TOPIC 13
PUBLIC SECTOR
PERFORMANCE

THE LIMITS OF SOCIAL COST-BENEFIT ANALYSIS FOR THE APPRAISAL OF PUBLIC INVESTMENT IN TRANSPORT INFRASTRUCTURE

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Abstract

This paper discusses the use of Social Cost-Benefit Analysis (SCBA) for the appraisal of public investment projects in transport infrastructure. The findings are based on an evaluation of 12 elaborate SCBA studies, mainly for major investment projects in Benelux port infrastructure. A number of theoretical limitations and major practical problems apparent in the post-evaluation are discussed. The relevance of SCBA for public decision making processes is examined. It suggests a more comprehensive socio-economic appraisal methodology.

INTRODUCTION

The concern for social efficiency and the optimal allocation of public resources constitutes the basis for formal public investment appraisal. In this context, welfare economics and its application through Social Cost-Benefit Analysis (SCBA) can play an important role. SCBA has been used by public decision-makers in many countries throughout the world. However, its foundations have been criticized from various perspectives (Sen (1970), Self (1975), Pearce and Nash (1981), Blackbory and Donaldson (1991), Gillroy (1992), Hanley and Spash (1993)). The second section briefly describes the theoretical foundations and inherent limitations of SCBA. The practical limitations and the implications of a number of controversies regarding the theory of SCBA are examined in the section that follows. In an era of limited public resources and increased attention to external effects public policy makers increasingly take into account the creation of employment and back-flows to government, as well as environmental impacts of important projects. These issues are discussed in in the final section where the relevance of SCBA results for public investment policy is examined.

THEORETICAL FOUNDATIONS AND LIMITATIONS OF SCBA

Pareto optimum

Paretian welfare economics constitutes the basis of any SCBA. The concept of welfare has received an explicit definition which, obviously, is not free from value judgements (Pearce and Nash (1981)). The purpose of a SCBA is to measure a project's contribution to the economic welfare of a community. A project is considered efficient when a *potential* Pareto improvement is obtained (based on the Hicks-Kaldor compensation test) (Dasgupta and Pearce (1972), Anderson and Settle (1979), Pearce and Nash (1981), Boadway and Bruce (1984), Ray (1984)). This implies that the benefits of the winners are sufficient to compensate the losers. Should this compensation actually take place, it would be a real Pareto improvement. However with SCBA it does not matter who benefits, only that the net welfare benefits exceed the losses (Gilroy (1992)). The prevailing income distribution is considered to be acceptable and real redistribution of income is not taken into account. In practice, this last element may be of little importance as the lack of a sound empirical function of marginal income utility prevents a correct appraisal and because the problem of income redistribution in industrialised countries is often regarded as irrelevant (ECMT (1992)). This implies, inter alia, that regional transfers can not be taken into account at this stage of the appraisal.

Willingness to pay

The measurement of costs and benefits is based on the concept of willingness to pay (WTP). It means that all projects with a strict positive net present value (NPV) are acceptable and should be executed. In theory, there should be no budget restriction at all, since SCBA has measured real willingness to pay on the part of the consumers. If government were short of funds, it should increase taxes, which, in theory, would not be rejected by the citizens (or their parliamentary representatives) because they revealed their real WTP. In practice, however, citizens may oppose tax increases. Thus, the WTP concept remains very controversial.

The WTP concept also supposes the acceptance of the value judgement that individual preferences should prevail. This implies that the individuals know what is good for them. In reality however, there seems to be a very high WTP for eg narcotics, as opposed to a very low WTP for eg education (Anderson and Settle (1979)). Thus, ignorance and a neglect of long term effects may, to a certain extent, undermine the WTP concept.

Compensation

When all the effects on economic welfare have been estimated and monetised, the overall result, eg the NPV, can be computed. This gives an answer to the question of return in terms of social surplus as a straightforward application of welfare economics. An unlimited compensation can take place between costs and benefits, which is characteristic for any conventional aggregation procedure. For example, any deterioration of the environment or any decrease in safety can always be outweighed by consumption, as long as the amount is sufficiently large. However, such compensation may be unacceptable, from a public policy maker's point of view. Any appraisal methodology that aims to be relevant for public policy makers should therefore have built-in mechanisms to avoid unacceptable compensation.

