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THE PRACTICE OF COST-BENEFIT ANALYSIS IN TRANSPORT: THE CASE OF FRANCE

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THE PRACTICE OF COST-BENEFIT ANALYSIS IN TRANSPORT

THE CASE OF FRANCE

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SUMMARY

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Introduction

The practice of cost-benefit analysis (CBA) has a long tradition in France, dating back to Dupuit (1849), but is still a topical subject. This practice is in fact the result of the combination of economic theory and decision processes regarding project choices. Both of these are constantly changing: advances and progress in the theory mean that the technical methods and tools used are constantly improving, while changes to decision processes and institutional organisations are transforming evaluation requirements. In some countries, the process of constant change has been very fast indeed. This is currently true in France, where major transformations are occurring. We are now leaving a period during which the doctrine was based on the strict application of traditional economic calculation and the pre-eminence of a single criterion predicated on surplus theory, and entering a phase very firmly focused on multi-criteria analysis in which traditional CBA is only one of the assessment factors. These transformations are under way, although not finished yet. However, the situation is already sufficiently clear-cut for this paper to outline the main points and pass judgment on their causes and effects.

The paper will then analyse the causes of the changes that are occurring. Some are attributable to progress in economic analysis. In addition to the still relevant traditional issues such as travel time and its many facets, these mainly concern risk assessment and the effects of investments on productivity and the spatial organisation of activities. Others relate to the institutional framework and are the result of the proliferation of decision-makers, the growing importance assigned to the environment and to consultation and the consequences of liberalisation (competition between operators, private finance).

The paper will then go on to describe the way these changes in the evaluation framework have affected evaluation procedures and how they have resulted in a shift from a single criterion doctrine to a multi-criteria doctrine. This multi-criteria doctrine is not yet finalised, but its aim is to introduce evaluation processes that will enhance projects throughout their lifecycle, introducing dialogues between analysts and stakeholders on decisions concerning the project into the dialectical dynamics. Although the corresponding guidance is not complete, it does very clearly point in this direction. This is confirmed by information on ongoing studies and research, on which future instructions would normally be expected to be based.

This policy has already been adopted in ongoing programmes and projects and in the way they are evaluated. The third part of this paper will describe its initial manifestations, which will demonstrate the advances but also the limits of the procedures in the making.

It will then be possible to pass judgment on these developments, highlighting their strong and weak points, the problems and challenges that they throw up and the research that needs to be done. The choice between multi-criteria analysis and cost-benefit analysis will be addressed first and it will become clear that these two frequently opposed techniques are in fact broadly complementary. We will then look at the changes and improvements

that need to be made to the usual cost-benefit analysis, which should remain the cornerstone of project evaluation.

Origins of changes in the doctrine

Major changes have been taking place in the way in which cost-benefit analysis (CBA) is performed for the past ten years or so. These changes are the result of progress in economic analysis allied with changes in society and, such is the synergy between the concerns of the researchers and the policy in the social environment in which they live, it is often hard to identify which of these two factors is the most influential. The way in which each of the factors addressed below will be included in one or other of the two categories is therefore somewhat arbitrary.

Progress in economic analysis

One factor which will be included on the theoretical analysis side is the continual progress made in assessing the effects of investments on travel times and its components such as reliability, non-adherence to timetables or the linkage between transport and the rest of activities, both at firm level (logistics) and people level (activity programmes). The references on these topics include Mackie *et alia* 2003, Gunn 2007, Hensher 2011 forthcoming for passenger transport and Beuthe *et alia* 2008 for freight transport, Bhat *et alia* 2004 for activity programmes. This progress can also be seen in knowledge of congestion phenomena. These have been studied for a long while now in the field of road transport (after the initial work of Arnott *et alia* 1993), but are less well known in railway and air transport.

Another factor included here is better knowledge of the interactions between transport and space. The New Economic Geography (NEG) is in the gradual process of developing its applications for project evaluation (Ottaviano, Tabuchi and Thisse 2002, Venables 2007). These are also found in the studies on agglomeration effects – productivity gains due to the proximity of agents (firms and individuals) – and the development of methods to quantify them (Graham 2007). These developments meet – but do not fully satisfy – a constant demand from policy-makers wanting to know the consequences of investments on economic development and the attraction of activities, with local elected representatives regularly hoping that the infrastructures put in place in their region will promote its economic development.

Two forms of uncertainty have also emerged on the economic analysis side. First, there appears to have been a systematic bias in evaluations (Flyvberg 2009). The United Kingdom guidance has addressed this bias and recommended how to anticipate and avoid it. The French guidance may possibly take the same route, but other avenues are currently being explored, in particular introducing audit systems to reduce if not prevent bias. The second form of uncertainty is more conventional, being the random factors as known and modelled by the financial markets. While particular attention is paid to these issues by the

study teams concerned[1], no precise recommendations have yet been issued (apart from the recommendation to pay special attention to this factor…), nor a firm doctrine stated. However, the next guidance is bound to include detailed and clear mention of this factor.

Changes in social organisation

It is also increasingly clear that our world is full of uncertainties – and the current economic and financial crisis is added proof of that. Risk also assumes greater importance with the development of Public-Private Partnerships (PPP). These manifest themselves in various forms: privatisation of motorway concession companies, operators of certain airports, franchises for public transport, fragmentation and liberalisation of certain parts of the activity as in rail transport. In all these cases, the partners pay considerably more attention to risk than used previously to be the case when public finance was the rule, when risk aversion was much lower because the only financial stakeholder was the government.

Risk has also increased as a result of liberalisation. More markets have been opened to competition that is not perfect but takes the form of oligopolies (in the railway or aviation sectors, for example), an unstable market structure in which there are many uncertainties as to the outcome of the confrontation between the players (how many entrants, in what niches, how will they compete, by price, quantity, etc.?) and which has serious repercussions on the conditions for performing cost-benefit analysis (Meunier and Quinet 2010, Sanchez-Borras 2010). All this contrasts with the relative stability afforded by the previous public monopolies.

Another source of change lies in the importance accorded to the environment. The environment has been a factor in CBAs for a long time now through the process of valuing externalities. Attention continues to focus on environmental aspects. An expert report recently made recommendations for the carbon value to be used in economic calculations (Quinet *et alia* 2008); similarly, consideration continues to be given to updating the other unit values for externalities.

The environment has become even more radically involved through the political process. The parliamentary majority after the 2007 elections introduced a major change in its policy to respond to environmental concerns. This resulted in what is known as the *"Grenelle de l'Environnement"*, or Grenelle Round Table on the Environment. The use of the term *"Grenelle"* is a reference to the Grenelle Agreements (thus called because the meetings leading up to the agreements were held in Boulevard de Grenelle in Paris) which brought together the Government, employers and the unions to negotiate an end to the May 1968 strikes. Similarly, the Grenelle Environment Round Table (Grenelle website) brought together a number of different stakeholders in French political life: central government, local authorities, firms, trade unions and environment groups. What emerged was a form of five-way governance (*"gouvernance à 5"*) which proposed environmental measures to the Government and Parliament which were largely adopted.

