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Massimo Florio and Silvia Vignetti

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THE USE OF EX POST COST-BENEFIT ANALYSIS TO ASSESS THE LONG-TERM EFFECTS OF MAJOR INFRASTRUCTURE PROJECTS

Massimo Florio* and Silvia Vignetti**

Abstract

This paper draws and expands from a recent ex-post evaluation carried out for the European Commission aimed at assessing the long term effects produced by a sample of ten major infrastructures in the Transport and Environment sectors and interpreting the key determinants of the observed performance. This evaluation study offered a unique opportunity to draw conclusions on the value of performing ex-post evaluations and to test an innovative evaluation design combining cost-benefit analysis (CBA) with qualitative assessment and adopting a long-run perspective (30 years), which extends into both the past and the future, and requires a mix of retrospective and prospective analysis. This paper presents the potential of ex-post CBA to assess long term impacts of major infrastructure projects and discusses some methodological and institutional implications related to its use¹.

Keywords: Cost-benefit analysis, Ex-post evaluation, Infrastructures

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* Università di Milano, ** CSIL, Centre for Industrial Studies

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1. Introduction

Examples of ex-post evaluation of large infrastructures carried out by academicians or professionals are available in the literature (among the most influential there is Flyvbjerg et al. 2003). However, although a great demand on measuring the results of large infrastructural projects is emerging, sheer ex-post CBA of infrastructure projects, i.e. carried out after 20 or 30 years after its financing, is not common practice within financing agencies. This is not surprising: first, retrospective evaluations come when all relevant decisions about the project have already been taken and, second, project promoters are not always particularly keen in assessing the actual effects of past projects.

CBA is a standard methodology for project selection, but it is useful after project implementation and closure to measure the actual net effects of the executed project. In principle ex-post CBA shall be performed exactly as an ex-ante but using historical rather than forecasted data. However, far from being as straightforward as apparently it would look like, performing an ex post CBA raises a number of interesting methodological issues. Indeed, the change in perspective ('the knowledge of what actually occurred rather than what is forecast to happen') affects, for example, the choice of an appropriate reference scenario, the definition of the relevant project 'boundaries', as well as the choice of the key parameters such as the social discount rate or the conversion factors.

This paper explores the need to adapt and expand the standard CBA model when performing an ex-post assessment and discusses some possible solutions to some of the key steps of the analysis, as learned in the context of an ex-post evaluation project recently carried out for the European Commission². It also discusses some institutional implications related to the use of ex-post CBA in the context of a performance-based delivery system. The paper is organised as follows: the first section provides a description of background and context, the second section reviews the typologies and scope of CBA according to the timing of implementation as respect to the project life cycle, the third section provides an in-depth discussion of the adaptation that the ex-post perspective imposes to the standard CBA model by providing some worked examples, the fourth chapter discusses the role of CBA in the decision making process.

2. Background and context

According to estimation³, half of public investment in the EU Member States is for infrastructure, the largest proportion being in the cohesion countries and New Member States and in the transport and environment sectors. Justification for public funding for infrastructure stems from the expectation that they foster economic growth, mainly by enhancing factor productivity, and promote convergence in income distribution and living standards⁴.

Traditionally, different endowments in basic infrastructures (as well as other basic resources such as factors of production, natural resources or technology) between regions or countries have been seen as the cause of disparities in economic performance. Justification of public funding for major infrastructures stems from the expectation that they foster economic growth by enhancing factor productivity, and promote convergence in income distribution and living standards.

The literature shows that although this holds true at an aggregate level (at country level or with an aggregate measure of infrastructural endowment⁵, if the regional dimension, different typologies of infrastructures and different conditions or nature of investments are considered a diverse picture emerges. Evidence is often mixed in terms of magnitude and direction of effects when typologies of infrastructures (whether it is high-speed rail, road, solid waste management, water treatment plant, as well as broadband connections, hospitals or gas distribution) and spatial effects are taken into account.

