted support for the control of dengue and neglected tropical diseases. It will also support improvement of provincial capacity for communicable diseases control, including community-based communicable diseases control in border districts and staff training. More emphasis is being placed on remote communities, links with other sectors, interprovincial and cross-border cooperation, gender and ethnic priorities, and results-based monitoring.

IV. Tourism

The GMS offers great development potential tourism, with its well-established beach locations in Thailand and Viet Nam, as well as sites of great antiquity and interest for high-income tourists in these and other GMS countries. Regional cooperation on visa arrangements, integrated packages of tourist circuits, and regional marketing offer scope for generating revenues and spillover effects that would not be available from stand-alone national projects. The Mekong Tourism Development Project is being implemented in three countries—Cambodia, the Lao PDR, and Viet Nam—although only the Lao PDR component was evaluated as part of this exercise. The project was designed to raise income and generate employment, while conserving natural resources and cultural heritage through sustainable tourism. The project has four components: (i) tourism-related infrastructure improvements; (ii) pro-poor, community-based tourism initiatives; (iii) subregional cooperation for sustainable tourism; and (iv) assistance in implementation and institutional strengthening.

In the Lao PDR, the project was implemented during 2003–2008 in four provinces: Champasak, Khammouan, Luang Namtha, and Luang Prabang. The subregional cooperation aspect includes improvement of tourist facilities at border posts, establishment of a network of tourism marketing and promotion boards across the GMS region, adaption of a region-wide hotel classification system, and the development of regional tours and tourist circuits.

Overall, performance at the initial assessment of the project was rated *highly successful* based on, among other indicators, the number of tourism products in target villages, the number of households involved in the provision of tourism-related services and activities, and tourist arrivals in target villages and the revenue these generated (LNTA and ADB 2008). However, this initial evaluation was not based on the type of rigorous impact evaluation applied in this study, which, as in the other cases, compared treatment and control households using the propensity score matching methodology.

A. Mekong Tourism Development Project, the Lao People's Democratic Republic

Since the adoption of the New Economic Mechanism as an "open-door policy" in 1986,

the Lao PDR's tourism sector has come to play an important role in the economy. In 2009, the country received more than 2 million international tourists, compared with 0.5 million in 1998. Currently, the estimated core workforce in tourism is 17,000 and indirect employment is put at 167,000–300,000 persons (LNTA 2009, 1). The government has identified tourism as one of the eight priority programs under its socioeconomic development plan and considers it one of the main engines of economic growth as well as a tool for poverty reduction through ecotourism, pro-poor tourism, and community-based tourism initiatives.

Of the four target provinces, Champasak and Luang Namtha were selected for the evaluation, with the Luang Namtha representing mountainous areas with a low level of tourism development, and Champasak being an area with a more varied topography and a busy tourism sector. Based on the assumption that the groups most affected by the project are households living in the villages targeted by the project and nearby areas, the treatment area was defined to include all villages receiving tourism-related support and assistance from the project to develop their tourism potential, as well as villages sharing a border with the targeted villages. These treatment villages are located in three districts in Luang Namtha (Luang Namtha, Mueangsing, and Viengphoka) and three districts in Champasak (Champasak, Pathoumphone, and Sanasomboune).

The control group was defined as households living in villages that have existing tourist sites or related tourism activities, but that were not receiving support from any component of the project. As villages in the comparison area are spread throughout every district in Champasak and Luang Namtha provinces, some comparison villages are located in the same districts as the treatment villages, while others are not. The distinguishing feature of the comparison villages is the absence of project interventions, but otherwise an effort was made to ensure they were similar to the treatment villages in terms of economic potential.

A household survey with a sample size of 800 was carried out in the two selected provinces in equal proportions. Of this sample, 480 units were households in the treatment group and the remaining 320 were in the control group. Before the household sample could be constructed, the survey villages in the treatment and comparison areas had to be selected. Survey villages were selected randomly from the list of villages in the treatment and comparison areas, with 48 villages chosen from the treatment group and 36 villages from the control group. The systematic sample selection technique was employed for choosing sample villages.

In each sample village, 10 households were selected randomly. To ensure that the number of households involved in tourism-related activities was sufficient for the assessment, all households in the survey villages were classified into two subgroups: those whose livelihood was linked either directly or indirectly with tourism, and others. Then, five households were selected randomly from each subgroup using the systematic selection technique. Since the stratification was related to the outcomes of the project, household outcomes as measured by income and non-income indicators could be biased. To address this, weighted and unweighted estimates of key impact indicators were compared.[18]

18 Some key Indicators were weighted according to the inverse of the probability of household selection. Weights applied to household indicators were the ratio of the five selected tourism-related households to the total number of households involved in tourism in each sampled village and the ratio of the five selected non-tourism-related households to the total number of non-tourism households in each sample village.

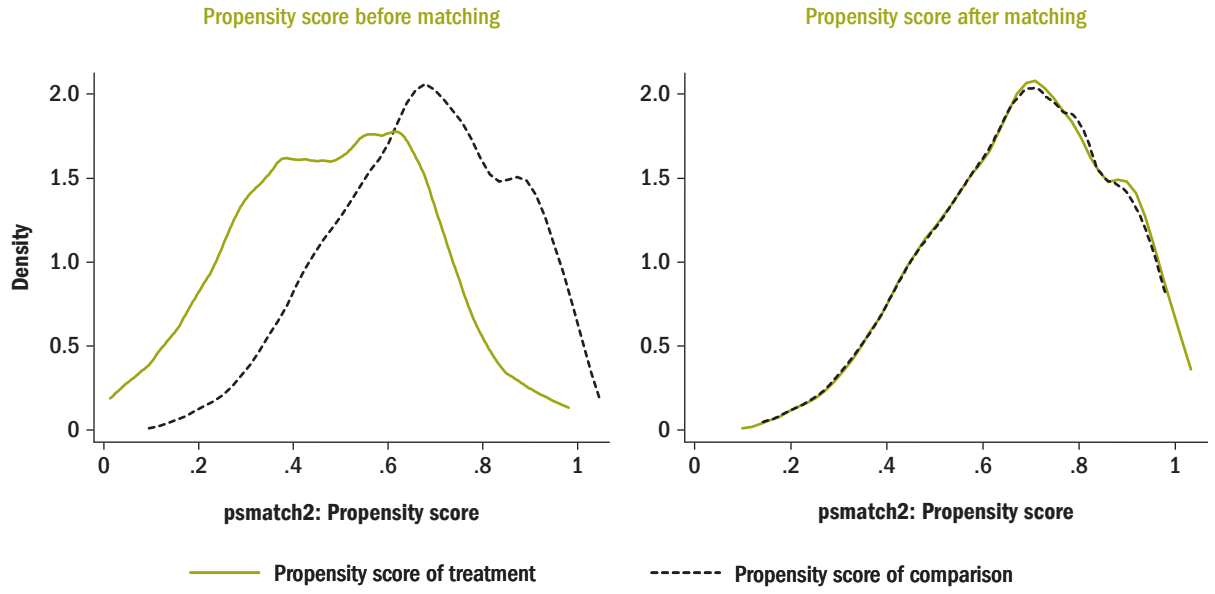
Household perspectives on their own economic status were similar in the two areas with the majority considering themselves nonpoor. About 23% in the treatment group thought they were poor, while the figure was only marginally higher for the control group. Both groups reported a small improvement in their livelihoods over the last 5 years. Simple unmatched comparison of means found a significantly lower level of food consumption expenditure in the treatment areas, but apart from that, other quantitative differences were insignificant. The attitude toward tourism among households was very positive for both groups, and there was a widespread expectation of job creation and income growth. A few negative concerns were raised, mostly with regard the risk of HIV and other sexually transmitted diseases.

