

TRANSPORT NOTES

TRANSPORT ECONOMICS, POLICY AND POVERTY THEMATIC GROUP



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Notes on the Economic Evaluation of Transport Projects

In response to many requests for help in the application of both conventional cost benefit analysis in transport and addressing of the newer topics of interest, we have prepared a series of Economic Evaluation Notes that provide guidance on some of issues that have proven more difficult to deal with.

*The **Economic Evaluation Notes** are arranged in three groups. The first group (TRN-6 to TRN-10) provides **criteria** for selection a particular evaluation technique or approach; the second (TRN-11 to TRN-17) addresses the selection of values of various **inputs** to the evaluation, and the third (TRN-18 to TRN-26) deals with specific **problematic issues** in economic evaluation. The Notes are preceded by a **Framework** (TRN-5), that provides the context within which we use economic evaluation in the transport sector.*

The main text of most of the Notes was prepared for the Transport and Urban Development Department (TUDTR) of the World Bank by Peter Mackie, John Nellthorp and James Laird, at the Institute for Transport Studies (ITS), University of Leeds, UK (The draft text of Note 21 was prepared for ITS by I.T. Transport Ltd). TUDTR staff have made a few changes to the draft Notes as prepared by ITS.

The Notes will be revised periodically and we welcome comments on what changes become necessary. Suggestions for additional Notes or for changes or additions to existing Notes should be sent to rcarruthers@worldbank.org

EVALUATION OF PUBLIC SECTOR CONTRIBUTIONS TO PUBLIC-PRIVATE PARTNERSHIP PROJECTS

The World Bank view of the role of private and public sectors in the provision of transport infrastructure and services is described in TRN 1 (*Public and Private Roles in the Supply of Transport Infrastructure and Services, World Bank, 2004* [1]). TRN1 provides guidance on the diversity of options for public private collaboration in the transport sector, not only in the funding and provision of infrastructure but also in relation to transport services and other activities that were once considered as exclusively for the public sector.

The World Bank's Toolkit on Public-Private Options for highways (World Bank, 2001, [2] [<http://www.ppiaf.org/toolkits/ppphighways/index.htm>]) describes a Public-Private Partnership (PPP) as a sustained collaborative effort between the public sector and private enterprises to achieve a common objective – for example, a road infrastructure project – while they pursue their own individual interests. In a PPP each partner:

- ❑ shares in the design of the project;
- ❑ contributes a portion of the financial, managerial and technical resources needed to build and sometimes operate the project in accordance with each partner's comparative advantage, and;
- ❑ bears a share of the risks associated with the project and obtains a share of the benefits that the project creates.

The efficient design of PPP projects, the sources of benefits and costs, the incentive structure, risk allocation mechanisms and the basis for comparison with conventional public sector procurement are discussed in a very large international literature, to which the World Bank has contributed. Examples of the PPP experience in transport, including roads, railways and ports, can be found in World Bank publications Silva (2000) [3], Galenson and Thompson (1993) [4] and Peters (1995) [5].

For PPP projects, as for conventional public sector projects, it is usual to produce an economic appraisal which conforms to the principles set out in *TRN 5: Framework*. But for PPPs there is a further question:

“what is the basis for determining the appropriate financial contribution from the public sector”?

The Bank requires that any public sector contribution to a PPP project be analysed and justified in economic terms. This Note will set out the basis on which such an analysis could be made and the case presented.

PRINCIPLES FOR A PUBLIC SECTOR CONTRIBUTION

The general principles underlying the analysis are the following:

General principles:

- ❑ public contributions to PPP projects should be justified on the basis of **external benefits** from the project, **compared with the scenario where no public contribution is made.**
- ❑ these external benefits are benefits for the wider economy or society which will arise from the project, but which **will not be appropriated by the private partner in the contract;**
- ❑ by implication, the social welfare gain must be greater than the amount of public money invested multiplied by the **cost of public funds:**

$$W_{PC} - W_{NPC} \geq C_p * MCPF$$

We will go on to explain all of these principles and translate them into practical method. Note that these principles imply that two or more scenarios may need to be considered for comparison against the PPP project

- ❑ a scenario in which the project proceeds but with different design, capacity or pricing from the original PPP project;
- ❑ a scenario in which the project does not proceed in the absence of the public contribution.