Evidence on the effectiveness of Structural Funds support to infrastructure for promoting regional growth is still debated. Despite much empirical work confirming a positive link between infrastructure and regional growth⁶, some others are rather critical of the potential of Structural Funds in reducing disparities in regional income levels in the long-run⁷. In order to understand what are the

2 "Ex post evaluation of investment projects co-financed by the European Fund for Regional Development (ERDF) and Cohesion Fund (CF) in the period 1994-1999" (Call for tender by open procedure n° 2010.CE.16.B.AT.036), carried out by CSIL – Centre of Industrial Studies (Milan), in partnership with DKM, Economic Consultants (Dublin), in association with Eurotec, Planning for development (Thessaloniki) and Blomeyer & Sanz (Guadalajara) on behalf of the European Commission, Directorate General Regional Policy. The full reports of the project are available here http://ec.europa.eu/regional_policy/information/evaluations/archives_1989_1999_en.cfm#

3 Up to 2% of GDP on average in the period 2000-2005. See EIB, 2007.

4 For a comprehensive review see Gramlich (1994) and Straub (2008).

5 see for example Barro (1990) or Aschauer (1989)

6 see, among others, Biehl et al. (1986), Rapún, Gil and Pascual. (2000) and Basile et al. (2001)

7 see Boldrin and Canova (2003) and Puga (2000)

actual long-term contribution of major infrastructure to economic development, and what the conditions for the actual verification and propagation into the socio-economic system are, a thorough assessment at project level is a highly informative exercise.

The use of ex-post evaluation, mainly in the form of ex-post CBA has been strengthened in recent years by the European Commission (EVA-TREN, 2007; European Commission, 2005; European Commission 2010a and 2010b). Ex-post evaluation is a regulatory provision (Art. 49 of Reg. 1083/2006) for Cohesion Policy programmes and, within the shared management system, it is the Commission bearing responsibility of carrying out the ex-post evaluation, although no specific provisions are made for the scope and approach to be used.

As far as major infrastructure projects are concerned, a first major attempt to compare ex-ante and ex-post results of CBA was made in the context of the ex-post evaluation of a sample of infrastructure projects co-financed by the Cohesion Fund in the period 1993-2002 (European Commission, 2005) which implemented in-depth project review to evaluate the efficiency, effectiveness management and impact of 60 selected projects in the transport and environment sectors. Despite problems with data availability and consistency, for the majority of the projects the Economic Rates of Returns have been re-computed in order to show the actual socio-economic impact of projects analysed and their deviation as respect to the ex-ante forecasts.

More recently, a sample of projects financed by Cohesion Fund in the 2000-2006 programming period in EU and former ISPA countries were subject of an ex-post evaluation in order to check, among others, the suitability of the CBA methodology and its actual use for decision making⁸. CBA results of ten selected transport (rail and road) and ten environmental projects (water, waste water and waste management,) have been re-appraised and compared to ex-ante results.

The main finding was that there is strong case for carrying out CBA for designing and selecting the most promising projects on the basis of the assessment of their expected net social benefits, but only if it is properly carried out. In fact, the actual practice is often to select and implement the projects according to political considerations and to use the CBA as a sort of 'ex-post rationalisation' of a decision already taken⁹. The fact that the CBA is a mandatory requirement to apply for co-financing under the Structural and Cohesion Funds and that the CBA results are actually used for calculating the EU grant, emphasises this 'thick the box' approach and provides an incentive to strategic misrepresentation in the CBA results.

Recently, the European Commission - DG Regional Policies has carried out an ex-post evaluation that aims at learning lessons from in-depth case studies of ten infrastructure projects¹⁰. The projects examined are in the transport and environment sectors across Greece, Italy, Spain and Ireland and were co-financed by the European Commission (EC) in the 1994-1999 programming period for a total of more than EUR 10 billion of investment¹¹. The evaluation study attempted to detect not only the types and strengths of effects generated by projects, but also the mechanisms behind a project's success or failure. Impact dimensions which have been researched by the study include a direct growth effect, shifts in the economic endogenous dynamics of growth, changes in institutional quality, social and territorial cohesion, effects on environment and, lastly, social happiness. Examples of the factors that may explain project performance include the project appropriateness to the context, the forecasting capacity of investors and promoters, the governance structure, the project design and behavioural response to unexpected events¹².