B. Matching Results

A logit analysis was applied to explain household participation based on respondent characteristics relating to the age and education of the household head, housing quality, ownership of durable assets and livestock, and monetary and nonmonetary measures of living conditions.[19] Figure 2 shows the distribution of propensity scores before and after matching.

The impact of the project on income, expenditure, and consumption was assessed by comparing the means for matched households in treated and comparison areas. The variables were expressed in both absolute and in log per capita terms (Table 14).

Figure 2 **Distribution of Propensity Scores (Nearest-Neighbor Matching), Mekong Tourism Development Project, the Lao People's Democratic Republic**



Source: Consultant's survey.

19 After matching, the means of the propensity scores became almost identical. Both nearest-neighbor and kernel matching techniques were used, and the results are very similar with the nearest-neighbor matching working slightly better. The mean standardized bias reduction of all independent variables used in the logit specification is reduced from 14.1% to 2.97% for nearest-neighbor and to 3.7% for kernel matching. With nearest-neighbor matching, the pseudo R^2 is reduced from 0.139 to 0.012.

Table 14 Expenditure and Income: After Matching, Tourism, the Lao People's Democratic Republic

Item	Nearest-Neighbor Matching			Unmatched		
	Difference	Standard Error	T-stat	Difference	Standard Error	T-stat
Expenditure						
Log of expenditure per capita	(0.303)	0.151	(2.01)[b]	(0.20289)	0.073658	(2.75)[a]
Expenditure per capita	(1,552,267)	1,223,734	(1.27)	(599,068)	627,437.8	(0.95)
Expenditure per capita interacted with gender of household head	(1,244,090)	1,294,837	(0.96)	(506,061)	624,702	(0.81)
Expenditure per capita interacted with dummy for ethnic Lao	(1,510,677)	1,261,439	(1.20)	(4,625.49)	872,802	(0.01)
Expenditure per capita interacted with dummy for ethnic Mon	(225,023.5)	405,898.7	(0.55)	(902,964)	639,626	(1.41)
Income						
Income per capita	(1,370,430)	1,304,332	(1.05)	(795,132)	765,668.5	(1.04)
Income per capita interacted with gender of household head	(701,872.5)	1,193,949	(0.59)	(545,272)	726,419.2	(0.75)
Income per capita interacted with dummy for ethnic Lao	(1,163,508)	1,270,469	(0.92)	(207,635)	997,795.5	(0.21)
Income per capita interacted with dummy for ethnic Mon	(709,714.5)	576,134.9	(1.23)	(1,258,209)	947,874.3	(1.33)
Food consumption						
Food consumption per capita	(484,289.2)	317,459.7	(1.53)	(442,125)	200,532.5	(2.20)[a]
Food consumption per capita interacted with dummy for gender of household head	(468,499.2)	325,455.5	(1.44)	(403,531)	189,139.5	(2.13)[a]
Food consumption per capita interacted with dummy for ethnic Lao	(44,7564.2)	319,886.3	(1.40)	(132,401)	327,140.1	(0.40)
Food consumption per capita interacted with dummy for ethnic Mon	(90,582.03)	229,309.7	(0.40)	(388,266)	284,942.3	(1.36)

( ) = negative.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
Source: Consultant's survey.

The most striking result is that for all expenditure categories the differences between means for treatment and control groups are uniformly negative. The unmatched means comparison shows the control group to have higher expenditure levels and matching does not change this. The difference is statistically significant for log total expenditure per capita in both matching methods and is weakly significant for food consumption per capita in kernel-based matching. In other words, there is little evidence that the project has had a positive impact on expenditure indicators, with control households having higher expenditure. Questions on training and awareness reveal that there is a statistically significant and positive difference in the level of training for those in the treatment

group; so the project does appear to be reaching households in the treatment villages, but this has not translated into higher expenditures. On the other hand, there is a statistically significant difference in housing quality, with houses in the treatment areas being more likely to have a part-brick as opposed to wooden structure.

These results suggest that the range of intermediate project outputs such as training, skills development, business management, and group development have not translated into concrete outcomes in terms of income and expenditures. These results may suffer from bias due to the stratification of village households into two groups. Thus, appropriate weights might need to be used to adjust for these biases. However, the weighted averages only seem to reinforce the pattern found earlier. The negative signs persist and the differences in the logarithmic and absolute values of per capita expenditures are now statistically significant, confirming the significantly higher levels in the control areas. For ethnic Lao households, differences in per capita expenditures are now also weakly significant, again with the control households having higher levels. Thus, weighting adjustments are unable to reverse the negative relationship already detected (Table 15).

