*Benefit Valuation for Regional Public Goods and Regional Projects*

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 *December 2017*

1. *Introduction:*

Regional public goods create benefits for a region which exceed those to the individual investors and countries involved. Hence, they are central to the concept of a regional project, as one where total benefits for the region exceed those that would be created if the investors or countries acted independently. The differing characteristics of regional public goods will determine how they can be supplied most efficiently and how far Multilateral Development Banks (MDBs) should be involved in their provision. Regional public goods can be classified along two dimensions – first the degree to which they match the classic properties of public goods – non-rivalry in consumption and non-excludability – and second the conditions under which they are produced (so-called ‘aggregator technology’).[[2]](#footnote-2)

Along the dimension of ‘publicness’ there are four categories.

* *Pure public goods*: where additional use does not reduce availability for others (non-rivalry) and where it is not possible to separate and charge individual users (non-excludability); where benefits of such goods are dispersed across a region they are pure regional public goods.
* *Impure public goods*: where there is partial rivalry in consumption (for example due to congestion or queuing) or where it is possible to exclude some users through charging.
* *Club goods*: where full exclusion is possible and pricing can ration use.
* *Joint products*: where more than one output is involved and at least one output has public good characteristics.

In terms of technology for the production of such goods four categories can be identified

* *Summation*: where the overall level of the public good supply equals the sum of the contributions of individual participating countries with substitutability so that extra effort by one can compensate for smaller effort by another.
* *Weighted sum*: where the overall level of public good supply is a weighted sum of individual country contribution with some countries are more important providers than others.
* *Weakest link*: where the smallest country contribution determines overall supply for the region.
* *Weaker link*: where the smallest country contribution has the greatest impact on supply, followed by the second smallest contribution and so forth.

In terms of specific types of regional public good curbing the spread of a communicable disease or global environmental protection are the clearest examples of a pure public good. All citizens benefit and there is no rivalry involved. In the first case as the disease will be spread from the most infected country the effort at the weakest link in the chain will determine the overall impact in the region. Where CO2 emissions are reduced there will be a global benefit in relation to climate change, which all will benefit from.

There are several examples of impure public goods. Treatment of AIDs patients involves rivalry in consumption as only a limited number can be treated, although there are widespread benefits for those who are not yet infected. The total impact at the regional level will be the sum total of patients treated in the individual countries. Watershed management will involve some rivalry in consumption and excludability for the water and sanitation component. As different countries will have different hydrological and related conditions management of the river will require different efforts in different countries and total regional impact will be a weighted sum with some countries having a larger role than others. Cross border trade facilitation is an impure public good because it is possible to exclude goods from non-participating countries. The overall effect on trade will be determined by the speed of reform in the countries where the remaining barriers to trade are higher. The output of regionally funded agricultural research is non-rival but in principle information is excludable to non-participants. The success at a regional level will be determined by the efforts of the most advanced research group.

Regional infrastructure schemes (such as roads or power grids) are normally club goods as some form of charging will be possible, even though there may be externalities that are not captured in the price. For a power grid regional impact will be a weighted sum of country efforts, although for cross-border road connections the quality of roads in countries with less developed networks will hold back cross-border trade flows and thus determine total regional impact. Preservation of eco-systems and bio-diversity create joint products, both environmental protection, which is a pure public good and some forest and agricultural commodities, which are pure private goods. The establishment of a telecommunications network through an optical fibre interconnection will create an information super highway that will have both public and private characteristics, as not all ‘connectivity’ can be charged for and its total regional impact will be determined by capacity in the sectors of the less advanced member countries.

This type of classification has been used to identify the problem in creating country co-operation and to identify where MDBs should focus their efforts in relation to regional public goods. Without assistance goods will be under-provided relative to the optimum by the member countries themselves

a) where there are pure or impure public goods with a summation technology, so that efforts of different countries are substitutable and there is a free-rider problem;

 b) where for club goods poorer member countries cannot afford the full cost of supplying these goods;

 c) where weaker or weakest link technology is involved and poorer member countries lack the capacity to supply to the relevant standard.

 The rationale for different regional public good projects of MDBs can be assessed from this perspective. In principle, for example, it provides a rationalisation for involvement with health and road projects (the weaker link case) and for some environmental projects (the weighted sum case). However full justification of such interventions cannot be assessed on a-priori grounds and requires estimates of the costs and benefits involved. This can be a complex technical process and some of the key issues of benefit valuation are considered below distinguishing between problems in different sectors.[[3]](#footnote-3)

1. *Decision criteria for project economic analysis of regional public goods*

From the project perspective a simple definition where a regional public good project is one which creates external benefits elsewhere in the region and for which it receives no financial compensation. Hence the total regional benefit as measured by the regional economic net present value (ENPV) exceeds the national ENPV. Where the regional ENPV involves projects in more than one country the external effect means that the sum of ENPVs of projects undertaken independently, but summing to the same capital cost, is less than the overall regional ENPV due to synergy between the projects. In terms of formal conditions If there is no budget constraint in theory investment in regional projects should be up to the point at which the marginal project yields an ENPV of zero at a discount rate, which reflects the collective social time preference in the region.

Where a separate and fixed budget is set aside for regional projects investment in regional projects should be up to the point that the budget is exhausted with projects with a positive ENPV. In any budgeting period if alternative but independent projects are available ranking of alternatives should be by the ratio ENPVi/Ki, where K is capital cost and i refers to project i.

Both criteria require use of a discount rate. The concept of a collective regional time preference can refer to society as a whole in the region or regional decision-makers acting on its behalf. Both concepts are highly abstract, but the so-called Ramsey formula related originally to individuals has been used in this context. For example, the current ADB discount rate of 9% is rationalised as a regional time preference rate.[[4]](#footnote-4) The Ramsey formula requires an estimate of future growth of consumption per capita (g), and assumptions about the rate at which the marginal utility of additional consumption declines (n) and of pure time preference (p). The regional time preference rate (RTP) is estimated from the expression

RTP = g.n + p

The rate of 9% is derived on the basis of some strong assumptions with high values used for future growth (g = 5%) and for the elasticity of marginal utility of consumption (1.5) plus a pure time preference of 1%. The resulting figure of 8.5% is rounded up to 9%.