The methodology proposed was a mix of quantitative (Cost-Benefit Analysis, CBA henceforth) and qualitative methods (case studies and storytelling). This evaluation is one of the first examples worldwide of usage of CBA backward and forward with a long time horizon (30 years), in a standardised form for ten projects in different countries and sectors. This specificity raises issues which are novel if compared to the standard model for the ex-ante appraisal.

⁸ See European Commission (2010a) and (2010b)

⁹ See European Commission (2012b)

¹⁰ See European Commission (2012a)

¹¹ The investment projects analysed are in the transport (road, rail, seaports) and environment (water supply, waste water treatment, waste management) sectors, across five Member States: Greece, Ireland, Italy, Portugal and Spain. They are: Port of Gioia Tauro (Italy); M1 Motorway (Ireland); Egnatia Motorway (Greece); Madrid Metro Line giving access to the Barajas airport (Spain); Mediterranean Corridor (Spain); Water supply in the city of Palermo (Italy); Urban solid waste treatment in Northern Lisbon (Portugal); Solis waste treatment in Galicia (Spain); Waste water treatment in Ría de Vigo (Spain); Dublin waste water treatment (Ireland).

¹² These factors are largely inspired by the seminal work of A.O. Hirschman (1967).

3. Timing and scope of CBA

The timing of CBA affects the scope and nature of analysis. Time horizon in CBA refers to the number of years for which the inflows and outflows are provided. Although the investment horizon is in principle unlimited, in project analysis you need to consider a specific point in time where virtually all assets and liabilities are liquidated simultaneously and it is possible to verify whether the investment was a success or not. This entails choosing a particular time horizon, which should be appropriate to the project economically useful life (i.e. the period over which the project would operate) and long enough to encompass its likely mid to long term impact. The international practice suggests different periods depending on the nature of the investment: for railway or waste water a period of thirty years is advisable while for industrial projects ten years is acceptable.

CBA can be carried out at the beginning of the time horizon, (ex-ante or perspective CBA), at the end (ex-post or retrospective CBA) or even during the lifetime of the project (in medias res CBA)¹³. The scope of an ex-post CBA is, by on side, increase transparency and accountability by giving evidence to the effectiveness of the investments in relation to the stated objectives. By the other hand, it is a learning mechanism both for analysts and decision makers. Indeed, retrospective analysis may feed into ex-ante CBA of future similar projects, for example by reducing optimism bias providing systematic collection of relevant project benchmarks. They can also trigger policy learning by verifying to what extent and under which conditions the funded project actually delivered the expected long-term net benefits.

Often referred to as ex-post CBA, re-appraisal carried out during project implementation are more specific in scope and more immediately useful for decision-making than retrospective CBA at the end of the project life. They may be carried out in two different points in time: at the end of the construction phase, or after some time of project operation. The former typology is more a monitoring activity aimed at reviewing the cost, timeframe estimations and compliance with the technical requirements in the light of possible adjustments and it is basically a re-appraisal on the basis of updated information and data. The latter is more a learning exercise aimed at measuring the actual effects brought about by the project and at comparing the forecasted with the actual state of the world. This is a rather hybrid typology of CBA, sharing features of both ex-ante and ex-post CBA.