As noted earlier, the project interventions involved training and skills development in tourism-related activities, so the treatment areas are expected to be better endowed in this respect. Two indicators were used to capture this effect: (i) whether there is at least one member in a household receiving training, and (ii) the number of household members trained in each area. As Table 16 shows, the difference in means between the two groups for both indicators is positive (and significant

Table 15 Weighted and Unweighted Difference in Outcomes: Tourism, the Lao People's Democratic Republic

Variable	Nearest-Neighbor Matching					
	Unweighted			Weighted		
	Difference	Standard Error	T-stat	Difference	Standard Error	T-stat
Log of expenditure per capita	(0.303)	0.151	(2.01)[b]	(3.22038)	1.057754	(3.04)[a]
Expenditure per capita	(1,552,267)	1,223,734	(1.27)	(2,140,681)	1,270,217	(1.69)[c]
Expenditure per capita interacted with dummy for ethnic Lao	(1,510,677)	1,261,439	(1.20)	(2,156,269)	1,295,624	(1.66)[c]
Income per capita interacted with dummy for ethnic Mon	(225,023)	405,898.7	(0.55)	(110,668)	407,417.7	(0.27)
Income per capita	(1,370,430)	1,304,332	(1.05)	(2,004,174)	1,276,218	(1.57)
Income per capita interacted with dummy for ethnic Lao	(1,163,508)	1,270,469	(0.92)	(1,868,029)	1,241,767	(1.50)
Income per capita interacted with dummy for ethnic Mon	(709,715)	576,134.9	(1.23)	(568,160)	579,756	(0.98)

( ) = negative.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
[c] 10% level of statistical significance.
Source: Consultant's survey.

for the kernel estimates) confirming the positive impact of the project on knowledge development.

Project interventions were also expected to lead to increased employment opportunities in the tourism sector. The key outcome indicator used to test this was the number of households in the tourism business. Table 16 shows that the number of households engaged in tourism in the treated areas is higher and statistically significantly different from those in the control area. Similarly, the mean number of household members working in the tourism sector is higher in the treatment area with the difference being weakly statistically significant.

A number of indicators were used to test differences in the level of awareness about the effects of tourism, for example on trading in wild animals, environmental effects, communicable disease, cultural conservation, and impact on natural resources. The level of awareness was generally

Table 16 Knowledge, Awareness, Assets, and Living Conditions: After Matching, Tourism, the Lao People's Democratic Republic

Nearest-Neighbor Matching								
					ATT		Bootstrap	
Variable	Obs	Treatment	Control	Difference	Standard Error	T-stat	Standard Error	T-stat
Knowledge development and job opportunity								
At least one family member receiving training	776	0.212	0.154	0.059	0.038	1.56	0.036	1.63
Number of household members trained	776	0.247	0.154	0.093	0.050	1.84	0.052	1.8
Number of household members working in tourism	776	1.908	0.398	1.510	0.841	1.8	0.841	1.8
Number of households engaged in tourism	776	0.104	0.047	0.057	0.022	2.66[a]	0.031	1.84
Awareness of effects on								
Trade in wild animals	776	0.273	0.190	0.083	0.042	1.99	0.053	1.56
Environmental protection	776	0.513	0.434	0.079	0.048	1.63	0.058	1.35
Risk of infectious disease	776	0.402	0.324	0.078	0.046	1.7	0.057	1.36
Cultural conservation	776	0.603	0.577	0.026	0.048	0.54	0.061	0.42
Family security	776	0.697	0.634	0.063	0.045	1.41	0.065	0.97
Durable assets: change in ownership								
Land size	776	0.703	1.437	(0.735)	0.260	(2.82)[a]	0.635	(1.16)
Motorbike	776	(0.164)	(0.439)	0.275	0.077	3.57[a]	0.182	1.51
Motor vehicle	776	0.058	0.118	(0.061)	0.038	(1.60)	0.091	(0.67)
Boat	776	0.035	(0.006)	0.041	0.019	2.15[a]	0.029	1.42
Tractor	776	0.088	0.145	(0.058)	0.032	(1.81)	0.050	(1.15)
Machine	776	0.025	0.018	0.007	0.016	0.43	0.026	0.26
Rice mill	776	0.023	0.013	0.010	0.023	0.44	0.021	0.47
Mobile phone	776	0.988	1.083	(0.095)	0.134	(0.71)	0.275	(0.34)

continued next page

Table 16 Continued

Nearest-Neighbor Matching								
					ATT		Bootstrap	
Variable	Obs	Treatment	Control	Difference	Standard Error	T-stat	Standard Error	T-stat
Livestock ownership								
Cow	776	(0.464)	(0.680)	0.216	0.424	0.51	0.761	0.28
Buffalo	776	(0.580)	(0.915)	0.335	0.216	1.55	0.547	0.61
Pig	776	(0.739)	(0.209)	(0.530)	0.442	(1.2)	0.458	(1.16)
Living conditions								
Toilet access	776	0.127	0.131	(0.004)	0.037	(0.1)	0.043	(0.09)
Brick house	776	0.067	0.053	0.014	0.023	0.6	0.029	0.47
Wood-brick house	776	0.060	0.020	0.040	0.018	2.24[a]	0.018	2.2
Wood house	776	(0.018)	0.013	(0.032)	0.027	(1.18)	0.022	(1.45)
Access to watershed	776	0.085	0.182	(0.097)	0.034	(2.84)[a]	0.070	(1.39)
Access to artesian well	776	0.088	0.108	(0.020)	0.033	(0.61)	0.046	(0.44)
Access to spring water	776	0.005	(0.001)	0.006	0.006	0.95	0.004	1.52
Access to piped water	776	0.053	0.011	0.042	0.014	3.03[a]	0.026	1.61
Wood self-consumption	776	(0.058)	(0.035)	(0.023)	0.025	(0.91)	0.042	(0.54)
Purchased wood	776	0.032	0.007	0.025	0.016	1.58	0.038	0.66
Charcoal fuel	776	0.120	0.047	0.073	0.027	2.76[a]	0.033	2.25
Gas fuel	776	0.007	0.000	0.007	0.004	1.74	0.004	1.62
Electricity	776	0.007	0.000	0.007	0.005	1.34	0.006	1.22
Kernel-Based Matching								
					ATT		Bootstrap	
Variable	Obs	Treated	Controls	Difference	Standard Error	T-stat	Standard Error	T-stat
Knowledge development and job opportunity								
At least one family member receiving training	799	0.215	0.146	0.069	0.035	2.010[a]	0.034	2.03
Number of household members trained	799	0.243	0.150	0.092	0.045	2.030[a]	0.046	2.01
Number of household members working in tourism	799	1.837	0.401	1.436	0.739	1.940	0.774	1.86
Number of households engaged in tourism	799	0.111	0.066	0.044	0.021	2.120[a]	0.033	1.33