[1] Note, in particular, in the field of risk, the forthcoming expert report putting the emphasis on risk assessment methods modelled on those for evaluating financial assets.

These measures cover all aspects of social life, including transport infrastructures. The transportation programme places great emphasis on railway infrastructures and public transport, relegating road infrastructures to the back seat. The transport infrastructure policy is also accompanied by significant administrative reforms, with the merging of the transport and environment authorities. Environmental concerns seem to have come off best in this merger. The Highways Department, which has previously been all-powerful within the Ministry of Transport, has been abolished and its personnel spread throughout the Ministry within a structure designed to promote and improve intermodality.

The five-way governance resulting from the Grenelle Environment Round Table is a sign of the increasing complexity of the decision processes. While that complexity is not new, it does serve to emphasise and signal the changes currently under way.

Project evaluation guidance

Old cornerstone

The old cornerstone for the guidance dates back to 2004 (Framework Instruction of 25 March 2004 on harmonisation of evaluation methods for major transport infrastructure projects and Instruction of 27 May 2005 updating it)[2]. This Instruction modified an Instruction on the same subject dating back nearly 10 years to 1995. It introduced changes to the evaluation of external effects and the unit values of those external effects. It also gave additional practical guidance on the presentation of studies to take account of changes in the decision-making context and the development of public discussion. It followed the same doctrinal line, developed in the report by Boiteux *et alia*, on which the corresponding approach was predicated, characterised by the statement that the central core of the evaluation is calculating the economic cost as this is an invaluable indicator for locating and ranking in the public decision process. It is even stated that this method of economic calculation is the only one currently allowing costed comparisons between different investment projects. This paper will not go into detail on the methods for performing profitability calculations as these methods are classic. Suffice to note the emphasis given to the problem of calculating user benefits which arises when wanting to use different values of time and associated parameters from those used for traffic modelling. There is a risk of serious inconsistencies when this happens. This problem arises when the Circulars recommend standard values of time, which is generally the case. It is particularly common in France where there are often calls to use reference values of time modified in relation to behaviour values to take account of collective preferences.

However, the 2004 Circular has already introduced some changes to this doctrine. Just after the positive statements in favour of economic calculation, it goes on to state that evaluation of a project must contain many other elements clarifying public choices and that these elements are either quantitative or qualitative. The Circular places particular emphasis on territorial and social equity and to the structuring effects of transport in territorial development. The need to provide decision-makers with the elements for evaluation is underlined, whether or not they are quantifiable or have a quantifiable

[2] For a more detailed description of the doctrine prior to 2007, see for example Quinet 2007.

monetary value for all the criteria that determine the public choices. Lastly, the developments to the Circular place great importance on project profitability calculations.

The Framework Instruction also stresses the need to carry out sensitivity tests to clearly identify for each project the long-term uncertainties and risks associated with the technical and economic environment, project implementation times and conditions and the various assumptions and valuations used.

In accordance with these objectives, the Instruction sets out how to perform profitability calculations and gives a standard set of assumptions for macro-economic conditions and the unit values involved. The recommendations given are fully in line with the economic theory and good practice of the period. One innovation that should be mentioned is the recommendations to calculate accessibility indicators as a means of understanding the consequences of the project on spatial organisation. But, apart from this point, the general principles that it highlights for taking structuring effects and equity into account are not accompanied by any tools to put them into practice.

All in all, the 2004 Framework Instruction expresses intentions that go beyond conventional economic calculation but, in terms of the methods proposed, remains within the strict framework of that calculation. This Framework Instruction was followed by an updating Circular in 2005, whose main purpose was to change the discount rate (from 8% to 4%) and introduce the marginal cost of public funds concept (value set at 1.3). This Instruction should be varied for all modes of transport to take account of the specific features of each. In fact, only one of the Application Circulars concerning roads has been taken to a certain completion point. But it is still at the draft stage and currently applied on a provisional basis without having been formalised. Its main provisions are outlined in Box 1 below:

Box 1. Main recommendations of the 2007 Draft Circular on the evaluation of road projects

The Circular sets out the general principles on the concept of project, development scenario and reference scenario. It then indicates the various stages of progression in the design of a project, drawing a distinction between the feasibility study and upstream public engagement, where only the broad brushstrokes of the project are defined (the alignment corridor may vary by several kilometres and there may be several competing corridors), and the outline design and public inquiries, where the alignment is must more precisely defined (to within tens of metres or a hundred metres). It states that the upstream studies must clarify the modal comparisons, landscape scheme and financial feasibility, and culminate in definition of a major traffic corridor; that the downstream studies must choose the alignment alternatives, phasing and priority for the different projects. It also states that each phase must include the evaluation of profitability indicators, calculation of non-monetary elements and financial analysis. However, it gives no precise indication on what it is possible to estimate and the degree of precision to be achieved in each phase.

The Circular gives guidance on traffic studies, specifying the relationships to be used for route choices (these models do not take travel time choices into account) and the rules for factoring in traffic induction. These relationships can be used either "manually" in the simplest cases or incorporated into more elaborate models standardised for large-scale studies. Traffic growth trends are also confined between the upper and lower bounds. In the case of more extensive studies where, for example, reverting to the basic factors would appear necessary, changes in macro-economic parameters such as GDP or oil prices are required.

Evaluations for user and other stakeholder benefits are highly confined by strictly defined numerical values leaving little room for the analysts to make choices. This is to avoid strategic bias and to facilitate comparison between projects. This is standard practice in Europe, as can be seen in the Heatco report (Heatco 2006). The valuations associated with user costs and travel times and comfort conditions are reproduced here, on the basis that similar tables exist for the environment and safety.

3 – TABLE OF UNIT VALUES	Physical unit	Unit value in euros 2000
* routine maintenance, tyres, lubricants		
- cars	Vehicle x kilometre	0.07
Including VAT		0.0115
- HGVs	Vehicle x kilometre	0.13
* vehicle depreciation		
- cars	Vehicle x kilometre	0.027
Including VAT		0.0044
- HGVs	Counted in the time value	
* tolls: to be defined on a case-by-case basis, in the absence of specific information, the average toll in 2000 excluding special structures and disregarding pre-paid was:		
- cars	Vehicle x kilometre	0.066
Including VAT		0.0108
- HGVs	Vehicle x kilometre	0.149
* fuel		
- cars (takes account of petrol/diesel split)	€/litre	1.00
Including tax on petroleum products		0.50
Including VAT		0.16
- HGVs	€/litre	0.71
Including tax on petroleum products		0.39
* standard time for economic calculation		
- cars (1)		
Distance d < 20 km	time/vehicle	9.88
Distance d 20 to 50 km	time/vehicle	13.41
Distance d 50 to 400 km	time/vehicle	0.0304 d +
Distance d > 400 km	time/vehicle	15.39
		34.36
- HGVs and coaches (1)		
		38.15
* discomfort penalty (cars only) (1)		
1 – Distinction depending on type of road:		
- 7m ordinary road	Vehicle x kilometre	
- 7m express road	Vehicle x kilometre	0.054
- trunk road	Vehicle x kilometre	0.032
- two-lane express dual carriageway	Vehicle x kilometre	0.023
- motorway	Vehicle x kilometre	0.007
		0
2 – Functional distinction (these values must not be rolled up with the previous ones):		
- single lane carriageway	Vehicle x kilometre	
- road with at-grade intersections	Vehicle x kilometre	0.025
- road with non-motorway status	Vehicle x kilometre	0.016
- road with unlimited access	Vehicle x kilometre	0.007
		0.007