Arguably this is an unrealistically high value for a time preference rate since it implies a dollar received in 3 years’ time is worth only 77 cents today. More conservative estimates of per capita consumption growth (g =3%) and a less progressive value for the elasticity (n = 1) reduce the discount rate by more than half (RTP = 4%). This is more line with estimates that have applied the Ramsey formula in national contexts. For example, for EU countries most estimates have been in the range from 3% to 6%, with most of the difference driven by the assumptions on future consumption growth.[[5]](#footnote-5) However since the discount rate is derived from a formula that is based on a forecast for growth plus two inherently subjective parameters (n and p) there is no objectively ‘correct’ parameter and uncertainty is inevitable.[[6]](#footnote-6) None the less, 9% appears an unrealistically ‘high’ figure for a time preference rate.

Where there is a budget constraint for regional projects the relevant discount rate ceases to be one of time preference and an opportunity cost rate will be require to ration the limited funds. In principle this will be given by the return on the marginal regional project. If there is a track record in funding such projects ex post analyses can provide a guide, but in practice probably only rough indicators of general returns to investment will be available and the ADB rate of 9% is likely to be adequate. The 9% rate as applied in ADB is de facto a rationing rate for funds.

The discussion up to this point has treated projects in different countries as independent but once interdependence is allowed so that the benefits of a project in country A depend on the scale of activity in country B (or in a series of other countries) the optimisation problem becomes more complex; for example, a highway project in A will benefit from a similar project in B as a result of cross border traffic flows. First there is a free rider problem. The project in B may benefit from the project in A even if no additional investment takes place in B. However, the gains to A and B will be greater if both countries invest. The appropriate role of an MDB is to solve this co-ordination problem and provide funding or technical advice to both. The co-ordination problem is more complex where economies of scale are important so net benefits per unit of investment rise with scale. Now there is a need for a formal optimisation model to determine both optimal scale and sequencing of investments.

Whilst regional sector master plans offer a partial solution to this problem, at present most offer cost minimisation solutions rather than a focus on maximisation of net benefits. This is because of the difficulty of attributing and valuing project level benefits in this type of model. For example, it is possible to set up infrastructure master plans in transport or power where projected demand can be compared with existing capacity and the least cost solution to meeting this demand can be assessed. This approach rarely goes into sufficient project-specific details to capture fully the inter-relationships between benefit estimates for individual projects.

Even setting aside this interrelationship problem there remain considerable empirical complications in assessing regional benefits. The remainder of the paper discusses the approach in a number of different sectors.

1. *Valuing Regional Benefits in different sectors*

3.1 Energy

Most power projects are part of a system network. Power generation projects add capacity to the system either to expand supply, to increase efficiency thereby reducing generation costs, or to improve the reliability of electricity supply. Power transmission projects link generation capacity with a distribution system, and distribution projects link the evacuated power from the grid to final users. Regional effects from power projects arise where they either allow power export in the region (through investment in either or both generation and transmission) or power import (through transmission investment). The complication over the allocation of benefits between countries arises because whilst financial revenue from the tariff charged in different countries will be known, the true economic value of sales may not equal the tariff and may differ between countries. Allocation of economic benefits from power export sales requires estimates of the economic value of power in different countries, as given by willingness to pay. Where power is traded between countries any difference between the export tariff and the economic value of power in the user country creates an external gain shared between power consumers in the importing country and the importing power company that is not reflected in the financial returns of the project.

The economic analysis of an export generation/transmission project must include the direct benefits of the sale of power given by the contracted export price (which is a national benefit) plus any surplus benefits received by consumers/importers in the importing country above the contracted export price. Similarly, the economic analysis of a transmission project which allows power imports must include both the benefits to domestic power users (which is a national benefit) plus the benefit to the exporting country, where there would be a surplus capacity for power generation without the demand from the regional importing country. Additional regional benefits will arise in an export generation project only where there is a consumer surplus in the regional importer country. Similarly, for a transmission project which allows power imports, regional benefits arise only if there is a producer surplus in the regional exporting country.

In the application of regional analysis, it is necessary to establish whether a power project creates either power exports to a regional partner or enables power imports from the region. If it is an export project the willingness to pay for power in the importing country should be estimated. Where this exceeds the tariff, there is a consumer surplus (or alternatively this surplus could be shared between the power importing company and consumers depending on the final retail price). If it is an import project (for example, a transmission line) the existence of surplus capacity in the exporting country should be assessed. If there is surplus capacity, the operating and distribution cost of moving the power to the point of export should be estimated. Where this is below the export price there is a producer surplus in the exporting country. Any regional benefits in the form of consumer and producer surplus in the neighboring country must be added to national benefits in the full analysis of the project.

3.2 Transport

Transport projects, covering road, rail, ports and airports, should provide direct benefits to users in terms of access to markets and services, lower travel time and cost, and improved comfort and safety. Transport projects bring benefits to the existing traffic, including that using the existing route in the absence of the project, and traffic on other routes and modes benefiting from traffic diversion as a result of the project. In addition, they can generate new traffic and related economic activity. The regional benefits of transport projects arise through the improved regional connectivity they offer through reductions in cost, time and convenience, sometimes combined with improvements in facilities at border crossing points to reduce transit time.

Benefit valuation largely based on savings in travel costs (principally travel time and vehicle operating cost) is the approach followed most commonly for road, rail, and port projects. Traffic surveys are necessary to establish the levels of traffic with and without a project and in principle for regional projects these can be extended to produce estimates of the country of origin of the traffic in order to allocate cost savings between countries. An empirically difficult question in the transport sector is always the extent to which vehicle, rail or ship operating cost savings are passed on to final consumers of the goods or people being transported. This is not a substantive issue when a project affects only one country, of which transporter and consumer are both residents. However, it may have significant regional distributional implications where transporters and consumers are residents of different participating countries. An answer to the question of how far cost reductions are passed on to consumers requires a judgment on the competitiveness of both the transport and the wholesale and retail trade sectors. In general, the expectation is that the more competitive a sector is the more likely will it be that cost reductions will be passed on. As a crude indicator the larger is the number of competing transporters (i.e., haulage firms or shipping companies) the more likely will it be that competitive pricing occurs within transport. However, this is an ambiguous indicator since there is' no minimum number that can be identified. Hence it is also useful to look at past pricing behavior to examine how freight rates or user charges have responded to previous cost changes, such as -those due to project improvements or events like fuel price rises. With an indication of the degree to which consumers as opposed to transporters or traders gain from project-induced cost reductions, estimates will then be required on the residence of the respective transporter, trader and consumer groups involved.