In some specific cases in medias res or ex-post CBA may rely on an existing and available ex-ante CBA of the same project. This fortunate event may provide additional insights in terms of assessment potentials. The comparison of ex-ante and ex-post or in medias res evaluation can shed light on the efficiency and appropriateness of the decision-making process and the role played by CBA in it, by asking for example whether the information set upon which the decision making process relied was sufficiently complete or whether the assumptions for future estimates were reliable. This implies updating the ex-ante with actual values based on the same analytical framework. This analysis has a clear accountability value and addresses the question 'was the financing decision worth taking?'. The value of this analysis stems not really on the assessment of the actual impact (which in some cases may require adjusting the ex-ante analytical framework and to some extent disregarding the circumstances leading to its financing) but mainly on the process and introduce the possibility to challenge the assumptions and working hypotheses made ex-ante.

Table 1 Timing and scope of CBA

Scope	Ex ante	After project completion	After some years of project operations	Ex post	Comparison ex-ante/ex-post or ex-ante/in medias res
Resource allocation	+++	++	+		
Re-direction		+	++		
Measure impacts			++	+++	
Policy learning			+	++	++
Accountability			+	++	+++
Feedback on future ex-ante			++	+	++

Source: Authors adapted on Boardman et al. (2006)

Whatever the timing is, CBA needs to be undertaken from "today's viewpoint". This means that, unless the entire project life has elapsed, the assessment of projects in the middle of their life cycles requires to deal with the stock of knowledge accrued about the past performance of the project and the external environment as well as to assume likely future development. This twofold nature of

¹³ See Boardman et al (2006)

the analysis implies a number of methodological considerations to fit the standard model into the ex-post. For example, the analysis comprises a set of historical data (from year zero until today), together with a set of forecasts of future demand, costs and revenues/benefits (from “today” until the end of the time horizon), which calls for the adoption of two sets of parameters (i.e. discount rates), to deal with a mix of current and constant prices¹⁴. The next section illustrates some technical solutions to deal with this hybrid nature of ex-post CBA.

4. Performing ex-post CBA

The key steps of an ex-post evaluation are summarised in Box 1. For each of the steps there are a number of considerations that have to be addressed. Namely:

- How to identify a proper unit of analysis;
- How to choose a proper counterfactual;
- How to deal with demand analysis;
- How to use financial data and performance indicators;
- How to value the willingness to pay;
- How to calculate proper shadow prices;
- How to calculate proper social discount rate;
- How to interpret results and draw lessons.

The following sections provides practical recommendations on how to deal with them in the context of a CBA.

Box. 1. The key steps of ex-post evaluation

According to EVA-TREN the steps of a correct ex post assessment are the following:

1. Establish exactly what has to be evaluated. The definition of what needs to be compared with what is a preliminary need that should be clearly stated. This involves the clear identification of the project boundaries, of the project main objectives and targets, and the questions the re-examinations should seeks to answer.
2. Measure the outcome of the project. The first step in measuring the outcome of the project is to establish what would have happened if the project had not been implemented. The first problem encountered in measuring the outcome of a project is to establish against what should the outcome be measured, in other words what is the reference solutions. The second issue concerns the availability of outputs and performance measures.
3. Compare the outturn of the ex post evaluation with the expected project outputs. The expected costs, revenues, demand and impacts of the project have to be compared with project performances collected in the previous step. It is not sufficient to identify and quantify the discrepancies between the ex ante appraisal and the ex post results, but as far as possible to assess what caused the discrepancies.
4. Classify the results and the causes of success and failure. It is important to distinguish among different types of discrepancies between what was foreseen in the appraisal and what was outturn in the evaluation. Only a careful distinction between forecasting errors in exogenous versus endogenous stochastic variables, and between the latter and planning parameter changes in economic analysis, can offer a meaningful ex post evaluation.

Source: Authors based on EVA-TREN

¹⁴ The mix of historical and forecast data affects the choice of the prices to be used, i.e. whether to use nominal (current) or real (constant) prices. A standard approach to be adopted is to use constant prices. This requires the following adjustments: i) Data from today onwards should be estimated in real terms (today prices, no inflation); ii) data up to and including the last reference year are historical and therefore expressed in nominal terms. In order to align the two levels of analysis, and to have only one price basis, the historical prices should be reflated so as to turn them into prices at today numeraire.