The discount rate is set at 4% until 2035, then 3.5% until 2054 and 3% thereafter. The indicators to be calculated are discounted profit, calculated on the basis of a 50-year investment lifecycle without residual value, internal rate of return, profit per euro invested and profit per public euro invested. A section is devoted to risk analysis and the favoured method is analysis of possible failures and scenario construction.

Alongside this conventional cost-benefit analysis aspect, non-monetary effects are required to be evaluated. These are specifically named as follows:

- Accessibility effects. A methodology for calculating accessibility indices and their changes linked to implementation of the project.

- The impacts on local or regional economic development. There are two types of impacts: first, the employment effects, for which ratios are given corresponding to the direct effects of hiring for construction and operation works. Then, the consequences on economic activity are subject to a very complex procedure based on surveying local and regional economic leaders and analysing local activity statistics. Linking these with the previously calculated accessibility changes, and using the classification rules laid down by the Circular, a qualitative estimate is obtained of the expected consequences on the project on local or regional economic activity.

It should be noted, however, that these analyses of employment and regional development are not complete. They do not take account of macro-economic effects on the corresponding markets. In more concrete and somewhat simplistic terms, they do not say whether the additional employment and economic activity identified are net creations or accompanied by reductions in other regions.

The non-monetary effects contain a third category: evaluation of the discomfort experienced by users in congestion situations: here, service quality levels are defined from this angle. This point reflects the fact that the time values given above poorly reflect the inconveniences associated with congestion and that traffic studies are also ill-suited to assess congestion conditions (they do not take traffic jam situations explicitly into account).

The Circular ends with requirements for financial evaluation. This evaluation is brief: it identifies the project revenue and compares it with the infrastructure manager's costs by calculating a Net Present Value determined using an interest rate based on market conditions. The analysis does not explicitly take account of the financing structure (capital or loan), only including it through the choice of interest rate which is a sort of WACC. It does not analyse the risks as private finance stakeholders would do, taking no account in particular of Debt Service Cover Ratio coefficients. It limits itself to giving an overview of private finance options.

Innovations after 2007

The tone and direction were to change completely after 2007 under the impetus of the new Government. As the title of the Circular published on 9 December 2008 (Ministry of Ecology 2008 a) suggests - the "Ministry evaluation reference system" - the thinking behind it is completely different. It concerns all the Ministry's spheres of decision and not just transport. It proposes an evaluation procedure which is very different from the previous system where cost-benefit analysis was at the heart of the evaluation. Here, the evaluation starts by defining the project aims and assessing how that project will meet them, in comparison with the other possible alternatives. These comparisons are made by analysing the project impacts. These impacts are ranked according to the three pillars of sustainable development: Economy, Social and Environment. An analysis matrix is given and reproduced below.

Table 1. Project evaluation matrix

Summary impact assessment table

Field	Nature	Qualitative description of impacts	Valuation of impacts (1)
Environment and Risks	Climate		
	Local air pollution		
	Noise		
	Aquatic environments		
	Bio-diversity		
	Landscapes		
	Soils		
	Safety, Security, Risks		
Social	Employment		
	Vulnerable groups, poverty		
	Redistributive effects		
	Training, human capital		
	Access to essential goods and services		
	Territorial cohesion, social mix		
Economy	Impacts on households		
	Impacts on firms		
	Total cost		
	Cost for public finances and fiscal impacts		
	Competitiveness and additional economic effects (2)		
Other			

(1) Value expressed in monetary or physical units; failing that, scope of the impact: from

negligible to extremely high.
(2) Some potentially important effects on the economy could be gradually factored in to the cost-benefit analyses: agglomeration economies, impacts on the markets in imperfect competition situations, impacts on the labour market and their fiscal consequences, etc. Moreover, the impacts mentioned in the table shall specify for each criterion the main risks and uncertainties that may have been identified and the main information concerning impact distribution.

It can be seen from this table that the surplus criterion no longer appears in name, but just under the headings of competitiveness and impacts on households and firms.

Emphasis is placed on the educational character of the procedure, which must be designed to produce an improvement in the project throughout its preparation and consultation through public debate. This concern for good project management is demonstrated in another Circular issued on the same date on the "Establishment of a Quality Charter for Evaluation in the Ministry" (Ministry of Ecology 2008 b): the evaluation must be impartial, transparent, pluralist and exhaustive; it must be possible to track the origin of the constituent elements of the evaluation (traceability). It must be geared towards consultation through wide public availability.

The final point to note is that this very short six-page Circular is relatively incomplete. It provides no guidance on how to complete the table, the indicators to be measured and the double-counting to be avoided. These tasks are left to subsequent circulars which will give detailed recommendations for each field and are in the course of preparation.

In parallel with this approach, the Ministry's departments are continuing to improve the procedures for performing economic calculations. They have been working on providing new carbon price evaluations (Quinet 2008) and this work has been based on the most orthodox economic analysis. Similarly, a report is being finalised on factoring in risk. It is based on the economic theories for financial asset assessment, here too in line with economic orthodoxy.

So, the situation at the moment is that there are two schools of thought and two ways forward, one a multi-criteria approach based on enumerating and quantifying a large quantity of impacts and the other, clearly single criterion, based on the surplus theory. These two schools of thought have existed in France for a long time and until now have always conflicted. Oscillations have been witnessed in the past, when the balance has swung from one to the other over different periods of ten or so years. The paradox of the current situation is that, for the time being at least, the trend is more syncretic: the two schools of thought co-exist and are in the process of developing in parallel. The multi-criteria analysis (MCA) recommended by the 2008 Circular is being applied for the first time, on a somewhat experimental basis, in the evaluation of projects arising from the Grenelle Environment Round Table, while those same projects are being subjected to socio-economic evaluations in accordance with the principles of the 2004 Circular. This paper will now look at how these evaluations are linked.

Assessments of recent programmes and projects

Since the turning-point of 2007-2008, many decisions have been taken on infrastructure projects. These may be presented and analysed in terms of the decision-making level, starting at the beginning of the process and general decision, i.e. long-term planning, and then moving to the end of the process and specific considerations, i.e. the technical specifications for projects that have already been decided.