In practice, a range of different reasons can be – and have been – put forward to explain public contributions to PPP projects, including the following:

- ❑ to pay for positive externalities, such as decongestion or improvements in environmental quality;
- ❑ to contribute to the cost of mitigating negative externalities, which private providers often have little incentive to take into account when designing the project;
- ❑ to secure network improvements necessary for economic development or other planning benefits, for which users are in the short term unable to pay.

These are considered one by one in Sections [2](#), [3](#) and [4](#).

CONTRIBUTIONS TO OBTAIN POSITIVE EXTERNALITIES

Decongestion

When a new transport link is introduced into the network, one of the effects it may have is a decongestion effect on competing links. In economic terms, these competing links are substitutes, although perhaps imperfect ones, for the new link. Typical examples include: the old primary road, when a new interurban highway is built; or traffic on street, when a metro is constructed. Congestion on these competing links is often part of the motivation for providing the project in the first place. And once the project is operational, there are often quantifiable benefits to users of these competing links, in the form of decongestion. A key component of decongestion benefits is usually travel time savings. Another common component is a reduction in vehicle operating costs. Both can be evaluated in the same way as any other time or cost savings in transport appraisal, using the rule-of-a-half (*TRN 5 Framework* and *TRN 11 Treatment of Induced Traffic*).

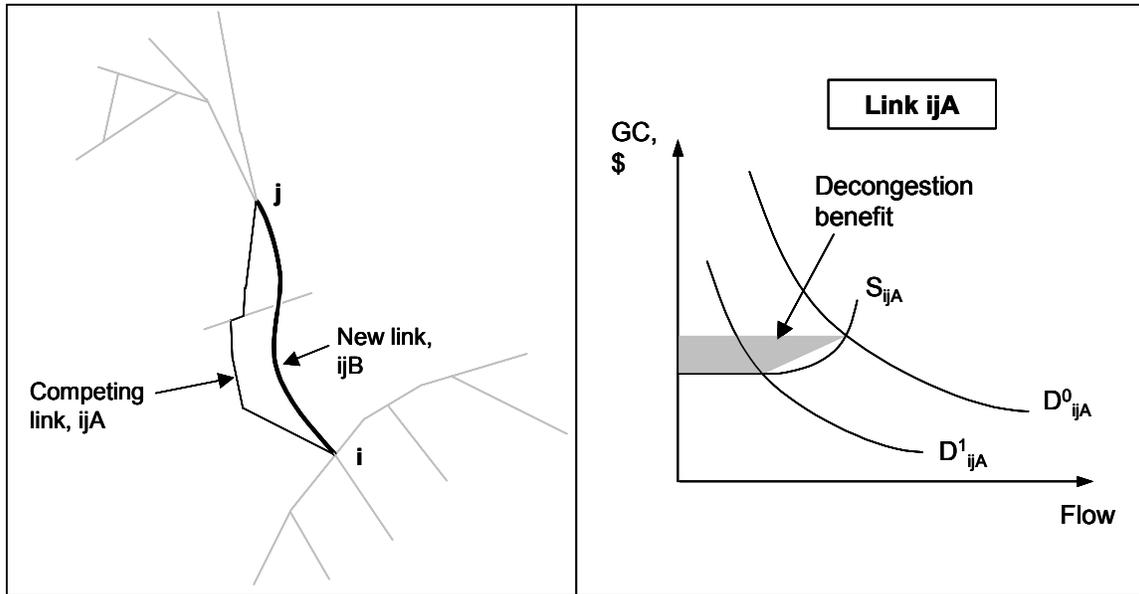


Figure 1. Decongestion in a Network

Unless the private sector partner is given control over the competing links as well, and the power to raise revenue from them, they will not be in a position to appropriate these decongestion benefits. What, then, should the public authority do?

If the project is financially sustainable for the private partner anyway, then the external decongestion benefits are not an issue. The private partner will secure their reward, and the citizens will take the decongestion benefit. There is no need for a public sector contribution.