continued next page

Table 16 Continued

Kernel-Based Matching								
					ATT		Bootstrap	
Variable	Obs	Treated	Controls	Difference	Standard Error	T-stat	Standard Error	T-stat
Awareness of effects on								
Trade in wild animals	799	0.262	0.195	0.067	0.038	1.770	0.052	1.29
Environmental protection	799	0.504	0.444	0.061	0.044	1.380	0.058	1.05
Risk of infectious disease	799	0.389	0.307	0.082	0.042	1.960	0.054	1.53
Cultural conservation	799	0.582	0.578	0.004	0.043	0.090	0.058	0.07
Family security	799	0.682	0.643	0.039	0.041	0.950	0.061	0.64
Durable assets: change in ownership								
Land size	799	0.717	1.272	(0.556)	0.233	(2.390)[a]	0.500	(1.11)
Motor bike	799	(0.178)	(0.380)	0.202	0.076	2.650[a]	0.162	1.25
Motor vehicle	799	0.067	0.102	(0.035)	0.038	(0.930)	0.074	(0.47)
Boat	799	0.042	(0.002)	0.044	0.017	2.510[a]	0.027	1.6
Tractor	799	0.092	0.163	(0.071)	0.029	(2.470)[a]	0.042	(1.7)
Machine	799	0.029	0.033	(0.004)	0.015	(0.250)	0.023	(0.16)
Rice mill	799	0.023	0.020	0.003	0.021	0.130	0.016	0.17
Mobile phone	799	1.067	1.064	0.003	0.124	0.030	0.229	0.02
Livestock ownership								
Cow	799	(0.414)	(0.634)	0.220	0.563	0.390	0.613	0.36
Buffalo	799	(0.755)	(0.994)	0.238	0.202	1.180	0.467	0.51
Pig	799	(0.697)	(0.279)	(0.417)	0.403	(1.040)	0.464	(0.9)
Living Conditions								
Toilet access	799	0.119	0.117	0.002	0.033	0.060	0.038	0.05
Brick house	799	0.061	0.054	0.007	0.022	0.330	0.023	0.3
Wood (brick house)	799	0.067	0.017	0.050	0.017	2.980[a]	0.018	2.78
Wood house	799	(0.021)	0.019	(0.039)	0.024	(1.610)	0.021	(1.86)
Access to watershed	799	0.077	0.164	(0.086)	0.030	(2.880)[a]	0.063	(1.36)
Access to artesian well	799	0.088	0.104	(0.017)	0.031	(0.530)	0.046	(0.36)
Access to spring water	799	0.004	(0.001)	0.006	0.011	0.530	0.003	1.7
Access to piped water	799	0.050	0.012	0.039	0.013	3.050[a]	0.023	1.69
Wood self consumption	799	(0.061)	(0.033)	(0.027)	0.022	(1.220)	0.031	(0.88)
Purchased wood	799	0.029	0.011	0.018	0.014	1.310	0.029	0.63
Charcoal fuel	799	0.123	0.050	0.073	0.025	2.930[a]	0.033	2.23
Gas fuel	799	0.008	0.000	0.008	0.004	2.010[a]	0.004	2.06
Electricity	799	0.010	0.011	0.000	0.007	(0.070)	0.011	(0.04)

( ) = negative, ATT = average treatment effect on the treated, obs = number of observations.

[a] significant at 5% level or below.

Source: Consultant's survey.

found to be high among all respondents, however there was no significant difference in awareness between the treatment and control groups.

Recall data on durable goods ownership for 2004 and 2009 was available, enabling estimation of project impact on a double-difference basis allowing for changes. The results show that the difference in the mean of durable asset ownership had both negative and positive signs, varying with the type of assets, so no conclusive pattern could be found. For example, treatment households increased their ownership of motorbikes and boats relative to the control group, with this difference statistically significant. On the other hand, the control group increased significantly their ownership of land and tractors relative to the treatment households. Other relative changes were not statistically significant.

Housing quality, energy use, and access to water and sanitation reflect household living standards. Related indicators used in the survey included whether there was access to a toilet in the house; the construction material of houses, whether of brick or wood; and access to water and energy sources. The results show little statistically significant difference in the living condition variables, except that the treatment households were more likely to (i) have houses that were not made of wood, (ii) have better access to mains water, and (iii) use more charcoal and gas for heating and cooking. All of these indicate a slightly higher living standard than that of the control group.

C. Conclusions

The study used cross-section data from two provinces, Champasak and Luang Namtha, to assess the impact of a community-based tourism project on the livelihoods of people living inside and outside the project areas. The results show that households in the treatment area were clearly more engaged with tourism than those in the control area, and that a number of interventions aimed at improving skills and management capacity in the sector appear to have been successful in reaching the treatment households. The study also found a lack of direct project impact, particularly on the monetary welfare measures of income, total expenditure, and food consumption, suggesting very little impact on poverty reduction. There is some evidence that treatment households had a higher living standard based particularly on housing quality.

The lack of evidence of impact can be attributed to the limited availability of data, the short time between the survey in 2009 and project completion, and the lack of development of full GMS cooperation in the sector. It is also noted that some of the survey data appear inconsistent, which may suggest faulty data recording. After matching treatment, households have lower expenditure but higher indicators of living standard such as housing quality and access to water. Nonetheless, the effective development of the capacity of target beneficiaries to improve livelihoods and earnings clearly remains a challenge. It is likely that the generation of benefits from the project is constrained by low skill levels despite the many training interventions and capacity development initiatives introduced by the project.