Grenelle I and II

The most far-reaching decision taken recently was the enactment of the two bills that will put the decisions that came out of the Grenelle Round Table on the Environment on the statute book. The first of these was Law No. 2009-967 of 3 August 2009 on the timetable for the implementation of the Grenelle Round Table on the Environment (Grenelle I). Along the same lines as the abovementioned Circular on assessment, this bill, which applies not only to transport but to all activities, first sets out general objectives. For the transport field, the objectives listed are: combating global warming, ensuring sustainable development by means of a reduction in pollution; and restricting destruction of the countryside. These objectives can be met, for example, through the development of mass transportation (by inland waterway, rail or coastal navigation). General objectives are then listed, for example for freight transport, aimed at increasing the modal share of non-road freight from 14% to 25% between now and 2022.

These objectives will be achieved by means of a co-ordinated set of measures described in the bill, with the maintenance and efficient use of existing infrastructure, as well as regulatory provisions, topping the list. Investment in infrastructure is just one of the tools available, and is not necessarily the preferred option.

Fairly specific details are given regarding the resources in terms of new infrastructure, at least as far as investment in rail transport is concerned. With regard to freight transport, for example, the bill provides for the construction of three "rail motorways" in order to achieve a targeted reduction in road freight. Improvements to the rail and river connections serving ports, sea motorways and the Seine-North Europe canal are also mentioned and some quantified objectives set in this regard.

In the case of passenger transport, the emphasis is placed is on pursuing the programme of new high-speed rail links with the aim of covering some 2000 km by 2020, with several lines being listed by name.

– Box 2. New high-speed rail projects under Grenelle I

– The South Europe–Atlantic line, consisting of the central Tours-Bordeaux section and three branch lines, namely Bordeaux–Toulouse, Bordeaux–Hendaye and Poitiers–Limoges.

– The Brittany–Pays de la Loire line.

– The Mediterranean Arc, including the Nîmes–Montpellier by-pass, the Montpellier–Perpignan line and the Provence–Alpes–Côte d'Azur line.

– The provision of services to eastern France, with the completion of the Paris–Strasbourg line and the three branches of the Rhine–Rhône line.

– The interconnection to the south of the high-speed lines in the Ile-de-France.

– French access to the international tunnel along the Lyon–Turin railway line, which is the subject of a treaty between France and Italy.

– An additional 2 500 km are also planned in order to complement the previous network or to substitute for links in the network that might not be ready in time. Reference is also made to a programme to extend local public transport, including measures for public transport on separate lanes in the regions and the Ile-de-France region.

The bill also provides for the drawing up of a National Transport Infrastructure Plan (*Schéma National des Infrastructures de Transports* – SNIT) and lays down the following criteria for determining the choice of transport links that will be included in it:

- the net balance of greenhouse gas emissions produced or avoided by the project in relation to its cost;
- progress made on other projects and the prospect of saturation on the networks concerned;
- environmental performance (combating noise pollution, severance effects, biodiversity conservation, etc.);
- multimodal access, economic development, opening up regions and regional development at the various levels;
- improvement of the efficiency, safety and cohesion of the existing transport system; and
- fulfilment of the objectives relating to the provision of access for persons with reduced mobility provided for under national legislation.

In the bill, emphasis is placed several times on the importance of following up projects and measuring their efficiency. The word "feedback" is not used, but this concept clearly pervades the text. Likewise, in the spirit of the Grenelle Round Table on the Environment, it attaches importance to consultation procedures and public debate, with the expected

outcome being precisely the enhancement of the projects and their efficiency. Thus, of the five action areas contained in the bill, an entire section is given over to governance and information.

Law No. 2010-788 of 29 June 2010 on the national commitment to the environment (Grenelle II) does not provide any additional information on investment programmes or choices of infrastructure, but strengthens those measures that are conducive to promoting dialogue in the public debates that will ensue).

Note that the commitments made in these two bills, and particularly those in Grenelle I, were subject to a summary report that was written in accordance with criteria laid down in the bill itself and based on existing data. However, this report did not serve as a guide for the decisions set out in the bills. Dating back to October 2008, the report was instead an ex-post assessment of the said commitments, while the draft Grenelle I had already been submitted to Parliament in June 2008. Moreover, the authors of the report themselves deemed it to be imperfect since it had been based on very incomplete data:

"Nevertheless, this report cannot strictly be called a cost-benefit analysis or cost-advantage analysis, which is the model that all assessment of public policy should eventually aim to follow. In fact, the timeframe within which this report had to be prepared and the status of the planning law rendered this kind of analysis difficult, and even impossible, for some objectives. This is particularly true of certain environmental issues (biodiversity, health-environment, etc.), for which the absence of reference values for their assessment adds an additional layer of difficulty."

This comment reflects both the inadequacy of the studies conducted prior to the investment provided for in the bill and the difficulties encountered by analysts in performing assessments in accordance with the principles laid down in that bill, which are the same principles as those set out in the Circular of 2008 referred to in the preceding section.

Attention is drawn to the fact that an internal assessment (Study on the impact of the draft Grenelle environment bill) was conducted on the Grenelle commitments using a cost-benefit analysis method. This assessment was rudimentary since cost-benefit analyses were not available for all of the projects and measures involved. Nevertheless, it did enable the cost-effectiveness of the measures listed under each objective to be compared. This revealed that several of the measures in question were only cost-effective for implicit valuations that were significantly larger than those usually imputed (notably of the carbon price).

A yearly report is drawn up and submitted to Parliament by the *Commissariat général pour le développement durable* (General Commissariat for Sustainable Development – CGDD, 2009) that gives an update on the implementation of the Grenelle commitments. This report looks at the implementation of the measures rather than at the progress made towards achieving the objectives.

National Transport Infrastructure Plan

Grenelle II provides for the preparation of a National Transport Infrastructure Plan (*Schéma National des Infrastructures de Transports* – SNIT). A little later than originally scheduled, a draft SNIT was published on 13 July 2010 (Ministry of Ecology, 2010), with a view to organising a public consultation, involving, among others, dialogue with the locally-elected representatives concerned, interministerial co-operation, consideration of the plan by the *Conseil économique, social et environnemental* (Economic, Social and Environmental Council) in its new composition, a wide-reaching public debate, followed by a debate in the Parliament. The strategy underpinning the plan consists of the following fourlines of approach: optimising the existing transport system; limiting the construction of new infrastructure; improving the performance of the transport system serving the regions and energy installations; and reducing the environmental footprint of transport infrastructure. Around sixty measures have been decided upon, covering areas such as the maintenance, modernisation or development of infrastructure. As far as infrastructure is concerned, and as part of the policy line described above, emphasis is placed on the objectives set out in Grenelle I to:

- strengthen intermodal transport, in favour of rail transport;
- modernise major sea ports;
- enhance the integration of environmental considerations into existing transport infrastructure;
- shift the focus away from road and air transport; and
- provide support for the development of public transport.

For each of these objectives, a list of items, criteria and indicators is proposed. Table 2 below shows the criteria and indicators for assessing the first objective to develop rail transport.