The optimal social discount rate

As the NPV is often very sensitive to modifications in the discount rate, the choice of an appropriate rate of discount is of crucial importance. In the academic literature, the discussion on an appropriate discount rate, which govemment should use for the appraisal of public investment projects is still going on (Sen (1967), Baumol (1968), Bradford (1975), Lind (1982), Quik and Terasawa (1991), Pearce et al. (1990), Nijkamp and Rouwendal (1988)). Since arguments in favour of particular discount rates are based upon a variety of perspectives ranging from purely theoretical economic considerations to specific ethical and philosophical concepts, the choice of an optimal social discount rate appears to be much more complex than the selection of a financial rate of return (Warr and Wright (1981), Paelinck et al. (1981), Bentcover et al. (1986), Glazer (1989).

PRACTICAL LIMITATIONS OF SCBA AS REGARDS TRANSPORT INFRASTRUCTURE PROJECTS

Research sample

In practice, there are many discussion points that make the application of a generalized method of SCBA very difficult. Our findings as regards the application of SCBA are based on a comparative study of 12 SCBAs for major transport infrastructure projects (seaport infrastructure and inland waterways) in the Benelux over a period from 1975 to 1991 (Winkelmans et al. 1992). The list of projects can be found in Appendix.

The relevant community

Determining the geographic scope of a project implicitly reflects what will be included as benefits and costs (Wohl and Hendrickson 1984). When a SCBA is performed using a regional perspective, this may lead to additional problems, because it is often difficult to determine which benefits and/or costs accrue to the regional community, eg profits made by companies owned by foreign multinational firms, may be repatriated to the mother companies' home country. In contrast, the adoption of an international point of view implies that interregional and even intemational transfers of traffic, employment, etc. have no impact on the outcome. Therefore, an explicit determination of the geographic scope is crucial for a correct interpretation of the results of a SCBA. However, in practice an explicit determination of the geographic scope was found in only nine of the twelve SCBAs.

The importance of forecasting

The reliability of the outcome of any public project appraisal depends primarily on the quality of the (traffic) forecasts. Sound forecasts require at least some form of prospective market research.

The nature of the project will obviously determine the nature of the forecasts required. Often highly specialised knowledge of the sector involved is indispensable but, unfortunately out of reach for SCBA analysts. In addition, in order to guarantee objectivity, the market research and the forecasting should be executed by independent experts. This was not the case for all studies involved. Moreover, in a number of studies, assumptions were made about future traffic, without mentioning the source of the information or the underlying rationale.

Externalities: environmental and safety issues

The problem of quantifying external effects was often left to policy makers, given the political sensitivity associated with the choice of specific monetary values to quantify external effects. Especially the problem of unlimited compensation in SCBA constitutes a major problem here. In addition, discounting long-term (strategic) environmental effects and viewing them merely as a component of overall streams of costs and benefits, may implicitly reduce their importance. The view adopted in this paper is to include only the monetary and near monetary effects in the SCBA and to take into account other elements through eg an Environmental Impact Assessment (EIA), which should then in a later stage of the analysis be integrated with the SCBA.

A similar approach can be used for safety implications in particular. Especially monetising injuries and fatalities has been a sensitive issue. For example, the value of human life differs strongly in function of the underlying derivation method. In Belgium, Lesceu (1991) derived a value of life of 42,262,000 BEF through a *stated preference* method based on Lee Jones, whereas other authors arrived at a WTP of 205,500,000 BEF by comparing wage differences between safe and dangerous labour, ie a *revealed preference* method.

Values of life and health as used in SCBA also vary between countries. Table 1 illustrates the enormous disparities that exist among a number of European countries. The value of a human life in Greece is estimated at 48,879 ECU, whereas in Finland it is valued at 1,414,200 ECU. Does this mean that a Finnish citizen is worth approximately 29 times more than a Greek citizen?