4.1. Project identification

Project identification refers to the definition of the proper unit of analysis i.e. the definition of the study area. The general criterion to be used for project identification for ex-post evaluation is that a comprehensive project should have been realised and is mature enough to enable the assessment of the effects produced. Still, in an ex-post perspective, the identification of the project boundaries (i.e. which infrastructures and operations are included in the project) is complex and affects the evaluation result. The question of 'what needs to be compared with what' is a preliminary need that should be clearly stated. This implies determining also the research questions the analysis seeks to answer.

While in the project appraisal phase the object of the analysis is usually related to a financing decision (being it either public, private or a mix of both), after some time the initial investment may have undergone several modifications and expansions which has affected the initial project design for which the original financing decision was taken. Actually, project decisions and implementation are not isolated, but are part of a wider system of public interventions, which may determine modifications to the original design, as well as the need to be physically integrated with other complementary infrastructures. This holds true especially for network infrastructures (typically transport and energy).

What to include and what to exclude from the ex-post CBA should be assessed by the analyst on a case by case basis. Two broad criteria can be used for the purpose: i) self-sufficiency, ii) pertinence.

The first criterion recalls the rationale that the object under scrutiny should be a self-sufficient unit of analysis¹⁵. This requires not focusing on too narrow an object, i.e. the assistance for a specific phase or component of a project, or on a too broad one, i.e. the assistance for a strategy or a programme of interventions. This has two implications:

- If the ex-ante financing decision was addressed to a specific phase, or a sub-portion, of a given broader self-standing intervention, the latter should be considered as the subject of the CBA.
- In cases where the financing decision was related to a project which was part of a larger set of independent interventions (a programme) all aimed at achieving the same priority (but all of them being a self-sufficient unit of analysis), the former should be considered as the subject of the evaluation.

The second criterion concerns the pertinence of the investments and addresses the issue to deciding whether modifications, new components, technologies development, etc. introduced later during project implementation have to be considered as part of the initial investment or not. Insofar as the aim of the CBA is to assess the long-term performance of the project, an initial investment has to be singled out as the subject of the ex-post evaluation. The question is how far one should go in limiting the scope of this initial investment. Some considerations are the following:

- Investments incurred after project's completion, but not occurring on the original infrastructure should be excluded from the CBA, even if they affect its performance. For example, in a transport project traffic flows are usually expected to increase substantially after the opening of additional axes of the network which may be planned or under construction at the time of the evaluation. Despite their potential influence on the project performance, such additional investments do not pertain to the original investment and thus their construction cost have to be excluded from the CBA.
- Investments in the project incurred after its completion should be included in the analysis if pertaining to it and consistent with the original logic of intervention e.g. for replacement of short life-time equipment. This is the case for example of new technologies not envisaged in the original design introduced as additional components to improve the performance of the project and deliver a better service. Such modifications, complementary and consistent to the original investment, should be considered part of the subject of the CBA. This holds true also in case such investments are undertaken by an institution other than the initial investor, for example in the case of different public agencies holding responsibilities in the operation of different segments of the same transport network. However, whenever these modifications or new components are of a scale that radically modify the original project design, so as to create a new project in themselves, they have to be considered for all purposes a new project, outside the scope of analysis.
- Investments in the project incurred after its completion should not be included in the analysis if, although pertinent, they pursue objectives functionally disconnected to the original project's rationale. For example, interventions aimed at

¹⁵ As the European Commission (2008) puts it, a project is defined as a "self-sufficient unit of analysis comprising a series of works, activities or services intended to accomplish an indivisible task of a precise economic or technical nature".

upgrading a water supply distribution system may target either reliability of supply, or improvement in water quality, or enhancing the efficiency by reducing water leakages, or even increasing the available quantity of water from natural sources and coping with periods of drought.

4.2. Reference scenario

Cost and benefits need to be compared against a reference scenario in order to adopt an incremental approach. The with-without project comparison implies ex post to identify a scenario defining – in principle - what would have happened in the absence of the project, i.e. a counterfactual scenario. Usually, as for the ex-ante, also for conservative reasons a “do nothing” or “do minimum” option are preferred¹⁶.