As far as regional cross-border transport projects are concerned a key issue is how far generated traffic and the induced trade and production created specifically by the cross-border dimension of the project can be estimated accurately. All road transport projects face the difficulty of separating normal traffic, which would have used a road or transport mode anyway, from diverted traffic, which shifts from other roads or transport modes, and generated traffic that results directly from the new project. A particular regional dimension arises because traffic can be generated not just because of a reduction in fares and vehicle and time costs, but also because previous obstacles to cross-border trade, in the form of lengthy customs procedures, are removed. Project analysis of national transport projects often uses conservative assumptions concerning generated traffic and in practice it is often approximated as a modest proportion (say, 10 per cent) of normal traffic. However, in the context of a cross-border road with national improvements on both sides of the border and a relaxation of border crossing procedures the expectation must be that there will be a significant effect on traffic and production. It is also possible that the reduction in economic distance between production centers in different countries creates cross border agglomeration effects leading to benefits in terms of higher productivity growth in the linked locations.

Transport projects which improve purely national routes which at some point in the future may be part of a regional network that crosses the border are often classed as regional projects. However, it is virtually impossible to assess how far such projects will contribute to higher regional traffic flows in the future since completion of the regional network will be dependent on other projects being undertaken at some point in the future. As isolating their regional impact is not feasible whilst they can be described as contributing to a potential regional network their benefits must be assessed on a national basis. Where the national route runs directly to the border it will be more plausible to expect a trade effect, but even here there may still be a dependence on other aspects of the network being in place. Hence, the extent to which the network will be completed over the life of the project under examination needs to be assessed before any cross-border effect can be attributed to the project.

Where it is judged that a transport project has an impact on regional trade leading to generated cross-border traffic as result of induced production there are two alternative approaches to benefit valuation. One treats the demand for transport as a derived demand arising from additional productive activity and assumes sufficiently competitive conditions in both transport and productive sectors for the willingness to pay for transport to match exactly the net additional income that use of a new transport facility creates for transport users. Therefore, as with national traffic flows this assumes the value of the journey to users is captured by their benefits in the transport market and can be approximated by half the unit savings in generalized travel cost with the project. Projection of transport flows is usually based on forecasts of GDP growth, with income elasticity of demand estimates for different types of travel. Sometimes price elasticity estimates are also introduced in combination with the change in generalized travel cost or perceived user cost to allow for generated traffic. This approach to transport benefits can be misleading where the pre-project traffic flow is low or non-existent and where a transport project creates a major change in time and costs. Under these circumstances, the alternative is to estimate benefits from generated traffic directly as the net income created in productive activities whose additional output is marketed as a result of the transport project.

3.2.1 Transport elasticity approach

In relation to regional transport projects, assuming there is already a significant level of cross border traffic to benefit from the project, application of the first approach requires estimates of transport elasticities for different regional transport flows. Here, the problem is to identify the component of regional traffic in total project traffic over the project’s life. This requires first separating total traffic into national and regional from traffic counts and surveys of the current position and then applying appropriate elasticities.

The approach for national projects can be summarized as follows:

 TNit+1 = Tit\*((1+g)\*y)

 where TN it+1 is normal traffic for vehicle type i in year t +1 and Tit is total traffic for vehicle type i in the base year t, g is the projected GDP growth between t and t +1 and y is the income elasticity of demand for travel by vehicle type i.

At some point, congestion can set in and reduce normal traffic but in the early stages of a project this is normally not an issue. Thus, with base traffic of a particular type at 1000 vehicles per day on average, and with a projected annual growth of 5% and an income elasticity of 1.2, projected normal traffic is 1060 (1060 =1000\*(1.05\*1.2).

Generated traffic arises through the impact on savings in cost and time that the project creates.

 TGit+1 = Tit\*((GTCit-1- GTCit)/GTCit)\*n))

 Where TGit+1 is generated traffic of vehicle type i in year t +1, Tit is base year traffic, GTCi is generalized travel cost (including time and vehicle operating costs) for vehicle type i and n is the price elasticity of demand for travel for vehicle type i.

As the benefits of a road project are expected to include lower user costs the expression (GTCit-1- GTCit)/GTCit is negative and when multiplied by a negative price elasticity n gives a positive number. Thus, with a price elasticity of -0.5 and a 20% reduction in GTC for a base traffic of 1000 vehicles per day generated traffic will be 100 (100 = 1000\*(-0.2\*-0.5)).

A simple expedient to modify this approach is to disaggregate the estimates of original traffic flows into national and regional traffic. The standard equations given above can then be applied to two different base year traffic flows – national and regional. Further, where possible different income and price elasticity parameters should be applied as it is likely that international trade flows will be more responsive than national goods movements to changes in GDP, vehicle costs and time savings.

Hence this requires estimating normal regional traffic as

 TNRit+1 = TRit\*((1+g)\*yr)

 Where, TNR is normal regional traffic, TRit is base year regional traffic and yr is the income elasticity for regional traffic flows.

Similarly, for regional generated traffic

 TGRit+1 = TRit\*((GTCit-1- GTCit)/GTCit)\*nr))

 Where, TGR is generated regional traffic, TRit is base year regional traffic and nr is price elasticity for regional traffic.

Once regional flows have been separated from national flows they can be valued in the same way at GTC savings for normal traffic and half GTC savings for generated traffic. The value of benefits for regional normal and generated traffic gives an estimate of the regional connectivity effect of the project. Which countries in the region receive these benefits would be difficult to establish as it will depend upon how the cost reductions for freight traffic are shared between vehicle operators and consumers, the ownership of the vehicles and the balance between exports and imports in the regional trade flows. Hence, it will be very difficult to conduct a full regional distributional analysis for most transport projects.

3.2.2 Estimates of induced production

As noted above this approach to regional benefits will not be appropriate where current regional traffic flows are low and a project offers a major change in time and costs. Here, applying elasticities to a very low baseline will be misleading. In such cases the alternative is to make direct estimates of the induced activity as a result of the project. In principle, what is required is to estimate the net economic value of any activity undertaken specifically as result of the transport project under appraisal. This is the per unit economic value minus all necessary costs of production plus all transport costs to the final market. Simply using an assumed value of additional exports or domestic production without netting out costs will greatly overstate benefits.