Table 2. Criteria and indicators for assessing the development of rail transport objective

Detailed objective	Criteria	Indicators	What is to be assessed?	Infrastructure at stake
	Ability of the project to provide an alternative to air transport for areas with an airport that serves short-haul destinations	Amount of air traffic shifted to rail	Estimate the modal shift to rail and the consequences in terms of CO^2 emissions	Rail
		CO^2 equivalent in tonnes avoided		
	Ability of the project to contribute to network effects	Number of links between regional metropoles with travel times	Assess the time savings between the main hubs of the high-speed rail network	Rail
	Ability of the project to increase the country's high-speed rail coverag			
Increase the access of large regional agglomerations to high-speed rail	Ability of the project to increase access to high-speed rail travel	Number of cities of more than 100 000 inhabitants that become a "TGV city"		
Develop a rail alternative to air and road transport		Number of cities of more than 100 000 inhabitants with direct access to TGV	Assess the improvement in the access of urban agglomerations to the TGV network	Rail
		Agglomerations with a population of more than 100 000 with access to high-speed service with in less than 20 minutes		
		Cities with more than 100 000 inhabitants saving travel time of more than half an hour		
	Ability of the project to act as a substitute for non-collective transport	Amount of traffic shifted from road transport		
		Amount of CO^2 equivalent in tonnes saved by transfer from road to rail	Estimate the modal shift from road to rail and the consequences in terms of CO^2 emissions	Rail
Cope with the increase in traffic with a sufficient quality of service by means of upgrading existing lines, improving operations or building new tracks when necessary	Ability of the project to reduce congestion	Number of nodes and length of links where congestion has been reduced	Assess the consequences of the project in terms of network congestion	Rail

Detailed objective	Criteria	Indicators	What is to be assessedt?	Infrastructure at stake
	Possible market for rail in the framework of an interconnection betwe rail and road	Amount of traffic possibly transfered from air to rail in the case of an air-rail interconnection	Assess the benefits of an air-rail interconnection	Airports, rail
		Amount of CO^2 equivalent in tonnes saved in this case		
Improve the interchanges between modes for passengers and freight		Number of passengers and amount of freight using rail to and from the airport terminal		
	Quality of public transport from TGV stations	Characteristics of the regional network from TGV stations (frequency, number of lines, etc.)	Assess the quality and coherence of the public transport system linked to the TGV network	Rail
		Characteristics of the mass transit network (frequency, length of the network) from TGV stations		
		Amount of traffic diverted from Paris stations to new stations on outskirts		
Increase the interconnections in the Ile-de-France in order to improve the quality of the national network		Number of services between TGV areas		
	Impact of the project on the number of new stations in the Ile-de-France		Assess the ability of the project to relieve congestion in Paris stations and to improve the direct services from province to province	Rail
Establish a plan for railway stations in Paris in order to cope with the growth in traffic, taking into account th increase in traffic owing to the improvement of intercity routes	Ability of the project to improve the services between the areas of TG services	Share and volume of long-distance road freight traffic (more than 500 km)		

Detailed objective	Criteria	Indicators	What is to be assessedt?	Infrastructure at stake
		Amount of truck traffic which can be diverted towards other modes	Determine where part of the transport demand can be served by rail, inland waterway or sea transport	Rail, sea ports, inland
	Size and type of market possibly concerned by rail, inland waterway	Amount of CO^2 tons avoided	Assess the impact of the project on climate change	waterways
Improve the quality of intermodal transport logistics	sea transport	Traffic of sea ports in the area of the project	Assess the impact of the project vis-à-vis the accessibility of sea ports	
through rail motorways, combined transport,		Number of ports benefitting from an improvement in reliability		Rail, road, inland waterways
and ordinary rail services			Assess the performance of the project on sea port reliability	Rail, inland waterways,
		Travel time savings stemming from the project on a representative		sea ports
	Ability of the project to develop the hinterland of sea ports	O-D	Assess the ability of the project to improve sea port accessibility	Rail, inland waterways,
		Share of logistic sector employment in the area under consideration		sea ports
			Assess the ability of the project to improve sea port accessibility	Rail, road, inland waterways
		Number of combined transport terminals and multi-modal platforms in the area of the project		sea ports, airports
			Find areas where interconnections between modes could be	Rail, road, inland waterways
	Presence of traffic generation sources in the area		improved and estimate the contribution of the project to this improvement	sea ports, airports

An examination of the project assessments undertaken shows that the assessment methods used are more in keeping with the previous practices and principles.Firstly, many of the projects included in the Grenelle bills and the SNIT have already been subject to detailed assessments, for example in the framework of the preliminary public debates or public utility surveys; secondly, the corresponding reports are not structured in the same way; third, they all comprise project impact assessments, in particular on the local economy and the environment; andthirdly, they all include a socio-economic analysis undertaken in line with the circulars of 2004 and 2005, giving rise to cost-effectiveness indicators, which, in general, are summed up in the internal rate of return.

Overall decision on cost-benefit analysis versus multi-criteria analysis

The difficulties and benefits of multi-criteria analysis

The change in approach that took place in France has not taken hold. The general guidelines set out in the 2008 Circular have not been transformed into implementation measures. Even the recently published draft SNIT has not yet used the new approach in any assessment, which is testament to just how difficult it is to implement in practice. It is necessary to recognise the ambitious nature of MCA, since it reflects the expectations of decision-makers and does not take into account the difficulties involved in achieving those goals. From this perspective, it suffers from two major difficulties.

The first relates to the existence of overlap between the various criteria or objectives listed. The reader is referred to Table 2 above, where it can be seen that, for example there is overlap between the categories "impacts on human capital" and "impacts on firms", as well as between "access to essential services" and "impacts on households". It is necessary to establish more accurately where each of these impacts starts and ends. The complexity of this task can be gauged by comparing the consequences for firms with those for households. This reveals the time-saving achieved in general as a result of investment in infrastructure or changes in accessibility. Current assessment procedures use both types of indicator, but the second set of indicators are simply a translation of the first in aggregate spatial terms. More generally, most of the economic impacts listed in Table 1 have a time-saving impact, but it is necessary to ask whether assessing them in terms of time-saving as well as other expected impacts amounts to counting them twice.

The second issue relates to the difficulty of measuring secondary impacts. From this point of view, the assessment form does not provide any added value, but instead contributes to the problem without coming up with a solution. Indeed, there are some impacts that we do not know how to assess: this is undoubtedly the case for impacts like competitiveness. Secondary impacts certainly need to be taken into account, but the difficulty lies in measuring the cause and effect relationship between the completion of an infrastructure project and the changes in productivity entailed for firms. In recent years, significant progress has been made on this issue, which has not resulted from the endorsement of MCA over CBA, but from advances in general economic analysis, in particular with the advent of the "new economic geography". If these advances had not been made, MCA would be as powerless as conventional CBA in assessing the impact of competitiveness.