The adoption of the “business as usual” as an appropriate counterfactual is not problematic if the project is aimed at improving the delivery of an already existing service for which, in any case, the continuation of the position prior to the project is always plausible given the present circumstances and expectations about their future evolutions. For example, in case of the construction of a new transport segment, the reference scenario may consist of continuing to serve the destination with the existing transport modes. In the case of an upgrading of an already existing infrastructure, the reference scenario may consist of maintaining the operations of the conventional service. Again, in a water supply project aimed at improving the reliability of supply it may consist of keeping in operation the water distribution network as it is, with a minimum quality level of the water service.

However, in the case of projects that are motivated by the need to solve an urgent need which makes the ex-ante situation no longer sustainable for internal or external reasons (e.g. under capacity of the existing system, need to comply with a new regulation), a ‘do-minimum’ option (i.e. the least cost project that removes the endogenous or exogenous constraint) is considered more appropriate. As an extreme situation, the catastrophic business as usual scenario (e.g. a circumstance implying a dramatic economic loss) are not an appropriate counterfactual since they would lower the threshold for acceptance of the proposed project.

In the case of the need to comply with new environmental regulations, the “business as usual” would mean maintaining an illegal situation and perpetuating an infringement of legislations and environmental risk and so a “do-minimum” option (i.e. the least cost project that ensures compliance) must be adopted. In these cases, the “do-minimum” (i.e. the technically minimum capital expenditure to ensure compliance) should be carefully defined, so that the counterfactual scenario is both feasible and realistic and do not cause undue and no real additional benefits or costs. In practice, however, depending on sectors, the identification of an appropriate counterfactual may lend itself to an intricate debate. In the solid waste projects there are various technological options that range from a minimum to maximum, in a scale of possible alternatives that can be adopted to reach the stated objective¹⁷, thus, a minimum capital expenditure to be used as basis for comparison of costs and benefits is generally identifiable.

In some cases, however, owing to technological constraints, it can be impossible to identify a technically viable minimum solution capable reaching the stated objective, other than the project itself. In such cases, the “business as usual” option should be considered an acceptable counterfactual, as the only technically feasible basis for comparison of costs and benefits of the project. For example, under the current EU regulations, primary and secondary treatment with an advanced disinfection system are all mandatory for the treatment of waste water in large urban agglomerations. If a project aims exactly at introducing such treatments, there is no scope to identify a possible minimum intervention capable of introducing the necessary improvements in order to comply with legislation. Accordingly, the reference scenario may be that of keeping the “business as usual”, e.g. waste water continues to be directly discharged into the sea either without any treatment or with only primary treatment. Although this scenario would violate EU legislation, it should be considered as the only possible, realistic and technically feasible basis for comparison of costs and benefits of the option adopted. In this case, the CBA should however include also the costs due to possible fines imposed by the EU authorities as consequence of law infringement.

The above considerations apply to the ex-ante as well as to the ex-post CBA. However there are problems which are typical of the ex-post situation.

¹⁶ The “do nothing” consists of a continuation of the position prior to the project. In the case of an upgrade of an already existing infrastructure, this means keeping in operation the system as it was before the project’s realisation, including incurring appropriate operations and maintenance costs. For this reason, it is also called “business as usual”. The “do minimum” consists of the least cost solution involving a minimum capital expenditure to address - at least partially – the stated objectives.

¹⁷ For example, EU Directive 2008/98/EC (known as the Waste Framework Directive) introduces a five-step waste management hierarchy, where prevention, i.e. reduction of waste generation, is to be considered as the favoured option, followed by re-use, recycling and other forms of recovery, including energy recovery through incineration and composting, with disposal to landfill as the last resort management system.