There may be a need to consider the effect of tourism-related productive assets such as roads, proximity to markets, remittance and others, and

the difficulty of villages to accurately recall income and expenditure. The evaluation of this project by ADB was completed in December 2013 and the validation rated it *successful*.[20]

Notwithstanding the admitted deficiencies in the study's survey approach and results cited above, it is worthwhile to note that the ensuing Sustainable Tourism Development Project, which also covers the Lao PDR, is expanding traditional community-based tourism development approaches to new models of tourism development that involve and benefit more poor local communities. These models include development of community-based tourism products in areas where poor communities live, and the establishment of supply chains through programs that increase the contribution of tourism to the local economy (through provision of handicrafts, food, transport, accommodation, and guiding services). In addition, to address some constraints to achieving the planned impact of the project, the next phase of the GMS Tourism Infrastructure for Inclusive Growth Project is being prepared for the Lao PDR. This project incorporates complementary investments in infrastructure, enterprise promotion, and capacity building for public and private tourism managers. The following performance indicators have been selected to assess inclusiveness: (i) number of people with access to newly paved roads, (ii) number of people with access to improved sanitation, (iii) number of jobs created and percentage of women employed in tourism, (iv) number of depositors with commercial banks that have access to microfinance, and (v) percentage of women holding management positions in tourism destination management organizations. The results and outcomes of this project may be used to further assess the impact of tourism projects in the Lao PDR.

20 ADB. 2013. *Validation Report: Greater Mekong Subregion: Mekong Tourism Development Project (Cambodia, Lao People's Democratic Republic, and Viet Nam)*. Manila.

V. Conclusions

The three impact evaluation case studies demonstrate that with planning and resources it is possible to conduct rigorous studies using the research expertise of local institutions. However, the results of the studies show relatively limited impact from the GMS projects examined. It is noted in the Lao PDR statistically significant impact was found in the transport project. For both the North–South Economic Corridor (NSEC) Project and the Greater Mekong Subregion Regional Communicable Diseases Control Project, the results were ambiguous or showed limited project impact in the case studies for Cambodia, Thailand, Yunnan Province in the People's Republic of China (PRC), and Viet Nam. To interpret these results, however, it is necessary to consider the intrinsic difficulty of implementing regional cooperation projects, which tend to be large relative to national projects in the same sector and require the agreement and cooperation of many different stakeholders. It is also noted that delays in implementing the Cross-Border Transport Agreement to facilitate the flow of intraregional trade and in completing all of the road links and bridges required by the road corridors that cross the participating countries may partly explain the lack of impact from the roads studied. Furthermore, the household surveys on which the case studies were based were all conducted in 2009 and 2010, which was typically no more than 3 years after project completion. Supply-side responses to the opportunities created by the road and tourism projects, for example, will be stronger after a longer period of time has elapsed.

However, there are also important methodological issues to consider. While the propensity score matching technique has been applied accurately in these cases, and therefore the matching of participant and nonparticipant households generally meets the required statistical standards, the impact analysis is of a cross-sectional rather than longitudinal type. In other words, matched households with similar characteristics are compared at a point in time after project implementation, with no consideration for the pre-project or baseline scenario. This approach is adequate provided there are no unobservable differences between treatment and control households that are not captured and included in the logit or probit analysis used to derive propensity scores. If there are such unobservable factors, these will bias the results and the average

treatment effect from the comparison of the means of the outcome variables used in the analysis will not give the true picture of project impact. This may explain, for example, the fact that treatment households exposed to the Mekong Tourism Development Project had lower monetary levels of welfare than nonparticipants in the control group.

This risk is clearly present in the analysis of the road corridor projects because the choice of location of roads is not random and it is difficult to ensure that the treatment areas directly affected by a project are comparable in terms of economic potential with the selected control areas. This problem of treatment bias is a familiar one in the evaluation literature. The approach used in the case studies of seeking expert advice in the selection of control areas may have been the best that could be done under the circumstances but it risks introducing bias into the analysis.

A similar problem arises where external factors that affect the control and treatment groups differently become part of the unobservable factors. It may be, for example, that part of the reason for the lack of impact found for the Greater Mekong Subregion Regional Communicable Diseases Control Project in Cambodia and Viet Nam is that most households obtained their information on such diseases from radio and television broadcasts that are available nationally and not just in areas served by the health project. If the impact of broadcast media on knowledge, attitudes, and practices was not controlled for adequately, this too would have contaminated the results.

A response to these concerns is to combine a pre-project baseline analysis with a later survey after project implementation. Provided the unobservable factors involved—such as differential area potential for growth or differential exposure to broadcast media—remain constant over time, a double-difference analysis using propensity score matching to compare households will give an accurate picture of impact. In other words, for the selected outcome indicators the difference between the means for the treatment and control groups after a project has been in operation can be compared with the difference in means before the project. Nonetheless, the lack of evidence of short-run impact from important GMS projects, some of which have already been rated *highly successful* in qualitative or less-rigorous quantitative evaluations should be a cause for concern. In the case of the road projects, this may be due to the lack of full implementation of supporting arrangements or of all project components. However, there is the suggestion in other cases—for example the tourism project in the Lao PDR and the health project in Cambodia and Viet Nam—that project workers have not been as effective as they might have been in providing key services or in transferring key skills. These studies do not reveal the full picture of project performance, but the lack of immediate impact from important GMS projects should prompt further consideration of how their effectiveness might be raised.

APPENDIX 1
Thailand: Gravity Model

A modified Gravity Model was used to assess the trade effect of the improved road condition from Kunming to Chiang Khong. First, the determinants of Thailand's bilateral trade with its trading partners were estimated for both exports and imports classified at the 2-digit level of the Harmonized Commodity Description and Coding System (the Harmonized System [HS]). From the results of the gravity regression, the commodities whose trade flows were found to have a significant relationship with a logistic cost variable were identified. For these commodities, the trade effect of the project was simulated by calculating the difference in trade value between that predicted by the standard equation allowing for a project-induced fall in logistics cost and that predicted by the same equation assuming logistic cost remains constant, as in the without-project case.