As mentioned previously, employment is another classic case. It is possible to determine with sufficient accuracy how many people are employed in the construction or operation of a new infrastructure project: it is simply a case of observing how similar existing infrastructure projects are run. It is also possible to establish through observation the number of jobs required to manufacture the inputs that the suppliers of public works providers will use. However, this quantitative assessment does not take into account the reactions of the labour market: an increase in the number of jobs offered by public works providers usually leads to an increase in salaries across all or part of the labour market, and thus to a decrease in employment. It is not known if the calculation of the number of jobs created using the mechanical reasoning currently applied provides an accurate picture of all the impacts that need to be taken into account.

This situation could even descend into charlatanism. Simplistic methods of calculating the number of jobs created, which gloss over secondary impacts that we do not know how to measure, have the benefit of providing results that are easy to understand, can be communicated easily, readily garner support and are held to be the truth. MCA is exempt from the charge often made against CBA that it is the computer, rather than the decision-maker, that takes the decisions and, moreover, following opaque procedures. However, it does fall into a similar trap: with MCA, decision-makers appear to be more in charge of decision-making, but they may base their decisions on an outcome that they think they understand because it is simple, but which can be fundamentally wrong.

Conversely, MCA enjoys several advantages over standard CBA. Bearing in mind the abovementioned caveat that simplicity may be deceptive, MCA does tell the decision-maker more than a presentation on a rate of return or discounted benefit. Communication is enhanced, which is a major advantage in a public debate situation, where the speakers understandably may not comprehend the subtleties of economic theory or how surplus value is calculated. This argument is even more relevant given that such decisions increasingly involve multiple stakeholders, all with different points of view and between whom it is essential to establish a common language. This is the case for the public debates that large infrastructure projects undergo. However, beyond the official framework of such regulatory public debates, it is well known that decisions on infrastructure are complex and involve multiple actors, none of whom possesses the ultimate power of decision over the remainder.

Although a simplification of what is, in fact, a very variable situation, the following groups can be distinguished:

- political decision-makers, of which there are many and who are often in conflict with one another. For example, conflict between central government (which is aiming for a degree of rigour in allotting funds) and local authorities which are trying to attract as many infrastructure projects as possible to their region, and which are concerned moreover with considerations of fairness and distribution of advantage;

- associations of "active minorities", such as environmental organisations that try to encourage policies and measures in favour of the environment;

- the private sector (equipment manufacturers, public works providers), which fights for developments in the sector of activity concerned;

- investors, who are looking to deploy the resources at their disposal, under conditions that are most favourable for them; and lastly

- economists, who generally portray themselves as the champions of efficiency through CBA.

In this context, project assessment can no longer be seen as a tool for use by a kind of enlightened despot to calmly impose an order of priority on projects submitted in line with the public interest. This view might have served in the distant past as a simplistic, but convenient representation of reality, but is no longer justified today. In fact, CBA and other methods for assessing projects should be considered as resources in the discussions that develop between these actors, whereby all parties make use of them, exploiting the room for manoeuvre afforded by their high margin of uncertainty. In this regard, MCA is more enlightening, since it provides each group with an array of resources for identifying which of the impacts will most affect them, whereas conventional CBA simply provides an overall indicator.

In a similar vein, it is probably easier to modify a project that has been assessed using MCA since it distinguishes more readily than CBA between different types of performance and points to those that are less satisfactory, for example, by comparing them with similar projects.

Complementarity of CBA and MCA

This should not make us lose sight, however, of the advantages of CBA, which are in some sense complementary to those of MCA. Firstly, it provides a consistent general framework in which the impacts taken into account flow from general assumptions regarding the functioning of the economy and, provided that these assumptions are broad based, avoids double counting, as demonstrated by the fact that the impacts that it calculates can be summed to obtain the overall impact. Next, since in its most commonly used version it values goods at market prices – subject to corrections for externalities that are also taken into account on the basis of actors' willingness to pay – it is in a sense democratic since it incorporates and respects actors' choices.

Lastly, it makes it possible to take into account different valuations, which are easily incorporated into the calculation. When a decision-maker attributes a value other than the market value of a specific good, it is possible both to calculate the rate of return of the project with this new value and to determine the extent to which this new value changes the choices available. Lastly, a CBA can be used, with respect to a decision based on multiple criteria, to determine the implicit value given by the decision-maker to these criteria. For example, as was indicated above, the *ex-post* analysis of the decisions of the Grenelle Round Table on the Environment with regard to climate change showed that these included measures that were only justified for very high carbon values, significantly higher than those generally presented in the literature at this time. Similarly, CBA can, as will be seen

later, be adapted to take into account redistribution concerns, an effect often stressed by the proponents of MCA.

In all, while admittedly there are areas where a MCA and CBA conflict, they also complement each other, and while attention is frequently drawn to the areas where they conflict, the complementary aspect is probably not emphasised enough, even though it becomes readily apparent when both methods are conducted in a properly co-ordinated manner. It would feasible to devise a procedure in which a CBA is performed alongside a presentation of the basic impacts. The CBA provides a framework which ensures that the impact assessment is consistent and automatically eliminates double counting. It provides results expressed in monetary units with specific monetary valuations – e.g. for individual actors' willingness to pay – that can easily be changed if, for some reason, the decision-makers wish to do so. It makes it possible, with respect to a decision based on the analysis of non-monetarised impacts, to determine the underlying implicit unit value.

In cases where effects of interest to decision-makers are not taken into account in the CBA, it is generally because their impact is poorly known, and in this case it is important is to learn more about them. In such cases, to introduce them in the form of indicators that have not been confirmed by scientific analysis in a multi-criteria analysis is only a stopgap measure that must be used cautiously since its scientific validity is uncertain. If these are known but have not been identified by the ordinary CBA, then the procedures being used in the CBA must be updated. With these considerations in mind, in this composite perspective, an analysis will now be made of the problems presented by traditional CBA and the adjustments that need to be made to enable it to play its role better.

The analysis will also include the well-known arguments that MCA used in isolation opens the way to arbitrary and subjective judgements, and that CBA alone all too often functions like an incomprehensible black box, while combining them eliminates both of these shortcomings.

Some ideas for improving cost-benefit analysis

These ideas for improvement can be grouped into two partially overlapping categories. The first will consist of ideas concerning the inadequacies of economic knowledge and the second of the ideas on how cost-benefit analysis fits into the decision-making process.

Methodological problems

Many of these problems are related to two of the key characteristics of CBA that stem from the fact that it is based, as currently practised, on a partial equilibrium analysis, which means that it is only valid if the entire economy is in a first-best situation in which all companies price at the marginal cost – which occurs naturally if markets are in a state of perfect competition. This also means that CBA only provides the total surplus, without giving any valid indication regarding its composition, for example, regarding those who will benefit or suffer because of the project. The fact is that these two characteristics are very ill-adapted to the current conditions of economic activity and the decision-making process.