The choice of a proper reference scenario in the ex-ante phase is subject to a high degree of uncertainty about the future evolution of some of the key variables. In an ex-post perspective the uncertainty is partly mitigated by the knowledge of how the circumstances have actually evolved over time, as well as how the project reacted to them. For instance, the observed trend in the demand evolution may restrict ex post the possible ranges of reference scenarios potentially deemed feasible in an ex-ante perspective. In fact, the 'business as usual' scenario may have been considered unfeasible in an ex-ante phase on the consideration of, say, an expected demand increase, while ex-post the same scenario may be considered acceptable on the observation of an actual decrease or steadiness in the demand trend.

At the same time, however, the choice of a proper counterfactual suffers from the well-known problems in historical reconstruction of the identification of realistic non-actual possible worlds. This relates not only to the choice of the initial situation but also to its evolution and the possible adaptation of the reference scenario to it. While ex-ante the future trend are based only on the forecasts of the key variables, ex-post possible external shocks should also be considered. Therefore, the point is to what extent the analyst should consider the ex-post knowledge about development of prices and quantities in order to, first, set the counterfactual and, second, to estimate the possible evolution over time of key variables in the counterfactual scenario.

Although the choice of the counterfactual may reflect a so-called "hindsight bias", which suggests that people cannot ignore a known outcome when assessing an event's likelihood (i.e. the analyst cannot ignore what the actual demand trend is) a realistic scenario is the one deemed feasible on the basis of the ex-ante knowledge. For example, the analyst should ignore the effect of an unpredictable exogenous event occurred after the project start when setting the counterfactual scenario. The same effect should however be considered, once the counterfactual is set, on the estimation of the financial and economic variables. For example, if ex-post it is observed that, due to an external shock, the demand of a given service suddenly decreases (e.g. the demand of air transport after the terroristic attacks of 11 September 2001) the choice of reference scenario should not be based on the knowledge of the occurred shock but its performance indicators should be calculated with the knowledge of the actually occurred global demand shrink.

4.3. Demand analysis

The evaluation of projects in the middle of their lifetime requires forecasting of expected outflows and inflows from today until the end of the time horizon. The analysis deals with forecasting the expected demand of users, costs and revenues from today until the end of the time horizon. Future demand of passengers, freights, volumes of water supplied, volumes and composition of wastewater discharged, tons and composition of the waste treated, etc. – on which outflows and inflows depend – should be primarily determined on the basis of the indications provided by the service operators and other stakeholders in order to derive the most likely scenario ("base case").

To do so, the past performance is the starting point. Then, forecasts can comprise either an inertial continuation of the previous trend or a deviation from it, depending on how the projects are expected to perform in the coming years and if events breaking the current trend occur or are expected. If there are no reasons to believe differently, forecasts shall just concern an inertial continuation of the previous trend. Generally, for environment projects demand is relatively stable (i.e. depending on population growth dynamics and citizens behaviour in the use of water resources) and project analysis should adopt this approach.

On the contrary, demand estimation in transport projects should consider that they operate in more competitive markets and the price and income elasticities of the demand are high. For example, in the considered projects sample, on a global and national scale transport projects experienced a non-linear trend, overall consisting of a substantial decrease in traffic after a systematic increase up to 2009, as a consequence of the international economic crisis. Care should be taken therefore that forecasts are consistent with international macroeconomic forecasts and with the expected performance of competing modes. Hence, a prudential approach would be of maintaining the negative trend in the future years and then forecasting a turnaround, following a progressive recovery from the crisis. In other cases, when indications exist that a substantial deviation from previous performance is expected in the future years, forecasts should be based on new assumptions and models. For example, the opening of new transport axes can strongly affect the future demand of a transport project for which a 'shock' in the existing demand model has to be considered.

To mitigate the risk error when forecasting the future, the main assumptions should always be tested in sensitivity, scenario and risk analyses for all projects, so as to have a range of options and calculate the expected performance of the projects.