Table 1 Accident costs per person expressed in 1990 ECU

Country	Value per Fatality (in ECU)	Value per serious injury (in ECU)	Value per light injury (in ECU)	Original Value Year[a]
Denmark	628,147	...	...	1990
France	269,129	24,390	1,598	1985
Germany	406,672	43,611	4,089	1985
Greece[b]	48,879	6,429	656	1987
Portugal	78,230	6,543	475	1990
Spain[c]	100,529	25,519	...	1990
United Kingdom	935,149	26,357	529	1988
Finland[d]	1,414,200	897,081	9,473	1990
Sweden	984,940	139,755	9,370	1990

Notes:

a: Original Value Year refers to the date that the country value in question was most recently revised.
b: The Greek values represent study findings and cannot be regarded as "Official values".
c: The Spanish value quoted for a serious injury is actually used for a "casualty" in the Spanish framework.
d: The Finnish values quoted for serious and slight injuries are actually used for permanent and temporary disabilities in the Finnish framework.

Source: Amison et al. (1992).

If SCBA included such obviously arbitrary values, it could be argued that this would improve neither the credibility of SCBA, nor the evaluation of external effects. Therefore, the authors of this paper suggest to avoid a debate on correct monetary values by including in the SCBA only those externalities that have an unambiguous monetary value. The other external effects would

then be taken into account separately, in a different part of the appraisal and expressed in non monetary terms.

Employment effects

To the extent that wages do not reflect the marginal product value of labour, the cost component needs to be adjusted (Anderson and Settle 1979). In economic systems faced with high unemployment figures, as is the case in many European countries today, the opportunity cost of drawing labour from the ranks of the unemployed equals the value of the leisure time (VLT) foregone. While some experts argue that VLT equals zero (Hemschoote et al. (1987)), others believe that VLT equals the amount which is necessary to convince an unemployed worker to get hired and still others are convinced that VLT should be determined for each individual separately. Once the problem of estimating the VLT has been resolved, a second problem emerges, namely the estimation of the percentage of the workers employed by the project that would have been unemployed otherwise. In practice, different interpretations of these issues have resulted in a wide range of correction factors.

The repercussions of this effect are substantial as they include corrections of all wage costs, and often of the wage component in material costs too. Considerable discrepancies were found at three levels in the SCBAs studied. Firstly, in the estimation of the percentage of the incremental demand for labour that will be drawn from otherwise unemployed resources. Secondly, in the estimation of the value of leisure time or the shadow wages of the unemployed. Thirdly, in the way the effect was included in the SCBA (as a negative cost or as a benefit).

The various approaches used in these SCBAs are explained in detail below. The correction factors used in these approaches are presented in Table 2. In this table, the correction is represented as a positive benefit, but in practice some analysts made this correction as a negative cost. Although this inclusion as a cost or a benefit is in itself unimportant when calculating the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Profitability Index (PI), it is of considerable importance for the calculation of Benefit-Cost ratios (B/C).

Approach 1: *One part of the workers employed by the project is assumed to be drawn from the ranks of the unemployed, the other part is not. The VLT of the former is valued at 60 % of the wages.*

As regards the category of workers that would have been unemployed without the project, the value of leisure time is estimated at 60 % of the wages. Hence, the benefit, for this category of workers, equals 40 % of the wages (0.4W). As regards the category of workers that are not drawn from the ranks of the unemployed, the real cost equals the wages paid. As far as this category of workers is concerned, the benefit due to creation of employment is zero (0W). The average of both categories is taken into account as final correction factor at the benefit side ((0.4W+0W)/2=0.2W). This implies that 50 % of the workers are assumed to be drawn from the ranks of the unemployed.

Approach 2: *The value of leisure time and the part of the workers that is assumed to be drawn from the ranks of the unemployed are calculated explicitly for each project.*

With this approach the value of leisure time is calculated as the average of two hypothetical values: VLT = 0 and VLT = net wages - unemployment pay (=0.17W). Hence, the benefit of drawing workers from the ranks of the unemployed equals (W+0.83W)/2. A Dutch application of the reaction function developed by Haveman and Krutilla (1968) underlies the assumption that 97 % of the workers would have been unemployed without the project. Hence the final benefit that should be taken into account as correction factor equals 0.97(W+0.83W)2=0.89W.

Approach 3: The value of leisure time is assumed to be zero. One part of workers is assumed to be drawn from the ranks of the unemployed, the other part is not.