 Information to fully incorporate any induced regional production is rarely available. A detailed modelling exercise utilizing a Spatial Computable General Equilibrium Model is one option but such models are highly data-intensive and are rarely available for an individual project. Where there is a strong case that a transport project will create a regional benefit through induced additional investment in a neighboring country (for example, investment in a gold mine in response to a cross border road which allows the gold to be shipped to a port for export) the appropriate procedure is to include the induced investment and the associated benefits and operating costs in the appraisal of the original transport project. Thus, in the gold mine illustration the investment and operating costs of the mine must be added to the costs of the road and the benefits from the mine will be added to the other benefits arising from the road. However, large induced investments will be relatively rare and should only be treated in this way where it is clear that they would not have taken place without the original project. Where induced effects are judged likely but difficult to quantify these should be discussed and the linkages between the project and the anticipated induced activity explained clearly as an additional but unquantified benefit.

A very specific induced effect, which does not involve additional investment, can arise where a cross border economic corridor project connects two or more production centers in neighboring countries. In principle, this can create higher productivity through agglomeration effects as firms in one country become closer in economic terms to firms in another. The reduction in time and travel costs reduces the economic distance between these centers creating the possibility of agglomeration benefits in the various locations. These benefits arise through increased productivity per worker due to access to markets, suppliers, workers and similar firms. The scale of agglomeration can be captured in a measure of economic mass between the locations. For any one location affected by a transport project economic mass is measured by the level of economic activity in each location linked to the original location by the project weighted by the economic distance between the other locations and the original location. This approach has been applied largely to estimate the benefits through agglomeration from national transport projects however the logic applies equally where economic distance between production centers or clusters in neighboring countries is reduced by a regional project.

In the most common application of this approach the economic importance of locations is measured by employment (N) and economic distance by generalized transport cost (GTC). Hence for original location i linked with a series of other locations j by a project Economic Mass (EM) for location i is measured as

 EMi = Σdij.Nj

 Where dij is the economic distance between i and location j, Nj is employment in j, and summation is for all trips i to j.

The weight on location j is given by the inverse of the generalized transport cost between i and j, allowing for a decreasing impact of agglomeration on productivity as distance increases. Hence

 dij = 1/(GTCij)α.

 Where GTCij is generalized transport cost between i and j and α is a ‘distance decay’ parameter, reflecting the declining impact of agglomeration as distance from i rises.

A transport project will change economic mass by reducing GTCij (and depending on the model possibly also Nj). Therefore, EMi can be calculated with and without a project and the greater the difference the greater the potential impact on productivity through agglomeration effects. In principle EMi can be calculated for different transport modes and different sectors, although in practice aggregates are often used. Once the change in EM due to a project is estimated a relationship between EM and productivity growth taken from the research literature is applied to derive an estimate of the impact of the project connectivity on productivity in the locations linked by the project. If the change in EM occurs only once the growth in productivity will occur only once but can be assumed to stabilize at the higher level over the life of the project, so it remains a constant annual benefit.

If agglomeration benefits are present and the scale of agglomeration effects is approximated adequately by EM there should be a relationship between a change in EM and a change in productivity and this in turn implies a relationship between a change in GTC and productivity. Estimates of the elasticity of productivity with respect to economic mass are available from the research literature.[[7]](#footnote-7) Once these have been used to derive an estimate of the change in productivity due to a project agglomeration benefits can be approximated by the estimated productivity growth rate multiplied by the product of the numbers employed in i with the project and the average wage in i. This annual benefit figure for an individual year can be increased in real terms over time in line with whatever is assumed about the value of working time in the overall transport appraisal. Annual agglomeration benefits can then be added to annual user benefits estimated either on the basis of GTC or as induced production.

There is considerable uncertainty attached to calculations such as these given the fact that unique elasticities for a specific location are highly unlikely to be available. None the less they provide a means of deriving order of magnitude estimates for a possible regional effect from transport projects which are intended to create economic corridors to link production clusters in different countries. However, it will only be under clearly defined circumstances (that is where a direct link between production clusters is established) that cross-border agglomeration effects will be created and where such estimates have been made for national transport projects they tend to be low relative to overall benefits.

3.3 Trade facilitation

Trade facilitation projects aim to stimulate regional trade through harmonizing and streamlining procedures for export and import through, for example, the modernization of border crossing posts and the establishment of national single windows, which allow the processing of data on trade flows before they reach the border crossing. Economic analysis of such projects typically estimates benefits in terms of time and cost savings for governments (through higher staff productivity at border crossings), and vehicle operators (through time savings and lower working capital requirements as less goods are needed as working capital as they spend a shorter period in transit). These are largely national benefits.

Regional benefits can be expected through the impact of lower transit time on international cross border trade flows. Prediction of the extent to which there will be a rise in exports or imports as a result of such projects is extremely difficult. Procedures that delay goods at the border have a cost in terms of time that can be valued and is in principle equivalent to the cost imposed by an import tariff. The bulk of costs per unit will be composed of the cost of the time of vehicle operators and of administrative staff involved in pre-shipment processing, unless the goods are perishable in which case a proportion of lost output will create an additional cost. If estimates of the import elasticity of demand with respect to import tariffs are available these can be combined with the percentage reduction in estimated unit cost of a good due to a trade facilitation project to derive an approximate estimate of the impact of the project on trade. However, if this exercise is carried out the trade effect is likely to be slight because the costs saved by the project due to improved logistics will be a small proportion of the value of most goods, unless they are perishable. For example, if the import elasticity of demand is -0.8 (so a 10% fall in price due to a tariff reduction leads to an 8% rise in demand) but the reduction in unit cost due to trade logistics reform is 2% the impact on demand from a trade facilitation project will be only 1.6%.

The main regional effect of this type of trade facilitation will be in terms of creating an operating environment, where it is perceived that transit procedures are no longer an obstacle to trade with neighboring countries. This can encourage investment in export activities on both sides of a border. This type of induced trade effect will be very difficult to capture at the project level and will not be picked up in trade elasticity estimates. As in the case of road projects where it is judged that investment in a specific type of export activity will be expanded as result of the trade facilitation project the costs and benefits of this investment should be included in the appraisal of the original project. However, this will only be appropriate where there are strong grounds for assuming direct causation so that removal of the trade logistics barrier, as a result of the project, leads directly to the new investment, which would not otherwise occur. These circumstances will be relatively rare. In most instances for trade facilitation projects, it will be adequate to assess projects on the basis of national benefits and to describe possible regional effects through higher trade flows qualitatively. However, the qualitative discussion should identify clearly areas for potential specialization on both sides of a border and the extent to which there is the capacity to expand exports.