However, if the project is marginal for the private partner, there may be a case for the public authority to contribute in respect of decongestion benefits provided. In this case, the relevant economic analysis is:

- ❑ an assessment of the total decongestion benefits on competing links, based on the usual transport appraisal principles and method;
- ❑ an assessment of the social opportunity cost of the proposed public sector contribution;
- ❑ a comparison, through the usual NPV and IRR procedures of the benefits against the costs of the public contribution (see *TRN 6: When and How to Use NPV, IRR and Adjusted IRR*).

Environmental Quality Improvements

Another category of potential benefits external to the project is environmental quality improvements. Two common investments are:

- ❑ **bypasses.** There may be significant gains in environmental quality in a settlement when facilities are built to take through traffic away from it on a bypass. These benefits are measurable: noise, air quality and severance are all key indicators and the World Bank's guidance on environmental assessment shows how to predict them.
- ❑ **low-emission public transport in cities.** Electric light rail, metro, even heavy rail, and low-emission buses can all contribute to reducing emissions and improving air quality in cities.

As discussed in the *TRN 17: Treatment of Environmental Impacts*, these benefits, whilst measurable, are not always monetised in appraisals for a variety of reasons. In the case that they are not monetised, the approach should be to: set out clearly the benefits in quantitative terms; and calculate the opportunity cost of the public contribution (see Section 5). This will enable the cost-effectiveness of the public contribution to be assessed (see *TRN 6: Where to Use Cost Effectiveness Techniques Rather than Cost Benefit Analysis*).

As with decongestion, there should be no presumption that public sector contributions are needed. The aim of the analysis should be to establish what additional benefits the contribution secures, over a scenario without the contribution.

Contributions to Mitigate Negative Externalities

For some projects, governments do agree to meet the cost of mitigating potential environmental externalities. By mitigation, we mean for example: noise barriers to minimise the effect of transport links on adjacent settlements, measures to minimise the severance effects of new infrastructure, and measures to compensate in kind for any damage to ecology – for example, by creating replacement habitats away from the new transport facility.

Public authorities need to be very aware of the incentive effects of such offers, on the private providers of schemes. For example, if a public authority states its intention to meet the additional costs of environmental mitigation, a principal-agent problem arises, because a lot of the variables which determine the size of environmental mitigation costs are in the hands of the private provider. For example, there may be an incentive to run the scheme closer to sensitive areas if that reduces the cost to the provider for a given level of revenue, whilst incidentally raising the cost of the scheme to the public purse Baumol and Oates (1988) ^[6].

Many countries deal with this by controlling environmental impact not through state-funded mitigation, but through environmental impact regulations with legal status. The incentives are then internalised within the private provider to find the lowest cost (or most profitable) way of delivering the project without infringing the agreed standards.

The latter may be a more efficient way of proceeding, from the country's point of view. Any appraisal of the alternatives should consider:

- ❑ the extent to which the aims of environmental protection are met;
- ❑ the cost to the public sector budget (see Section 5).

CONTRIBUTIONS TO COMPENSATE PRIVATE PARTNERS FOR USERS' INABILITY TO PAY

A further possible basis for public contribution is that a project may create wider economic impacts at the regional or national level which cannot be internalised by the private partner. Caution against accepting such arguments uncritically should be exercised (see the SACTRA (1999) ^[7] for a comprehensive review). However, where the case for wider economic impacts additional to the user and operator benefits is sustained, it may be that charging full commercial tolls for the use of the facility in the early years (before incomes have risen) risks jeopardising that growth - and the use of the facility.

The Hungarian M1 and M5 'motorway cross' is an example of this phenomenon in action. The citizens' ability to pay was not high enough to meet the tolls on the new roads, so long-distance traffic continued to use the conventional road network, whilst the motorways operated far below capacity – and 45% lower than forecasts – with serious financial implications for the concessionaire (see Silva (2000) [3]).