The gravity model is specified as:

$$\ln(\text{Export}_{ijk}^{t}) = b_0 + b_1 \ln(GDP_i^t) + b_2 \ln(GDP_j^t) + b_3 \ln(rfex_j^t) + b_4 \text{Logistic}_{ij} + b_5 Tariff_j^t + \varepsilon_{ij}^t$$

$$\ln(\text{Import}_{ijk}^{t}) = b_0 + b_1 \ln(GDP_i^t) + b_2 \ln(GDP_j^t) + b_3 \ln(rfex_i^t) + b_4 \text{Logistic}_{ij} + b_5 Tariff_j^t + \varepsilon_{ij}^t$$

where,

i = Thailand
j = Thailand's trade partners (the Lao PDR and Yunnan Province in the PRC)
k = customs gateways (Mae Sai, Chiang Saen, and Chiang Khong)
t = trading years (1996, 1997,…., 2008)
Export = export of a product defined at HS 2 digit through customs gateway k
Import = import of a product defined at HS 2 digit through customs gateway k
GDP = real gross domestic product
Logistic = index of transport cost from Bangkok through customs gateway k to destination j at border town[1]
Tariff = applied tariff rate of importing country i or j
rfex = real effective exchange rate (local currency to $)
ε = error term

1 This was estimated by Thailand Development Research Institute, Bangkok.

There were 5,904 observations for exports and 6,048 for imports. The trade data set was acquired from the Customs Department of Thailand and expressed in Thai baht. Gross domestic product (GDP) figures for each country were from the World Bank World Development Indicators except for the GDP of Yunnan Province, which was from the China National Bureau of Statistics. The applied tariff data came from the secretariat of the Association of Southeast Asian Nations and the World Trade Organization Integrated Database. The real effective exchange rate was calculated from data from the World Development Indicators.

The results of the gravity model regression estimate for pooled products are in Table A1.1. The signs on the coefficients are mostly as expected and are statistically significant. In the export equation, the coefficient on Thailand's GDP is positive and significant at the 1% level. According to the result, a 1% increase in Thailand's GDP results in an increase in its exports of 7.6%. However, the coefficient on trading partners' GDP is negatively significant at 1%, which is unexpected. This implies that rising GDP in trading partners leads to import substitution at the expense of sales from Thailand. The signs are as expected for the real exchange rate, logistic cost, and tariff rate variable. For the logistic cost, the result confirms the expectation that the reduction of the logistic cost index raises bilateral exports from Thailand.

The result for the import equation is similar. Again, the coefficient for Thailand's GDP is significant with a negative sign implying import substitution.

Tables A1.2 and A1.3 present the results from the gravity model with the major products (both export and import) classified at 2-digit HS level as dependent variables. The results for each major product are consistent with the findings of the pooled export and import analysis. At the 2-digit level the logistics index is negatively significant for four major export product and six major import product groups.

Table A1.1 Regression Results: Gravity Model

Item	$LNEXPORT_{ij}$	$LNIMPORT_{ij}$
$LNRGDP_i$	7.6005[a]	(2.5007)[a]
	0.9939	*0.8475*
$LNRGDP_j$	(1.5329)[a]	(0.0275)
	0.4511	*0.4532*
$LNRFEX_{ij}$	1.0199[b]	2.1234[a]
	0.4914	*0.4436*
$Logistic_{ij}$	(0.0106)[a]	(0.0269)[a]
	0.0037	*0.0032*
$TARIFF_{ij}$	(0.0212)[a]	(0.0917)[a]
	0.0074	*0.0185*
Constant	(151.8679)[a]	76.9420[a]
	24.1529	*20.8365*
Obs	5904	6048
R^2	0.0912	0.1243

( ) = negative.
Note: Robust standard errors are in *italics*.
[a] 1% level of statistical significance.
[b] 5% level of statistical significance.
Source: Consultant's survey.

The products where the logistic index is significant were examined to estimate the effect of a reduction in transport and other trade costs due to the project. This was done by first predicting the export and import value for each selected product using the estimated coefficients from Tables A1.2 and A1.3 with actual data. Then, another set of the export and import values was estimated using the same coefficients, but holding the logistic cost variable constant over time to simulate the scenario of no

Table A1.2 Major Export Products North–South Corridor: Random Effects Model

HS	$LNRGDP_i$	$LNRGDP_j$	$LNRFEX_{ij}$	$COST_{ij}$	$TARIFF_{ij}$	Constant	Obs	R^2
HS 40	16.7904	(8.92870)	8.6201	(0.0478)	(0.3836)	(192.75)	61	0.2620
	19.0442	*6.0615*	*6.6824*	*0.0483*	*0.2616*	*484.71*		
HS 08	29.6629[c]	(10.4675)	8.9185	(0.0363)	0.0344	(495.90)	63	0.1293
	16.3219	*8.8185*	*8.8416*	*0.0603*	*0.1213*	*433.08*		
HS 27	1.2113	0.7871	0.0932	(0.0405)	(0.0184)	(27.75)	63	0.1736
	9.3897	*8.3819*	*7.7909*	*0.0452*	*0.3121*	*240.44*		
HS 15	(5.5799)	3.8817	(0.0099)	(0.0426)	(0.1188)	76.70	63	0.3888
	6.6015	*5.2444*	*6.1428*	*0.0306*	*0.1145*	*274.10*		
HS 87	11.8987	(0.5960)	(1.7370)	0.0070	(0.0639)	(283.27)	63	0.1595
	10.0403	*5.0872*	*6.0518*	*0.0473*	*0.0536*	*279.29*		
HS 20	11.7857	0.5661	(3.2120)	0.0356	(0.1048)[c]	(315.74)	63	0.2079
	9.8454	*5.1395*	*7.3538*	*0.0563*	*0.0612*	*296.66*		
HS 29	10.6964	(4.5673)	1.3517	0.0142	(0.6425)	(157.84)	63	0.1890
	8.7008	*6.9232*	*6.7896*	*0.0530*	*0.4031*	*164.42*		
HS 85	16.1863	(2.3912)	0.1189	(0.0001)	(0.1500)[c]	(351.83)	63	0.2536
	12.1111	*2.7110*	*3.4758*	*0.0439*	*0.0829*	*311.85*		
HS 22	7.0034	(0.7622)	1.0584	(0.0289)	(0.0104)	(144.15)	59	0.1782
	8.6571	*7.0767*	*8.2771*	*0.0596*	*0.0177*	*277.67*		
HS 25	0.5430	(2.3778)[a]	0.5698	(0.0329)[b]	(0.0534)[c]	57.97	61	0.0107
	3.4024	*0.7138*	*1.2218*	*0.0156*	*0.0320*	*86.76*		
HS 39	(2.3652)	4.8772	(3.1918)	(0.0290)	(0.0985)	(37.09)	63	0.3211
	3.5514	*6.4283*	*7.2955*	*0.0453*	*0.1146*	*99.87*		
HS 73	14.2895	(0.4017)	(2.3110)	0.0240	(0.2279)[c]	(356.04)	63	0.2732
	11.6424	*2.8567*	*3.8490*	*0.0422*	*0.1350*	*328.78*		
HS 72	5.8643	(3.1015)	2.5078	(0.0538)[a]	0.1172	(55.40)	61	0.1688
	4.7980	*2.4550*	*1.9901a*	*0.0188*	*0.1263*	*96.97*		
HS 19	20.4597	(6.4228)	3.8423	(0.0141)	(0.0193)	(361.54)	61	0.2289
	16.3335	*5.6758*	*7.9558*	*0.0801*	*0.0713*	*466.87*		
HS 30	(18.4870)	1.5562	3.4627	(0.0632)[a]	(0.2260)	462.89[c]	63	0.1695
	14.9276	*4.8646*	*3.7439*	*0.0182*	*0.2378*	*270.66*		
HS 02	(2.1658)	(5.6365)[b]	8.5058[b]	(0.0654)[c]	(0.0201)	212.02	63	0.1006
	4.5097	*2.2863*	*4.1881*	*0.0387*	*0.0323*	*165.99*		
HS 55	(2.4855)	(1.4032)	4.2903	(0.0572)	0.0826	117.37	63	0.0360
	4.1314	*3.3188*	*4.0130*	*0.0381*	*0.0551*	*98.14*		
HS 84	8.6229	(1.2954)	(0.4407)	(0.0077)	(0.1899)	(179.60)	63	0.2107
	7.3598	*4.0936*	*4.7969*	*0.0303*	*0.2252*	*210.54*		