3.4 Education

Regional co-operation education projects normally involve co-operation in terms of higher education and research institutes to spread the fixed costs of university teaching and research across a number of countries. Economic benefits of education projects are typically based on a ‘human capital’ approach that values education on the basis of the higher productivity that additional years of education or research expenditure create. For education projects, higher productivity in turn is approximated by the incremental life-time earnings that arise from the education project with an adjustment for the possibility of periods of unemployment. It is recognized that this is potentially a crude means of capturing education benefits as in principle there will be external benefits not captured by the individual university or school graduates, in terms of the changes in innovation, health and social attitudes that arise in a better-educated society. These educational externalities are rarely incorporated in national analyses of economic education benefits and it is unrealistic to expect that they can be approximated in a meaningful way on a regional basis. However, for education projects a simple modification of existing practice can be used to approximate regional as opposed to national benefits.

The standard procedure, for example, for a project to set up or expand a university, is to estimate annual benefits B as

 B = (Yw\*Uw - Yo\*Uwo)\* (1-d)\*N

 Where Yw is discounted projected lifetime earnings before tax for a graduate and Ywo is discounted projected lifetime earnings before tax for a non-graduate, Uw and Uwo are unemployment rates with and without the project, d is the fail or non-graduation rate for those enrolled each year and N is the number of students enrolled each year as a result of the project.

A regional dimension can be added by disaggregating N into students in the country of location of the project and students from elsewhere in the region. This will require a survey of how far movement to study is taking place within the region. Where R refers to regional students, regional benefits (BR) are

 BR = (Yrw\*Uw – Yrwo\*Uwo)\*(1-d)\*R

Where are Yr refer to projected lifetime earnings for regional students some of which may not be earned in the original country in which the education project is located.

3.5 Health

Health projects can be conducted on a regional basis as a means of control for contagious diseases. Benefit valuation in the health sector can be controversial and a cost-effectiveness approach may need to be used rather than a standard benefit-cost calculation. Analysis of regional health projects requires either a demonstration that a regional approach offers a cost-effective alternative to separate national projects or that a regional approach offers higher benefits, if these can be quantified satisfactorily in economic terms. Health impacts in terms morbidity and mortality are typically quantified as Disability Adjusted Life Years. This approach has the advantage that it can be used to convert a diverse set of health outcomes into comparable units. Cost effectiveness analysis compares the cost per DALY saved with project costs. An economic rate of return analysis requires that the DALYs saved be given a monetary value per unit to create a benefit value.

There are different approaches to valuation of DALYs. One estimates their per unit value as the average costs of prevention by other means, which implicitly converts the analysis into a version of cost effectiveness. Another uses average GDP per head in the country of location or in some instances a multiple of average GDP per head, A third bases valuation on estimates of the ‘statistical value of life’ available for high income countries, which are then scaled for life expectancy in the reference country for which the estimate is made and for income differences between the reference country and the country of project location.

An appraisal of regional health projects must determine which approach to valuation to adopt. For practical purposes the same value should be attached to a DALY in each participating country. Once this decision is made an estimate of their distinct regional effect is required. For regional projects to control infectious disease the key will be to establish how far the populations of neighboring countries are at risk from epidemics in their neighbor. This will require data on the population at risk in border areas of the respective countries (P), estimates of annual disease incidence and morbidity and mortality rates without the project allowing for the probability of national and regional disease outbreaks (D), estimates of annual disease incidence and morbidity and mortality rates with the project applied on a solely national basis and therefore vulnerable to epidemics in neighboring countries (D1), and estimates of annual disease incidence and morbidity and mortality rates with the project applied regionally so all neighboring countries are covered (D2).

The net annual health effect with the project involving all neighboring countries is

 H = (P\*D - P\*D2)

 However, the regional effect due to joint regional-based efforts at disease control is

 HR = (P\*D1 - P\*D2)

 where HR is the net annual reduction in disease due to joint action by neighboring countries.

The national effect HN is

 HN = P\*D – PD1

 Since H = HR + HN

 H = (P\*D1 - P\*D2) + (P\*D – PD1) = (P\*D - P\*D2)

The regional benefit HR is part of the total benefits of the project and is not additional. It can be highlighted separately to demonstrate the regional benefits which the project has created. The change in disease impact must then be converted to DALYs and the selected economic value per unit of DALY gives the annual benefit figure. Given the importance of health projects for regional public goods Appendix 1 illustrates a regional analysis of a multi-country health project.

3.6 Environment

Environmental valuation is an important and difficult issue and often in practice a short-cut approach involves transferring values for such effects from one study site to another and applying these transferred values in a particular appraisal. Once a value can be identified some types of environmental effect may be easier to allocate between participating countries, than others. For example, regional watershed management projects may create a range of environmental benefits, including soil conservation and improved forest cover. There are two types of major impacts from soil conservation; on-site and off-site effects. On site benefits from soil conservation include incremental agricultural production and the net income from this is the normal measure of economic value. Since production will be from identifiable agricultural land it should not be difficult to allocate such benefits to farmers located in particular countries. Off- site impacts (eroded soil from one site will have an impact on water quality, flood levels or siltation at another site) will be more difficult to assess if they are distributed among several countries affected by a river-basin.

The treatment of improved forest cover is also complex in distributional terms. A significant part of the benefits of preserving forests is likely to be in the form of bio-diversity protection and carbon sequestration. Since removing CO2 from the atmosphere and protecting rare species are international effects, in principle, both will create benefits that affect countries and their residents well beyond a particular region. If carbon sequestration and CO2 emission reduction is valued at a standard price (ADB Guidelines 2017 recommends $36/ton at 2016 prices rising annually at 2%) a simple procedure for a regional project which reduces emissions is to allocate the value of the emissions reduction between the participating countries on a population basis on the grounds that all residents of the region will benefit equally. A considerably more sophisticated procedure, which may be required where such environmental effects are the main form of project benefit, is to mount contingent valuation surveys in the different countries involved to estimate willingness to pay for the preservation of particular environmental conditions. This would allow an estimate of willingness to pay per head of population in. the different countries and remove the need to rely on transferred values and a simple allocation on the basis of total population.