The underlying problem concerns the time profile of the costs vs. that of the benefits. The government regards the project as a 'necessary' condition for growth of the economy in the medium to long term. Meanwhile, the private investor wishes to see their commercial return over a short to medium term horizon. In effect, the government may find itself wishing to subsidise provision of the infrastructure in the short term in order to secure a longer term gain in productivity and GDP per capita.

Deferment of the project should of course be considered (see *TRN 6 When and How to Use NPV, IRR and Adjusted IRR*). But if there is no case for this, then the government may want to consider – and appraise – a public sector contribution.

In this case, it might be an explicit part of the contract that the state will taper the subsidy away to zero over a stated period, say 10 years.

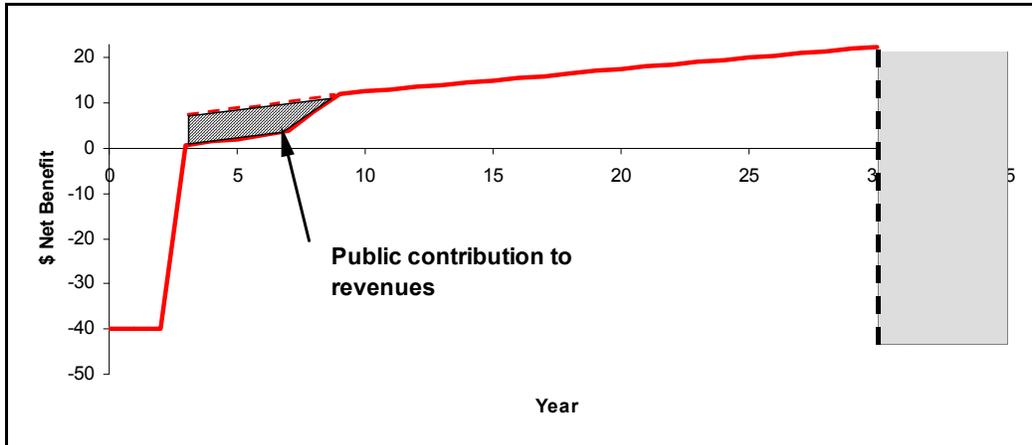


Figure 2. Compensating the Provider for Users' Short-Term Inability to Pay

In making the case for public contributions, the essential steps are:

- ❑ to consider the alternatives, including: allowing the private partner to raise revenue from the existing network in the early years to improve their cash flow [see (see Silva (2000) [3]); scaling down the project to a lower-cost solution; postponing the project until demand has grown sufficiently; or removing any constraints on commercial pricing of the new facility.

IF those are shown to be ineffective in meeting the country's development needs, then proceed:

- ❑ to set out the demand forecasts for the alternative toll/pricing scenarios in the early years;
- ❑ to calculate the corresponding consumer surplus benefits for users in each scenario;
- ❑ to determine the Marginal Cost of Public Funds (MCPF) for the country concerned World Bank (1998) ^[8], and use this to estimate the opportunity cost of the public contribution;
- ❑ to carry out an incremental IRR calculation (see *TRN 6 When and How to Use NPV, IRR and Adjusted IRR*) including the additional user benefits in the scenario 'with public contribution' versus 'without public contribution', and the stream of public contributions at opportunity cost.

Cases where a Public Contribution may be Difficult to Justify

In cases where the project is designed to relieve chronic congestion or crowding on an existing network, it is not appropriate to assume that public contributions are the best way to obtain these benefits. Instead, the aim should be to find ways for the new infrastructure to be paid for by its users, in this way securing the means to manage the future use of the resource effectively. This is discussed further in *TRN 23 Evaluation Implications of Sub-Optimal Pricing* (see Sections 1 and 3). Of course, there are counterarguments, including the 'decongestion and environmental benefits' case outlined in Section 2 above. Whatever case is put, appropriate supporting evidence should be provided, in line with the guidance in these Evaluation Notes.

CALCULATING THE IRR OF PUBLIC CONTRIBUTIONS

The first step is to monetise the stream of incremental external benefits as usual (see *TRN 6 When and How to Use NPV, IRR and Adjusted IRR*). These should be set against the stream of public contributions, multiplied by the MCPF. Calculate an IRR or NPV in the usual way. This is the IRR or NPV of the public contribution.