The value of leisure time is assumed to be zero (no explanations were given). Hence, the opportunity cost of the unemployed is zero. Eighty % of the workers employed by the project is assumed to be drawn from the ranks of the unemployed. The correction factor that is taken into account at the benefit side equals 0.8W.

Approach 4: The value of leisure time is assumed to be zero. Only the part of workers that have low qualifications is assumed to be drawn from the ranks of the unemployed. The other part is not.

As regards the part of workers employed by the project, a distinction is made between workers with high qualifications and workers with low qualifications. The former are assumed to have been employed before the project started and are assumed to get employed again when the project will be finished. The latter are assumed to be unemployed without the project. Fifty % of the workers employed by the project is assumed to belong to the first category and 50 % is assumed to belong to the second category. Due to regulations, the unemployed in Belgium are compelled to search for a job. If it can be demonstrated that a person is reluctant to work, he/she may loose unemployment pay. Therefore, there is no freedom of choice for the unemployed. Hence, in times of high economic unemployment, the value of leisure time is assumed to be zero. Thus, the correction factor that should be taken into account at the benefit side equals 0.5(0W+W)=0.5W.

Table 2 Cost corrections for labour market distortions resulting from unemployment

	Benefit Due to Creation of Employment
Approach 1	(0W+0.4W)/2=0.2W
Approach 2	0.97(W+0.83W)/2=0.89W
Approach 3	0.8W=0.80W
Approach 4	0.5W=0.50W

The use of diverging approaches regarding the VLT, the percentage of workers that will be drawn from unemployed resources and the inclusion of the correction factor as a positive benefit or as a negative cost resulted in substantial difficulties when comparing the results of various SCBAs. Furthermore, it appeared that the evaluation of a project could be strongly influenced by the approach used, which is important, given that the creation of employment is mostly not the main objective of transport infrastructure projects.

Discounting

The controversy as regards the appropriate discount rate has sometimes led to incomparable project appraisals in the past. The rates applied varied from 2% to 10% in the SCBAs considered in this paper. In the sensitivity analyses a test-rate was used. The SCBA results were thus computed and presented with two (sometimes more) discount rates. The problem associated with this simplistic (yet pragmatic) discount sensitivity analysis (DSA) method is that such a DSA is based on the assumption that any project's result curve (R = f(discount rate)) is linear. This is not always true. In practice, the shape of the result curves depends upon the way in which costs and benefits are spread in time. For instance curve C in Figure 1 below corresponds with a project that has a high negative residual value. If a traditional DSA were performed with two test rates, eg 2 % and 8 % with respective results R(2%) and R(8%), this would lead to the suggestion that discount rates between 2 % and 8 % would give a result between R(2%) and R(8%). This is obviously not the case with result curve C, as a discount rate of eg 4 % leads to the result R(4%), which is greater than R(2%) and R(8%). Therefore, in this case traditional DSA would not only be deceptive but also fundamentally wrong.

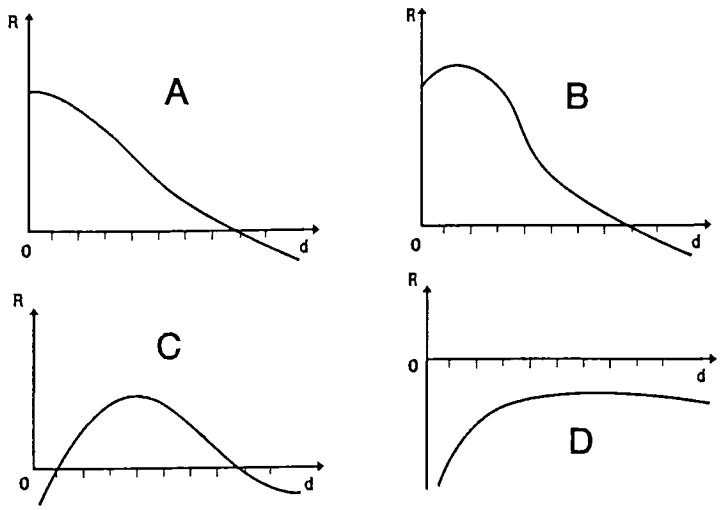

Figure 1 Hypothetical shapes of result curves

One solution is to apply a comprehensive sensitivity analysis in a plausible discount range (which allows to achieve univocal results). Here, the choice of the discount rate is left to policy makers, but an objective evaluation is given of the extent to which the project really depends upon the rate of discount. Research is being conducted in this field by the authors, see De Winne et al. (1995).