1. *Conclusions*

Valuation of regional benefits is essential for an appraisal of the impact of projects that create regional pubic goods. The level of difficulty of this exercise will vary between sectors as different sectors can involve different categories of regional public goods and pose different challenges for valuation of benefits. As noted at the outset health projects that curb the spread of a communicable disease or environmental projects that preserve a species or have their sole effect as emissions reduction global environmental protection are the clearest examples of a pure public good. All citizens benefit and there is no rivalry involved. Preservation of eco-systems and bio-diversity create joint products, both environmental protection, which is a pure public good and some forest and agricultural commodities, which are pure private goods. Transport and power projects are normally club goods as some form of charging will be possible, even though there may be externalities that are not captured in the price. Cross border trade facilitation is an impure public good because it is possible to exclude goods from non-participating countries.

The ability to at least approximate regional benefits will be important both to provide a justification for investment in the project concerned and in addition to assess the distribution of net benefits between participating countries. In principle if a regional ENPV is estimated it should be possible the estimate approximately how it is distributed between participating countries.[[8]](#footnote-8) Where more than one country is involved, it will be important to ensure there are adequate incentives for countries and their various stakeholders to participate in the project. Any major discrepancy between a country’s share in the costs of a project as compared with its share in the benefits can create an incentive issue and may need to be addressed by an MDB, or the governments concerned, by introducing appropriate compensatory measures.

**Appendix 1 MULTI-COUNTRY REGIONAL HEALTH SECURITY PROJECT**

**A. Project Development Objectives**

Health is a key regional pubic good since infectious disease can be transmitted readily across borders wherever there is movement of people and goods between countries. The GMS Health Security Project is a $132 million project to assist the governments of Cambodia, Lao PDR, Myanmar and Vietnam (CLMV) to strengthen systems for the control of communicable diseases that can have a major impact on the welfare of the region. The project is implemented specifically in the border areas of each country where the risk of transmission between countries is highest. Across the four countries 386 districts within 67 provinces are to be reached with an estimated total population of 31 million. The project is taken as having a 10 year operating life. It was appraised initially on a national basis with separate estimates of economic returns in each of the four countries. No regional dimension was incorporated into the analysis as the operation of the project in each country was treated in isolation from the activities under the project in the neighbouring countries. Given that the interdependence of communicable disease conditions in neighbouring countries provides the rationale for designing the project on a regional basis this is an inadequate approach. The case-study illustration demonstrates how with some additional assumptions (which would need to be tested in practice) benefits arising from the co-ordination of interventions under the project across the region can be estimated separately from benefits arising from project interventions within national borders.

**B. Project Outputs**

The project RRP defines three distinct project outputs

1. *Improved regional co-operation and disease control in the border areas*. Under this heading the project is to provide technical assistance and funding to improve exchange of information on disease conditions in each country and to strengthen their disease control strategies. Standard disease reporting procedures are to be followed and hospitals in the targeted border areas are to meet minimum national standards. Specific disease control campaigns are to be mounted in border areas as needed.
2. *Strengthened national disease surveillance and outbreak response systems*. Under this heading the project is to strengthen reporting at the community level and to improve the capacity to respond to disease outbreaks. It is to provide expertise for the design of reporting systems as well as hardware for screening and outbreak control, some of which can be used at border entry points.
3. *Improvement of laboratory services and hospital infection prevention and control.* The project is to ensure that laboratories and hospitals meet minimum standards, for example for sample testing and hygiene practices. The project is to do this through training, the provision of basic equipment and minor repairs to hospital wards.

The RRP contains a detailed economic analysis of the project which follows the procedures of the Guidelines (2017) with additional assumptions relating to health benefits. This analysis shows the returns from the project to each of the four CLMV countries, but does not separate a distinct regional effect. For comparability and in the absence of further information the reworking of the economic analysis here accepts all of the key values used in the original calculation but changes a few assumptions and reorganises the information on the project to show how an estimate of the project’s regional effect can be derived. This shows, as would be expected, that the returns to each country are far higher due to regional co-operation than if the same expenditure is made by each country acting independently.

**C. Economic Analysis**

The economic analysis uses a domestic price numeraire with a SERF of 1.1, which is assumed to be applicable for each of the CLMV countries. No labour market distortions are included so all labour CFs are 1.0. Project benefits in term of health improvements are assumed to last for 10 years after the implementation of the project. Benefit valuation in the health sector is complex and the treatment of the benefits arising from the three distinct project outputs is the critical aspect of the economic appraisal. These are discussed in turn.

Benefits from output 1) *Improved regional co-operation and disease control in the border areas.*

Project health effects from a set of infectious diseases (HIV, Tuberculosis, Dengue and Helminth) are expressed in terms of Disability Adjusted Life Years.[[9]](#footnote-9) Hence if the project reduces the incidence of each of these diseases (normally expressed as per 1000 of population) this allows an estimate of its quantitative heath impact. For use in an economic analysis a monetary value must be allocated to each DALY saved by a project. The original calculation uses the estimated income per capita of the population in the border areas of each country served by the project as the value of each DALY saved. This means that each year of life saved has a country-specific value. The derivation of an income per capita figure to use in this calculation is based on an adjusted average GDP per capita to allow for a lower average in the border areas of each country. The adjustment factors used are 0.78 (Cambodia), 0.82 (Lao PDR), 0.87 (Myanmar) and 0.78 (Vietnam).

The improvement in disease incidence due to the project is estimated by assuming that the gap between health status in the border areas and the national average will be reduced due to the project by 10% annually over the project’s 10 year life. Although described as ‘conservative’ this assumption is retained here for comparability. In the original analysis the calculation of DALYs saved is an approximation and is not the only way in which the analysis could have been conducted. Total DALYs from each of the four diseases without the project are taken from the WHO Burden of Disease data. An estimate is made of the difference in health status between border areas and the national average. This is done by comparing urban and rural areas in each country using an estimate of health conditions in rural areas as a proxy for health status in border areas. Average differences between urban and rural areas are used to derive a composite health index which is used to adjust the national average data to reflect conditions in the border areas. Table 1 shows the compilation of this indicator for each of the CLMV countries.