[Example 1](#) represents a situation where the project would not go ahead without a public contribution, as a consequence of the marginal commercial return available from it. With a public contribution, however, the project is found to be financially sustainable for the private partner. The question arises: what is the case for the public intervention? In this example, analysis has identified that there are decongestion benefits from the project which are not appropriated by the private partner.

Example 1. Public Contribution to Secure non-User Benefits

Year	Demand forecast, M trips WITH public contribution, (a)	Public contribution to private partner, \$M (b)	External benefit to non-users (eg. decongestion) WITH public contribution, \$M (c)	External benefit to non-users (eg. decongestion) WITHOUT public contribution \$M (d)	Opportunity cost of public sector contribution (e) = (b)*MCPF, \$M	Net benefit (undiscounted) (f) = (c)-(d)-(e), \$M
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	1.8	0.4	0.9	0	0.5	0.4
2007	2.2	0.5	1.0	0	0.7	0.3
2008	2.5	0.6	1.1	0	0.8	0.3
2009	2.5	0.6	1.2	0	0.8	0.4
2010	2.6	0.6	1.3	0	0.8	0.5
2011	2.8	0.7	1.5	0	0.9	0.6
2012	3.1	0.8	1.6	0	1.0	0.6
2013	3.4	0.8	1.7	0	1.0	0.7
2014	3.6	0.9	1.6	0	1.2	0.4
2015	3.7	0.9	1.5	0	1.2	0.3
2016	3.8	1.0	1.4	0	1.3	0.1
2017	3.9	0.9	1.2	0	1.2	0
2018	4.0	0.8	1.1	0	1.1	0
Net Present Value @ 12%						2.2

Example 2. Public Contribution to Compensate the Provider for Users' Short-Term Inability to Pay

Year	Price structure WITH public contribution	Demand forecast, M trips (a)	WITHOUT public contribution: project does not go ahead	External benefit to users (consumers surplus) WITH public contribution, \$M (c)	External benefit to users (consumers surplus) WITHOUT public contribution \$M (d)	Public sector contribution, \$M (e)	Opportunity cost of public sector contribution (f) = (d)*MCPF, \$M	Net benefit (undiscounted) (g) = (c)-(d)-(f), \$M
2004	n/a	0	n/a	0	0	0	0	0
2005	n/a	0	n/a	0	0	0	0	0
2006	Low	1.8	n/a	1.1	0	2.0	2.6	-1.5
2007	Low	2.2	n/a	1.3	0	2.4	3.1	-1.8
2008	Low	2.5	n/a	1.6	0	2.8	3.6	-2.0
2009	Standard	2.5	n/a	0.7	0	0	0	0.7
2010	Standard	2.6	n/a	1.1	0	0	0	1.1
2011	Standard	2.8	n/a	1.3	0	0	0	1.3
2012	Standard	3.1	n/a	1.5	0	0	0	1.5
2013	Standard	3.4	n/a	1.7	0	0	0	1.7
2014	Standard	3.6	n/a	1.9	0	0	0	1.9
2015	Standard	3.7	n/a	2.1	0	0	0	2.1
2016	Standard	3.8	n/a	2.3	0	0	0	2.3
2017	Standard	3.9	n/a	2.5	0	0	0	2.5
2018	Standard	4.0	n/a	2.7	0	0	0	2.7
Internal Rate of Return (IRR)								20%

The economic analysis shows that the present value of the external benefits gained exceeds the present value of opportunity costs for the public contribution. Therefore the contribution is acceptable. Whether it is the best level of contribution cannot be determined from this analysis. However, in negotiating with the private partner, the government will use the tools at its disposal to secure the best possible deal for the public. Hence the government will:

- ❑ seek to use competitive tendering processes to bid down the level of public contribution required to its lowest possible level, or to eliminate it or even secure positive payments from the private partner;
- ❑ have its own auditors working on the project, including assessing its financial viability, so that tenders can be assessed against a benchmark level of financial performance.