Economic life span

The economic life span of a project and consequently its residual value have also been subject to some controversy, in the practice of SCBA. In the projects under consideration, an infinite life span without any residual value was often taken as time horizon. This led to an important overestimation of benefits in cases where the true economic life span is actually much shorter. When the economic life span is restricted to eg 50 years, the infinite count of (a constant flow of) net-benefits results in an overestimation of approximately 16%, using a discount rate of 4%. The overestimation (again at a 4% discount rate) generated by an infinite life span, in a case where the economic viability of the project is only 30 years, already attains more than 44%.

In addition, residual values of transport infrastructure projects often tend to be negative, because redundant roads, bridges, docks, locks, etc. need to be torn down before new constructions can be built. The question is whether these expenditures should be added to the costs of the project that included building these infrastructural components or the project that requires the elimination of these components. Since at the time of the project proposal, the existence of a possible follow-up project is usually unknown, the residual value should logically be added to the costs/benefits of the first project.

SCBA RELATED TO PUBLIC INVESTMENT POLICY

The main aim of any project appraisal method should be firstly to distinguish desirable projects from non-desirable projects in terms of their contribution to general economic benefits to society,

and secondly to rank the desirable projects according to the importance of this contribution. This second purpose of project appraisal becomes important as public debts and budget restrictions become constraining factors for public investment policy. The selection and ranking of projects should take place in accordance with overall economic and social objectives. Therefore the output resulting from project appraisal should be comprehensive and relevant to these objectives.

The criteria which are used in SCBA to measure the contribution of a project to economic welfare, namely Net Present Value (NPV), Profitability Index (PI), Internal Rate of Return (IRR) or Benefit Cost ratio (B/C), only measure one well defined part of the effects related to economic welfare. For example, if economic welfare is defined in terms of contribution to the gross domestic product per unit of investment, an economic impact study (EIS) should be performed, as such effects are not accounted for in SCBA, although they may contribute substantially to the economic benefits to society. Therefore, through an EIS elements such as sustainable value added, sustainable backflow to government and sustainable employment induced by the project, could also be taken into consideration in project appraisal (Winkelmans et al. 1993).

In addition, some external effects regarding environmental and safety implications are very difficult to monetise and therefore can hardly be included into the SCBA, as was pointed out earlier. This information needs to be processed through an alternative analytical tool, in the form of an EIA.

It is our view that any SCBA should be limited to the analysis of all project related effects which can be expressed in monetary terms in an unambiguous fashion. This should increase the credibility of SCBA in practice.

Hence, a more comprehensive evaluation method is required whereby the results of an adapted SCBA, namely the profitability criterion (or any other relevant criterion emerging from an adapted SCBA) should be considered as one of the criteria, together with criteria resulting from EIS and EIA, on which the final evaluation should be based. Further research should lead to suggestions as to which form of Multi-Criteria-Analysis (MCA) is the most appropriate to the transport infrastructure case. The comprehensive MCA that will be proposed, should be able firstly to determine the desirability of a project (as a function of the broader social and economic objectives described supra) and secondly to rank these desirable projects according to the level of their contribution to economic benefits to society (as described above). The use of "multi"criteria-analysis is consistent with the critique on SCBA expressed by the management school (Pearce and Nash 1981), whereby it was argued that policy makers and not the analysts should introduce weights.

Table 3 summarizes a variety of elements relevant to public policy making and suggests the method that could be used to process the information regarding these aspects (some optional impacts may be included into the MCA directly, these are denoted between brackets).

Unambiguously monetisable effects emerge both from SCBA and EIS. SCBA supplies the NPV, the PI and the IRR. An EIS provides information about the contribution to GNP (value added and back-flow to government). Socio-economic criteria can be found in a study on income distribution effects and in the EIS (contribution to employment). The environmental issues are covered by an EIA (eg in accordance with EC Council Directive 85/337/EEC). Effects as regards safety are not included in the EIA, at present. These effects need to be assessed by experts and should in the end be included in the EIA or directly in the MCA.