 **Table 1 Urban/Rural Indicators used in Composite Health Index**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Urban/Rural Indicators  |  |  |  |  |
|  | Cambodia | Lao PDR | Myanmar | Vietnam |
| Immunization coverage 1 year olds | 1.00 | 1.30 | 1.00 | 1.20 |
| At least I ante natal visit | 1.10 | 1.80 | 1.20 | 1.10 |
| Improved drinking water | 1.09 | 1.17 | 1.10 | 1.05 |
| Improved sanitation  | 2.22 | 1.38 | 1.09 | 1.24 |
| Composite index for border areas | 1.35 | 1.41 | 1.10 | 1.15 |

Source: RRP Appendix Economic and Financial Analysis, Table 2.

Benefits are taken to be a saving in DALYs from each disease set at 10% of the disease incidence created by a difference in health status between the national average and the border areas. These benefits (Bdjk) are estimated for disease j in country k as

 Bdjk = (DALYjkwo \* Hk \* 0.10) \* POPbk/POPtotk

DALYjkwo is the total disease burden in DALYs (per 1000) in country k created by disease j without the project (which rises annually with population growth), Hk is the composite health status index, POPbk is the population in border areas (districts) in country k ( in 1000s) and POPtotk is total population in k (in 1000s).[[10]](#footnote-10)

Benefits from the reduction in disease are then estimated as DALYs saved times income per capita in the border areas. This calculation is applied to districts served by the project. In addition, an arbitrary 5% is added to allow for disease reduction in a wider area covering the provinces in which the districts are located.

This calculation assumes that benefits in border districts can be calculated from a notional national benefit measured by the term in brackets which is then allocated to the border areas in proportion to their share of population. However, this procedure is questionable and a more accurate approach, if data had been available, would have been to estimate directly the disease incidence per 1000 population in the targeted border areas for each disease and to assume that the project reduces the incidence of disease in the border areas to either reach or approach the national level. Total benefits in the border areas would then be calculated as

 (DALYjkbwo  - DALYjkw)\* POPbk

where DALYjkbwo  is DALY per 1000 from disease j in country k in border areas without the project, DALYjkw is the national incidence of disease from j in k with the project and POPbk is the population in border areas in country k (in 1000s).

As the data is not available to make this estimate the original values for benefits are retained on the assumption that had this alternative approach been applied it would have created the same estimate in DALYs saved. Using these estimates for DALYs saved from output 1 and the estimated border average income figures gives the benefit figures by country shown in table 2. As infectious disease by definition can travel readily across borders, particularly as in this case across land borders, it is a reasonable assumption that most if not all of the disease incidence reduction assumed in the calculations would not occur without complementary prevention and control measures in neighbouring countries. The benefits from output 1 of the project can therefore be assumed to be regional benefits arising from co-operation and coordination of health systems in the CLMV countries. The first section of Table 2 gives the country results for regional benefits as present values at 9%.

**Table 2 Economic Benefits: Present values at 9%**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Output 1** | **Disease**  | **Cambodia $mill** | **Lao PDR $mill** | **Myanmar $mill** | **Vietnam $mill** |
| District level | HIV | 6.93 | 4.18 | 0.99 | 9.79 |
|  | TB | 7.95 | 10.28 | 1.60 | 7.29 |
|  | Dengue | 1.98 | 1.97 | 0.12 | 2.88 |
|  | Helminth | 0.23 | 4.19 | 0.40 | 14.29 |
| Provincial level  |  | 0.85 | 1.03 | 0.16 | 1.71 |
| Total output 1 |  | 17.94 | 21.67 | 3.27 | 35.98 |
| **Output 2**  |  |  |  |  |  |
| Provincial level | Epidemic prevention | 0.95 | 0.68 | 3.93 | 10.05 |
| Total Output 2 |  | 0.95 | 0.68 | 3.93 | 10.05 |
| **Output 3**  | Dengue testing  | 3.65 | 1.15 | 1.31 | 6.08 |
|  | Hospital improvements  | 6.79 | 3.57 | 2.25 | 26.76 |
| Total Output 3 |  | 10.44 | 4.72 | 3.56 | 32.84 |
| Project Total |  | 29.33 | 27.05 | 10.76 | 78.85 |
| Regional Benefits % |  | 61 | 80 | 30 | 46 |

Benefits from output 2: *Strengthened national disease surveillance and outbreak response systems*.

The benefits of output 2 are less directly regional in that they arise from improved community and hospital level practices and do not appear dependent on what is happening in neighbouring countries. Benefits are estimated as a reduction in the incidence of epidemics assumed to be attributable to improved surveillance combined with the estimated cost of epidemics. Benefits from this output (Bsr) are calculated from the expression

 Bsr = Prob \* Cost \* SR \* Eff \* Y

 Prob is the probably of a disease epidemic, Cost is the cost of an epidemic as percent of GDP, SR is the benefit of surveillance and response activities in reducing the risk of an epidemic, Eff is the assumed effectiveness of the project output 2 in improving surveillance and response and Y is total GDP (which is growing over time in line with a growth projection). All terms apart from Y are given as percentages, so that the project impact on GDP by reducing disease incidence is estimated.

The calculation is at an aggregate level not distinguishing between types of disease outbreak. Further it does not appear to take account of the activities of the project under output 1 in reducing the probability of a disease outbreak. To allow for this and to avoid the risk of double counting in the recalculation the probability of a major disease outbreak (Prob) is reduced from 8% to 5%. The other parameters used in the original analysis are retained. These are the cost of epidemics as a proportion of GDP (Cost) 3%, the impact of surveillance and response activities in reducing the risk of an epidemic (SR) 10%, and the effectiveness of the project output 2 in improving surveillance and response (5%). The resulting benefit estimates in present values at 9% are shown in the second section of table 2. These are treated as national benefits because the impact of complementary measures in neighbouring countries has already been allowed for in the calculation of benefits from output 1.

Benefits from output 3: *Improvement of laboratory services and hospital infection prevention and control.*

Benefits from improved laboratory testing and hospital practices are estimated on the basis of costs saved. Two specific benefit categories are identified. One is reduced cost of dengue infections due to improved laboratory testing and other is a reduction in inpatient hospital costs due to shorter stays. A total national figure for dengue infections is given for each country, although its source is not explained. Benefits from reduced dengue infections due to improved screening in country k (Bdk) are calculated as

 Bdk = (Cdk - Cdk \*(1- Eff))\*( POPbk/POPtotk)

where Cdk is the total cost of dengue infections in country k (shown as rising over time with population),Eff is the effectiveness of project output 3 in reducing these costs (which is taken as 10% in each country), POPbk is the population in border areas (districts) in country k (in 1000s) and POPtotk is total population in k (in 1000s).