( ) = negative, HS = Harmonized System code.

Notes: Robust standard errors are in *italics*. The List of Harmonized System products accounted for 90% of the value of trade that occurred in the years since 1996–2008.

[a] 1% level of statistical significance.

[b] 5% level of statistical significance.

[c] 10% level of statistical significance.

Source: Consultant's survey.

Table A1.3 Major Import Products, North–South Corridor: Random Effects Model

HS	$LNRGDP_i$	$LNRGDP_j$	$LNRFEX_{ij}$	$COST_{ij}$	$TARIFF_{ij}$	Constant	Obs	R^2
HS 08	(33.2975)[a]	2.2826	4.2665	(0.0668)[a]	(0.0877)	831.59[a]	63	0.1024
	8.1311	*2.6409*	*3.3236*	*0.0223*	*0.1087*	*192.29*		
HS 44	(15.9614)[c]	1.7314	1.2743	(0.0717)[c]	0.0556	400.27	63	0.1790
	9.4866	*6.1113*	*5.8772*	*0.0368*	*0.3000*	*256.48*		
HS 07	(0.1392)	(6.5197)	7.3124[b]	(0.0368)	(0.3841)[a]	182.54	63	0.2683
	5.7071	*6.3286*	*3.0895*	*0.0259*	*0.1448*	*141.11*		
HS 27	(4.2326)	(1.4684)	0.1175	(0.0246)	(0.5862)	155.94	63	0.1163
	6.9217	*6.8297*	*6.1205*	*0.0457*	*0.5251*	*200.85*		
HS 01	(10.1551)	(7.4636)	6.2396	(0.0674)	(0.5138)[c]	465.36[b]	63	0.1360
	6.3498	*5.9084*	*6.8705*	*0.0447*	*0.2991*	*210.90*		
HS 12	(5.2184)	3.9513	0.0432	(0.0281)	(0.0359)	52.88	63	0.2938
	3.3764	*3.5736*	*3.7906*	*0.0323*	*0.1136*	*125.71*		
HS 87	(22.1234)	8.5041	(4.2342)	(0.0220)	(0.2184)	380.19	63	0.1961
	18.1949	*7.3297*	*6.3789*	*0.0290*	*0.1541*	*313.00*		
HS 62	(1.4694)	(0.3889)	6.1786	(0.0618)	(0.2112)	75.50	63	0.5783
	11.2386	*5.1513*	*4.2055*	*0.0406*	*0.2355*	*271.61*		
HS 63	6.0934	1.7797	1.9625	(0.0260)	(0.2883)	(181.34)	63	0.5482
	10.6552	*3.7427*	*1.3938*	*0.0265*	*0.2154*	*207.67*		
HS 10	29.9964[b]	(8.3323)[c]	4.0203	(0.0052)	(1.7054)[a]	(561.60)[c]	63	0.3376
	14.6323	*4.4961*	*3.2810*	*0.0206*	*0.2776*	*310.11*		
HS 09	3.2043	(8.6195)[c]	10.1325[c]	(0.0629)	(0.2944)	149.48	63	0.1124
	7.9340	*4.7379*	*5.3533*	*0.0489*	*0.3680*	*169.44*		
HS 84	(13.6129)	2.3001	0.3137	(0.0122)	(1.3862)	311.32	63	0.1943
	18.5797	*4.0345*	*5.0119*	*0.0386*	*1.1160*	*528.98*		
HS 72	7.4269	(1.5493)	3.7075	(0.0478)[a]	(0.1479)	(134.62)	63	0.3049
	8.1385	*4.3322*	*2.5225*	*0.0095*	*0.2462*	*176.80*		
HS 85	(7.6172)	(5.7688)	11.5239[b]	(0.0957)	(0.2432)	371.10	63	0.3437
	15.3333	*5.2900*	*5.1987*	*0.0450*	*0.6217*	*308.85*		
HS 28	(11.1416)[c]	2.0562	3.6446	(0.0641)[a]	0.1707	260.15	63	0.1609
	5.9813	*5.6739*	*3.9836*	*0.0132*	*0.4112*	*175.02*		
HS 36	(2.9079)	(4.8482)[b]	6.6567[b]	(0.0434)[b]	(0.0821)	205.61[c]	63	0.0161
	2.7181	*2.2798*	*3.0128*	*0.0182*	*0.0964*	*105.31*		
HS 23	(1.5474)	1.1443	2.5763[a]	(0.0424)[b]	0.5224	25.91	63	0.2132
	3.6064	*3.7118*	*0.7816*	*0.0215*	*0.6211*	*108.25*		

( ) = negative, HS = Harmonized System code, obs = number of observations.

Notes: Robust standard errors are in *italics*. The List of Harmonized System products accounted for 90% of the value of trade that occurred in the years since 1996–2008.

[a] 1% level of statistical significance.

[b] 5% level of statistical significance.