In function of the nature and the scope of the project, the table can be extended to include additional relevant analytical tools such as private investment analysis (PIA) eg for toll roads, tunnels, bridges or other infrastructure projects where private investment is involved, strategic positioning analysis (SPA) for major port investments, etc. In this way a flexible approach is proposed, which provides decision-makers with all information relevant for policy and necessary to reach an optimal allocation of public resources. The authors of this paper propose to use a specific form of multicriteria analysis, to synthesise the wide variety of information and to serve as an aid in the decision process.

Table 3 Survey of aspects relevant for policy and their inclusion in evaluation methods

Aspects relevant for policy	CBA	EIS	EIA	MCA
Financial economic aspects				
Monetary welfare impact*	+	-	-	+
Macro-economic impact (contrib.to GNP)	-	+	-	+
Socio economic aspects				
Generation of employment	-	+	-	+
Impact on income redistribution**	-	-	-	(+)
External aspects (non-monetary)				
Environmental impact	-	-	+	+
Safety impact	-	-	+	+
Other aspects				
Other monetary aspects***	-	-	-	(+)
Other non-monetary aspects****	-	-	-	(+)

Notes:

* In the sense of welfare economics
** Is considered negligible in industrialised countries
*** Eg. transfers to 'poor' regions
**** Eg. national security effects, regional image effects, effects on citizens' peace of mind, contribution to the cohesion of the EU internal market

CONCLUSION

A number of real world, practical applications of SCBA have been assessed in this paper. The authors agree that SCBA remains a useful tool to appraise the welfare economic effects of investment projects. However, the effects which can not be adequately expressed in monetary terms, should not be included in the SCBA, but described by means of eg an EIA. In this respect, it was argued that SCBA should be viewed as a partial tool for project appraisal, given that it measures only part of the economic benefits to society. To the extent that policy priorities shift towards taking into account budgetary and environmental constraints, which often cannot be included in a SCBA, additional tools for project appraisal, such as an EIS and EIA, may become indispensable.

The authors of this paper are presently developing a MCA-methodology which should allow to take into account all the relevant information which public decision makers may wish to take into consideration: it should build upon information derived from an adapted SCBA, an EIA, an EIS, etc. (see De Brucker et al. 1995).

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APPENDIX 1:

LIST OF SCBAs EXAMINED IN THE COMPARATIVE STUDY

1. *The outport of IJmuiden (The Netherlands)*
Title : A Social Cost-Benefit Analysis for the Outport of IJmuiden
Author : The Commission Seaport Consultation
Date : March 1975

2. *Improvement of the maritime access to the port of Ghent (Belgium)*
Title : Cost-Benefit Analysis of a port project in Ghent, (Anselin project)
Author : W. Nonneman
Date : December 1980

3. *Extension of the Belgian waterway network (Belgium)*
Title : C.B.A. of the extension of the Belgian waterway network
Author : M. Anselin, G. Blauwens, F. Thys-Clément, H. Tulkens
Date : March 1982

4. *Deepwater quay in Zeebrugge (Belgium)*
Title : C.B.A. of a project called "Deepwater quay" in the outport of Brugge/Zeebrugge
Author : Ministry of Public Works - Administration Waterways
Date : November 1983

5. *Container quay along the river Scheldt (Antwerp, Belgium)*
Title : Cost-Benefit Analysis of a container quay along the river Scheldt
Author : G. Blauwens
Date : July 1986

6. *Container quay in Zeebrugge (Belgium)*
Title : Cost-Benefit Analysis of a container quay in Zeebrugge
Author : G. Blauwens
Date : April 1987

7. *The Canal Zeebrugge-Merendree (Belgium)*
Title : The Canal Zeebrugge-Merendree. Socio-economic justification and environmental impact assessment
Authors : J. Hemschoote, I. Landuyt and N. Vanhove
Date : 1987

8. *The Canal du Centre (Belgium)*
Title : The costs and benefits of the *Canal du Centre*
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