Hence the benefits to the border areas are estimated as a proportion of the savings in total national benefits, with the proportion determined by their population share. As in the case of output 1 this is a questionable procedure because costs saved outside the border areas are ignored. Ideally cost saved from the project impact in the border areas should be specified directly based on infection and screening data from those areas. In the absence of such information the original data are used in the recalculation. In addition, the total national cost of dengue does not appear to include any allowance for the effect of the impact of output 1 and 2 of the project in the border areas. To allow for this approximately the original national costs associated with dengue outbreaks are reduced by 20% in each country. These benefits are treated as arising at the provincial rather than the district level in the border areas.

The second type of benefit under output 3 is the saving in hospital costs due to shorter patient stays due to improved practices. This is first calculated as the total national inpatient hospital cost (millions of bed days times the cost per bed day). A saving of 5% is then attributed to the project output 3 and this national saving is allocated to border areas on the basis of the population share. Hence benefits in the form of cost savings on bed days in country k (Bck) are calculated as

 Bdk  = (Dk \* Cdk \* S )\*(POPbk/POPtotk)

Where Dk is the number of bed days per year in country k, Cdk is the cost per bed day in k, S is the saving attributed to the project (5% in each country) and POPbk is the population in border areas (districts) in country k (in 1000s) and POPtotk is total population in k (in 1000s).

Again insofar as outputs 1 and 2 have an impact on bed days in the border areas this should be allowed for in the calculation. To allow for this cost savings from this aspect of output 3 have been scaled down by 20%.

Output 3 benefits from dengue screening and improved hospital practices in present values are shown in the third section of table 2. Because there has been an allowance made for the feedback effect from output 1 these are treated as national benefits that are not dependent on the actions of neighbouring countries.

**D. Results**

The revised economic analysis calculations are in table 3. Costs have been kept unchanged from the original analysis but benefits have been revised downwards as discussed above. Regional benefits are taken as arising only from output 1 with outputs 2 and 3 creating national benefits, after the effects of regional impact have been allowed for. Table 3 shows that regional benefits or spillovers are 61% of gross benefits for Cambodia, 80% for Lao PDR, 30% for Myanmar and 46% for Vietnam and 54% for the total project. The results show low project returns in Myanmar and very high returns in Lao PDR.[[11]](#footnote-11) Since the benefits in each country are inter-dependent if these results are accurate they would justify special financial support to the government of Myanmar to ensure that the project, which creates cross-border benefits for others, is continued despite its low return to the country itself. The strong regional effect – with over half of benefits dependent on complementary actions in neighbouring countries - is to be expected for this type of regional public good project.

 **Table 3 Economic Analysis Results Present Values at 9%**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | PV Total Benefitsa $ mill | PV Regional Benefits $ mill  | PV Costs $ mill | ENPV $ mill | EIRR % |
| Myanmar | 10.78 | 3.27 (30%) | 12.10 | -1.32 | 5 |
| Vietnam | 78.87 | 35.98 (46%) | 76.41 | 2.46 | 10 |
| Lao PDR | 27.07 | 21.67 (80%) | 11.75 | 15.32 | 58 |
| Cambodia | 29.35 | 17.94 (61%) | 21.01 | 8.34 | 22 |
| Total project | 146.07 | 78.82 (54%) | 121.27 | 24.80 | 15 |

Note: a) there is a slight discrepancy in the benefit values in this table and those in table 2 due to rounding.

1. Emeritus Professor of Development Economics, University of Bradford, UK. [↑](#footnote-ref-1)
2. This classification follows T, Sandler ‘ Demand and institutions for regional public goods’ in A, Estevadeordal. B, Franz and T, Nguyen (editors) *Regional Public Goods: from theory to practice*, IADB-ADB, Washington DC, 2004. [↑](#footnote-ref-2)
3. An overview of the issues is provided in R. Adhikari and J.Weiss “A methodological framework for the economic analysis of regional projects” in A Estevadeordal, B.Frantz and T.Nguyen (editors)*Regional Public Goods: from theory to practice*, IADB-ADB, Washington DC, 2004. [↑](#footnote-ref-3)
4. See ADB Guidelines for the Economic Analysis of Projects, ADB, 2017, Appendix 18. [↑](#footnote-ref-4)
5. See the analysis in M.Florio and S.Vignetti ‘Cost Benefit analysis traditions: the approach of EU regional policy’ in J.Weiss and D. Potts (editors) *Current Issues in Project Analysis for Development*, Edward Elgar, Cheltenham, 2014. [↑](#footnote-ref-5)
6. There have been attempts to infer a value for n from the progressive nature of the tax system as an indicator of government revealed preference for consumption at different levels of income. Use of this approach requires the strong assumptions of rationality in the tax system and it is not relevant in a regional context in the absence of common taxation. [↑](#footnote-ref-6)
7. Estimates for the UK suggest productivity parameters between 0.02 and 0.08, varying between sectors. 1.0 is broadly a midpoint value for α; see UK, Department for Transport, *Wider Impacts – Transport Analysis Guidance (TAG*), 2014 for further information. [↑](#footnote-ref-7)
8. There are a series of well established procedures for regional distribution analysis; these are illustrated in ADB *Guidelines for the Economic Analysis of Projects*, 2017, Appendix 15. [↑](#footnote-ref-8)
9. The DALY index allows for both mortality and morbidity effects and the age at which individuals are affected: see ADB *Handbook for the Economic Analysis of Health Sector Projects*, 2000. [↑](#footnote-ref-9)
10. In the RRP calculations a scaling factor varying between diseases is applied to the Bdjk result to reflect a judgement on the degree of effort involved in implementing change. A high factor (2.0) is applied in the case of dengue and a low factor (0.5) in the case of TB. [↑](#footnote-ref-10)
11. If 9% represents the cost of capital in Myanmar and benefits are captured accurately then with an economic internal rate of return of 5% this project would not be accepted. [↑](#footnote-ref-11)