[c] 10% level of statistical significance.

Source: Consultant's survey.

Table A1.4 Trade Effect from Logistic Cost Reduction

HS	Product	Trade Effect from Simulation (baht)
Export		
HS 02	Meat and edible meat offal	1,384,312
HS 30	Pharmaceutical products	888,632
HS 72	Iron and steel	134,621
HS 25	Salt, sulfur, earth and stone, lime and cement	2,176
Import		
HS 44	Wood and articles	4,938,831
HS 08	Edible fruits and nuts	1,835,926
HS 28	Inorganic chemicals	1,065,245
HS 72	Iron and steel	40,669
HS 36	Explosives, matches, pyrotechnic products	16,995
HS 23	Residues from food industries	13,949

HS = Harmonized System code.
Source: Consultant's survey.

road improvement project. The difference in trade export values between the two cases gives the with-project–without-project comparison. The results of the simulation are shown in Table A1.4 for the 10 products concerned.

The effect of a reduction in logistic cost on export value is relatively large for three major exported product groups: meat and edible meat offal (HS 02), pharmaceutical products (HS 30), and iron and steel (HS 72). The effect of a reduction in logistic cost on import value is also relatively large for three product groups: wood and articles (HS 44), fruits (HS 08), and inorganic chemicals (HS 28). Thus, from this analysis, the reduction of transport cost and the time saving created by the project does stimulate trade, as expected. However, at the time of the analysis, only a minority of product groups appears responsive to these cost reductions, and overall the magnitude of the trade effect is small. It will take producers and traders time to respond to the new opportunities created by the project, so stronger trade effects can be expected in the future.

APPENDIX 2

Incidence of Dengue in the Lao People's Democratic Republic

As a test for the impact of the project on the incidence of dengue and dengue-associated fatality rates, a regression analysis looked at province-level variations in dengue incidence (cases per 1,000 population); the dengue case fatality rates (dengue deaths per 100,000 dengue cases); and dengue mortality rates (dengue deaths per 100,000 population), which is the product of the first two indicators. The data used in the estimation were annual province-level national program data for 2005–2009. The effect of the project was represented by four annual dummy variables, each of which indicates whether a province was included in the project in a given year of implementation during 2006–2009.

Table A2 presents the results of fixed-effects estimation of the regression models. Breusch-Pagan tests of the absence of a separate province component in the random disturbance term are rejected at the 0.01 level in the dengue incidence and the dengue mortality rate models (columns 1 and 3), but not at even the 0.10 level in the case fatality rate model (column 2). Consequently, the case fatality rate model (column 2) was estimated using pooled ordinary least squares regression. The choice of fixed-effects estimation over random-effects estimation of the remaining two models (columns 1 and 3) was based on the fact that the data were national in scope rather than a random sample of provinces.

The results indicate that, as expected, the project had a negative effect on all three dengue indicators in every year of project implementation and that the magnitude of the project's negative effect tended to increase over time. However, only the estimated project effect on the dengue mortality rate in 2009 is statistically significant (at the 0.05 level), while tests of the hypothesis that all four project effect dummies are zero could not be rejected at even the 10% level in any of the three models. If a single dummy variable is specified to represent the effect of the project, instead of separate project dummies for each year, the estimated coefficients are all negative and statistically significant in the case fatality rate model (at the 5% level) and in the dengue mortality rate model (at the 10% level).

Overall, while the results are indicative of a negative project effect that increases in magnitude during the period of project implementation, they are not statistically significant.

Table A2 Dengue Incidence, Fatality and Mortality Rate: Province Level, the Lao People's Democratic Republic, 2005–2009

Dependent Variable:	Dengue Incidence	Dengue Case Fatality Rate	Dengue Mortality Rate
Estimation method:	**Fixed-Effects**	**Pooled OLS**	**Fixed-Effects**
Independent variables	**(1)**	**(3)**	**(2)**
Year = 2006	0.106	(0.429)	0.050
	(0.36)	*(0.64)*	*(1.44)*
Year = 2007	0.073	2.877	0.177
	(0.34)	*(1.16)*	*(1.82)*
Year = 2008	0.034	12.392	0.291
	(0.10)	*(1.49)*	*(1.35)*
Year = 2009	0.913	100.147	0.297
	(1.79)	*(0.96)*	*(1.99)*
Included in project, 2006	(0.093)	(0.258)	(0.353)
	(0.18)	*(0.51)*	*(1.52)*
Included in project, 2007	(0.126)	(3.158)	(0.392)
	(0.37)	*(1.23)*	*(1.23)*
Included in project, 2008	(0.204)	(11.959)	(0.351)
	(0.42)	*(1.40)*	*(1.53)*
Included in project, 2009	(1.113)	(99.279)	(0.483)
	(1.68)	*(0.95)*	*(2.12)**
Constant	0.672	0.979	0.139
	*(4.06)***	*(1.69)*	*(1.98)*
Number of observations	85	71[b]	85
Number of provinces	17	...	17
R-squared[a]	0.16	0.09	0.13
Breusch-Pagan test	0.0000	0.9856	0.0000
Hausman test	Indeterminate[c]	...	Indeterminate[d]

( ) = negative, ... = data not available, OLS = ordinary least squares.

Note: Robust t statistics are in *italics*. The four dummy variables indicating inclusion in the project during a given year are jointly insignificant at the 0.10 level in all three models.

* significant at 5%, ** significant at 1%.

[a] R-squared refers to "within" regression.

[b] the case fatality rate (column 2) is not defined for 14 province observations in which no dengue cases were reported.

[c] Variance-covariance matrix not positive definite.

[d] Theoretical chi-squared statistic is negative.

Source: National program data, the Lao People's Democratic Republic.

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Assessing Impact in the Greater Mekong Subregion
An Analysis of Regional Cooperation Projects

Cooperation among the Greater Mekong Subregion (GMS) countries has intensified in recent years. By the end of 2012, the program had mobilized $15.5 billion in investment projects and $311 million in technical assistance (TA), of which ADB's support amounted to $5.5 billion for investments and $108.2 million for TA. This study summarizes a recent major initiative to assess the initial impact of ADB-supported projects under the GMS Program. As part of this exercise, a range of representative projects in the road transport, health, tourism, and energy sectors were selected for detailed analysis, and research institutes working with international consultants assessed their socioeconomic impact.

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