There are a number of factors in the light of which the currently prevailing situations are far removed from situations of perfect competition. Firstly, there are externalities such as environmental externalities, which CBA has long since taken into account.

More important and more difficult to address are the situations of imperfect competition, such as a monopoly or duopoly maximising their profits, which are increasingly frequent in the transport sector. This is the case in air transport in Europe, in which markets are mostly oligopolistic; it is also the case in the rail sector in Europe in which rail competition in most markets has led to the emergence of a small number of competitors, who are also in an oligopolistic situation. In such situations, the usual practices of CBA need to be changed, but it is then necessary to analyse the nature of the competition and its impact on the prices charged by operators, which differs according to market structure (Meunier and Quinet 2010, Nash et al. 2010). In this case, traffic studies also need to be revised by considering that operators' prices are endogenous and are the result of market equilibrium. Variations in the profits of companies need to be taken into account when calculating surpluses.

There are other imperfections in sectors besides transport, which are generally observed to have positive Lerner indices, indicating a certain degree of market power (Laird et al. 2005, Vickerman 2007).

Lastly, nearly all taxes lead to economic losses. These losses can be incorporated by taking into account the cost coefficients of public funds. Some references on the corresponding theoretical problems are Calthrop, de Borger and Proost 2009 and Mayeres and Proost 1997.

These effects can be analysed on an individual basis by using correcting factors for traditional CBA. CBA in partial equilibrium can also be replaced with an analysis using general equilibrium models (GEM). This latter option has the advantage of providing not only an overall indicator of the rate of return of the operation and the collective surplus that it generates, but also a distribution of this surplus according to its beneficiaries (Brocker 2005). This provides a rigorous response to a frequent demand on the part of decision-makers, who wish to know the distributive effects of projects. Analysis using general equilibrium models is also the only way to introduce weightings into individual utilities, making it possible to highlight a given population category and thereby calculate an overall indicator that respects collective choices regarding income distribution.

A specific difficulty of CBA that is rarely mentioned arises in the case of countries of small size for which the transport flows and the beneficiaries of the investments are largely foreign to the country in which the infrastructure is located, as is the case in many European countries. In such cases, in order to assess the national interest of a project, it would be necessary to distinguish between national and foreign actors, both for the beneficiaries and the payers. This is rarely done, and it is easy to imagine the difficulties involved, but it is also clear that this can have a major impact on the results of the CBA. Here too, only procedures that take into account the entire economy, i.e. that go beyond partial analysis, can address this problem.

A special aspect of the demand from decision-makers concerns spatial effects. Economic analysis has recently made great progress in this field. With regard to modeling

calculations, Land-Use-Transport-Integrated (LUTI) models[3] have been developed and provide, as a sort of extension of general equilibrium models, the spatial distribution of activities and the changes in this regard that will be generated the project being examined. In terms of theoretical analysis, the new economic geography (NEG) has shed new light on the development processes of agglomerations and on agglomeration externalities.

Obviously, all of these discrepancies from the assumptions of a first-best economy are far from being perfectly understood. But more generally, all the parameters and mechanisms used in CBA need to be continually improved. Topics such as time and congestion are inexhaustible and any progress made opens the way to further progress. If the most urgent issues for research programmes in these fields had to be identified, two can be highlighted, other than the need for more in-depth study of spatial effects. Firstly, knowledge of congestion in public transport, which lags very significantly behind the field of road traffic, and the lack of information in this regard undermines the assessment of rail and airport projects. Secondly, the dynamic analysis of users' decision-making: a basic investigation of how users make decisions shows that changing their schedules is the first adjustment that they think of when supply conditions change, although most models are essentially static and do not take the corresponding mechanisms into account.

Methods of implementing CBA

Alongside these issues that concern economic analysis, its shortcomings and the areas in which it needs to be improved, other ideas for possible progress can be grouped according to how the CBA is implemented and incorporated into decision-making processes. In this regard, two aspects will be addressed: firstly, the uncertainties and imprecision involved, which can enable the various players to manipulate the decision-making process, and, secondly, imperfect use of the method.

The uncertainties and imprecision of the results of CBA are many and well known. Firstly, there are the risks that emerge as investment projects are implemented and brought into service, such as uncertainties about costs and traffic. There are those that result from the fact that traffic studies, like cost studies, use complex models that – beyond the general principles which underlie them (for example, a traffic model of the nested logit type, or a cable-stayed bridge of a given span) – entail a great deal of uncertain data, multiple relationships, secondary assumptions and also many parameters that are often derived subjectively through expert estimates. These uncertainties are clearly addressed by economic theory and can be taken into account in a variety of ways; the simplest procedures are based on the law of probability for the random variables involved and the degree of risk-aversion of the actor concerned. This factor is becoming more important because of the fact that, with the development of private financing, the actors involved are the most risk-adverse. Another type of risk is one that emerges gradually, and that can be treated using methods of the capital asset pricing model **(**CAPM**)** type. These methods are well known in many applications such as finance and operational research and it would be

[3] See Wegener 2004 and Wegener 2009

desirable and not too complicated to incorporate them into cost-benefit analysis. The theoretical analysis of risk situations has developed considerably and it is odd that the results obtained have scarecely been incorporated into CBA.

In the preceding paragraph, we have assumed that the variables were centred and with mean zero. Another source of uncertainty lies[22] in the fact that the calculations of rate of return are in general biased. The costs are underestimated and the traffic and rate of return are overestimated to a varying but often significant degree. A number of authors have provided ample documentation in this regard, in particular Flyvberg 2009. Their analysis and observations examine the different sources of bias which, according Flyvberg 2009, can be classified as technical, psychological and political-economic reasons. The most important are generally considered to be the political-economic reasons, since the actors who present a project and want to see it implemented are tempted to manipulate the many areas of imprecision and uncertainty contained in the calculations so as to support their arguments. What can be done to protect against this bias? This is probably the most important and difficult issue to address in the practice of cost-benefit analysis.

A number of procedures can be envisaged in this regard. Firstly, there is the systematic use of *ex-post* studies, which make it possible to exercise an influence, if only a moral one, on future evaluations. These *ex-post* studies can be used to establish comparisons by reference class, making it possible to compare the estimated costs of a given project with the average cost and with the distribution of the costs of a project of the same nature. Another method is to conduct an expert examination of studies. This can be done in a variety of ways, i.e. by calling upon a panel of experts that would audit all studies in a given sector, or by designating a group to examine each study. In these situations, the problem is to ensure the independence and quality of the expert examination, in a narrow field where there are few experts, who know each other and have often had contacts, sometimes as service providers, with the bodies promoting projects. The recent debates surrounding the IPCC show how difficult it is to preserve this independence. It must also be borne in mind that the expert examination of the study of a project is a long and costly matter, requiring a vast amount of information to verify the smallest details, for the "devil is in the details". Another approach consists of acting upon the methods used to produce studies and on the relations between the actors involved in the project. In this regard, the growing participation of private actors in the context of public-private financing is a key development. This entails risks, since private investors have important interests that they wish to further. They use their power of influence, which is the result, firstly, of information asymmetries in their favour and, secondly, of contractual arrangements regarding their intervention. On this latter point, Flyvberg (2009) proposes that the promoters of a project preserve a minimum capital commitment in a project for a specific period of time. Similarly, the conclusion of contracts between promoters and financers can provide an opportunity for the project to be assessed by actors who have both the ability to conduct an expert examination and an interest in this examination[4]. However, the expert examination will then be viewed from a financial standpoint and rather than from that of its collective rate of return.