In [Example 2](#), again the project would not go ahead without a public contribution, as a consequence of the marginal commercial return available from it. In this example, analysis has identified that there are user benefits from the project which cannot feasibly be appropriated by the private partner because of the limited ability to pay among businesses, citizens and government, in the early years – as in the case of the Hungarian M1 and M5. With a view to the stream of medium to long term benefits from the project, the government considers the case for a public contribution during the first three years of operation, to compensate the operator for the poor revenue stream over this crucial period. The analysis shows that the IRR from these contributions is 20% - sufficient to pass the test of acceptability.

Again, however, this does not demonstrate that the level of contributions chosen or the price structure agreed upon are optimal. In assessing whether better value for money could be obtained with a variation of this basic solution, the government's analysts should certainly consider:

- ❑ the price elasticity of demand (PE_d) in the early years, hence the response of the demand forecasts to different levels of price;
- ❑ the impact on revenues (if $PE_d > 1$, then a further price reduction will bring in an increase in revenue, and vice versa);
- ❑ the consumer surplus gain from each of these options (which will increase as price falls) versus the opportunity cost of the public contribution (which will start rising once PE_d falls below 1).

In the case of [Section 2\(ii\)](#) and [3](#), if the external benefits of environmental externalities are not being monetised, the use of cost-effectiveness analysis is appropriate. In such situations the analyst should estimate what is the social opportunity cost of each unit of environmental improvement (=cost to public sector * MCPF). For example, what is the social cost per unit of air pollution saved, or for a habitat protected.

Finally, remember that the analysis described in this Note is additional to the standard NPV or IRR calculation, and the standard presentation of costs and benefits by impact group (see *TRN 5: Framework* Section 4 (Reporting the CBA). That analysis will include the costs and benefits for the private partner, as well as the users, non-users and government. The purpose of this analysis has been to focus more closely on the government's contribution, to ensure that the economic case for it is clear and robust.

FURTHER READING

[1] The World Bank (2004), *Transport Note 1, Public and Private Sector Roles in the Supply of Transport Infrastructure and Services*, The World Bank, Washington DC.

[Also available online at http://siteresources.worldbank.org/INTTRANSPORT/214578-1099319223335/20273720/tp-1_pp-roles.pdf]

[2] The World Bank (2001), *Public-Private Options for Developing, Operating, and Maintaining Highways: A Toolkit for Policymakers*. The World Bank, Washington DC. [Also available online at <http://www.ppiaf.org/toolkits/ppphighways/index.htm>]

[3] Silva GF (2000), *Toll Roads – Recent Trends in Private Participation*, Public Policy for the Private Sector Note Number 224. The World Bank, Washington, DC.
[Also available online at <http://www1.worldbank.org/viewpoint/HTMLNotes/224/224Silva-1211.pdf>]

[4] Galenson A and Thompson LS (1993), *Forms of Private Sector Participation in Railways*, Infrastructure Note Transport No. RW-5. The World Bank, Washington, DC. [Also available online at <http://www.worldbank.org/transport/publicat/td-rw5.htm>]

[5] Peters HJ (1995), *Private Sector Involvement in East and Southeast Asian Ports - An Overview of Contractual Arrangements*, Infrastructure Note Transport No. PS-10, Washington, DC. [Also available online at <http://www.worldbank.org/transport/publicat/td-ps10.htm>]

[6] Or: Sommer D (1999), *Private Participation in Port Facilities – Recent Trends*, Public Policy for the Private Sector Note Number 193. The World Bank, Washington, DC

[7] Baumol WJ and Oates WE (1988), *Economics of Environmental Policy*, 2nd edition. Cambridge, Cambridge University Press.

[8] Standing Advisory Committee on Trunk Road Assessment (SACTRA) (1999), *Transport and the Economy*. The Stationery Office, London. [Available online at: http://www.dft.gov.uk/stellent/groups/dft_control/documents/contentservertemplate/dft_index.hcst?n=7944&l=2]

[9] World Bank (1998), *Handbook on Economic Analysis of Investment Operations*, Technical Annex, Paragraphs on MCPF, The World Bank, Washington, DC, USA. [Available online at: <http://www.worldbank.org/education/economicssed/project/projwork/Handbook.pdf>]