[4] If it is poorly designed, it can lead to greater deviation, for example if the expert assessment of the project and its rate of return is provided to a poorly informed and divided public.

Projects, and especially major international projects, frequently span multiple jurisdictions, for example a region level, a national level and often an international level (in Europe, the European Union). Each jurisdiction participates in decision-making, expects to derive a surplus from the project and does not want to contribute beyond this surplus. In this case, the decision-making project is a negotiation between these different organisations, even when there is a certain top-down relationship between them. For example, the regions have responsibilities over which the central government has no control. The usual process is for the regions to propose projects for central government financing, with a view to sharing the costs. The resulting contract is subjected to the usual effort incentive and information asymmetry mechanisms, with the lower level normally being the best informed. This situation has been analysed by a number of authors. Florio 2007 proposes a contract based on an *ex-post* verification of the project's rate of return. Caillaud et al. 1996 have also explored the interest of multiple jurisdictions through a revelation mechanism and they show the conditions in which decentralisation can be beneficial.

The last point to be discussed resides in the functions given to CBA. These are currently very limited. They are generally confined to verifying that if each project were realised today, it would have an acceptable rate of return or discounted cash flow. In this regard, it should be pointed out that the methods used to calculate the rate of return or the discounted cash flow are not very satisfactory since the lifetime of the calculation is clearly lower than that of the planned investment. For example, in France the lifetime set by the guidelines in force is 50 years, although transport investments have much longer lifetimes, and their impact on economic life, through land use for example, lasts even longer; what is more, no residual value is taken into account.

This has a number of consequences. Firstly, as they stand now, the procedures are not suitable for establishing a schedule of investments or for choosing between variants, since this would require determining the optimum dates for putting the operations into service, which is impossible given the limitations of the indicator calculated. Programming is therefore impossible, except in a very approximate way. Better outcomes can be obtained from the tool used, since the methods for achieving these results and finding the optimum programming do exist (Maurice et al. 2008) and their implementation shows that the usual indicators (internal rate of return, benefit per Euro invested) are of poor quality. But to obtain them, it is necessary to take into account the fact that the benefit differs depending on the year of entry into service and to avoid the inconsistencies that would result from comparing operations put into service at different dates but with a lifetime limited to 50 years without any residual value, which does not correspond to any real situation.

What is more, by limiting the lifetime to 50 years, this approach overlooks long-term consequences that are far from negligible, especially with relatively low discount rates (4% in France with a decrease beyond 30 years, 3 % in the United Kingdom, again with a decrease in the long term) and low market interest rates. However, the long term is a vital concern, as is shown by the debates on global warming and the concern over the impact of infrastructure on land use patterns. However, to extend the economic calculation to the long term, for example to 100 years and beyond, a number of elements need to be taken into account; firstly, relative prices may change very significantly, and to incorporate these changes the model needs to take interactions into account in a general way. Partial analysis

that neglects income effects must be replaced by a general equilibrium model. Behaviour can also change, as can utility functions; for this reason, analysis over the long term must incorporate, in the interest of risk analysis, breaks in parameters. Little information is available about these factors, but if we are convinced that they play a role, it is better to take them into account explicitly rather than to ignore them (or include them in an arbitrarily chosen residual value). Simulations conducted by taking, for example, the price of carbon, one of the goods of which the cost is likely to vary the most strongly in a distant future, show that extending the horizon and taking relative price variations into account in a macroeconomic framework has a major impact on the choices to be made; for equivalent immediate rates of return, low-carbon infrastructure programmes have an enormous advantage in the long term over carbon-intensive ones, but this only becomes apparent if lifetimes of a magnitude of one hundred years or more are taken into account, i.e. much higher than is currently the case (Quinet 2010).

Lastly, on a more practical level, most instructions for carrying out cost-benefit analyses remain very theoretical since they do not distinguish how the analysis should be conducted depending on the stage of the project. However, the questions asked and the information available differ significantly depending on whether one is viewing them from the standpoint of master plans or from that of the choice of technical variants for the same project. Normally, it is at the upstream level of master plans that the choices have the greatest impact, since they determine the entire future of the project; unfortunately, it is at this level that cost-benefit analysis is currently used the least. Steps should be taken to provide methods for adapting it to this stage of decision-making. These methods should respond to many challenges, and in particular make it possible to:

- Achieve quantified results at a stage when generally little is known about the project.

- Make long-term projections, which means taking relative prices into account by linking the transport sector to the rest of the economy, but through modelling that is necessarily approximate over the long term.

- Analyse a wide range of scenarios covering the possible developments that may emerge in the distant future.

Conclusion

In response to the changes that have taken place in society and the progress made in economic analysis, the approach to the assessment of projects in France has radically changed in recent years. Starting from an initial situation in 2004-2005 in which the approach was clearly focused on applying the economic theory of surpluses and single-criterion analysis, by 2007-2008 a very clearly multi-criteria approach had prevailed. However, the specific methods used for this approach are being implemented very slowly. This is partly due to the method of governance introduced by the Grenelle Roundtable on the Environment, consisting of five-party governance based on trial and error, experiences and feedback. But it is also due to the fact that establishing criteria that are not redundant

and cover all aspects of interest to decision-makers is no easy task. If the strengths and weaknesses of these two types of assessment are examined, it becomes clear that both procedures are as much complementary as they are rivals; cost-benefit analysis provides a rigorous framework for presenting multi-criteria analysis and makes it possible to better measure the cause-and-effect relationships between the project and the impacts being measured. This is a reason for focusing on the progress that can be made in cost-benefit analysis analysed in the last section. This progress is of various kinds. First of all, it concerns methodological aspects, for the analysis should go beyond the partial framework and be incorporated into general equilibrium models; this would make it possible to take into account the effects of spatial distribution, imperfect competition and distribution of benefits, which are constant concerns of policy-makers. To do so, we must improve our fund of knowledge on these issues, while continuing to investigate traditional subjects, such as the value of time and dynamic models. Lastly, cost-benefit analysis should be used better and differently; it is too limited to verifying the rate of return of a given project and does not focus sufficiently on the long term; the methods that it uses are well adapted to analysing the variants of a project already chosen, but they cannot be implemented completely in the upstream stages, where decision-makers have the greatest need for guidance. Progress in these two areas will require the implementation of new methods incorporating the impact of projects on the economy as a whole through general models that go beyond the usual partial equilibrium assumptions.

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