4.4. Financial analysis

Ex-post evaluation implies going back many years. This affects data availability since detailed figures on the past performance of the project cannot be available anymore. Therefore, project analysts should adopt simplifications to the standard, fully-fledged CBA model used in the ex-ante evaluation. For example, costs and benefits have to be treated in a rather aggregate way. If, on the one hand, standard aggregate categories limit the accuracy of the analysis, on the other, they ensure a smooth methodology for data collection and for presentation of results. However, in the ex-post evaluation, the calculation of the project's financial profitability is less relevant than in the ex-ante because the financing decision has been already taken.

Cash flows to be used in the financial analysis are the same of the ex-ante evaluation. All project inputs should be divided into investment and operating costs. Regarding investment, infrastructure construction costs should be accounted for. When available, the data to be used are the incremental cash disbursements encountered in different accounting periods, disaggregated by the various types of assets necessary to build the infrastructure: land, buildings, machinery, equipment, etc. If linked to a financial decision usually such data are available in a completion report.

Concerning operating costs, cash flows should comprise the past, on-going and foreseen disbursements for the purchase of goods and services, which are not of an investment nature since they are consumed within each accounting period. As for revenues, they should include the past, on-going and foreseen inflows generated by charging the users of the infrastructure.

The ex-post quantification of the operating costs and revenues is relatively less straightforward than for the investment costs. First, when a private company is in charge of operating the infrastructure there may be an issue of publicity of accounts. If the financial accounts of the operating body are available, then there could be problem of how to single out costs (and revenues) specific to the project. This problem arises when the project is part of a wider system of functionally integrated services, for example in case of municipal public services when a unique operator is multi-services (i.e. managing not only the water supply and distribution system but also the waste water treatment and the sewage system) or in the case of a transport network when a single segment needs to be isolated (e.g. a particular rail line in the entire rail network). In this case it is necessary to adopt assumptions to hive off inflows and outflows from the totals, for example by applying a standard ratio to the totals in order to isolate costs and revenues related only to the specific service provided by the project. In so doing, standard values available in the literature of costs related to a specific service can be adopted as a reference value.

Financial analysis carried out ex-ante has two main objectives: first, to assess that the project is in need of public funding, which is proved by a negative financial profitability (i.e. NPV lower than zero) and to assess that the business will be sustainable in the long run, which is proved by a positive financial sustainability (i.e. the cumulated net cash flow is never negative along the entire timeframe of analysis). Such an analysis, carried out ex-post, is less relevant. It can be informative, however, to judge whether the level of public funding was actually in line with the capacity to generate revenues by the project or rather over or underestimated. However, in an ex-post phase, the financial capacity of the operator rather than the sustainability of the project itself is more relevant. For example, the Greek Egnatia motorway proved to be financially unsustainable since the foreseen tolling strategy was disregarded for reasons of political consensus, but the project was actually financed with a national budget contribution to the public operator. In principle, the opposite can occur as well: a project can show positive cash flows, but, considering the other services, the operator may be not in the overall financial position to ensure its operation and maintenance. Thus, an assessment of the long-term financial position of the municipality, the railway operator, the port authority and so on by calculating the standard accounting indicators such as EBIT (Earnings before Interest and Taxes), ROA (Return on Asset) and the like is more appropriate at an ex-post phase. It should be noted that, when the operator is a state-owned company, its solidity also depends on the financial and institutional agreements in place with the government.

4.5. Willingness to pay

In economic analysis, the methodologies adopted in the ex-post evaluation to identify, quantify and value non-market costs and benefits do not differ, in principle, from those used in the ex-ante phase. One difference is that ex-post evaluation offers the opportunity to observe already materialised effects, in alternative to only short-term results as it is the case in the ex-ante appraisal. To provide an example, in a project of drinking water treatment, while ex-ante it is more likely to use a willingness to pay estimate which reflects health benefits, ex-post the health benefits may have materialised as a consequence of the systematic provision of purified water and can be directly measured for example through saved costs for hospitalization. A similar approach could be adopted for a transport project aimed at reducing travel time for a given journey, by looking, ex-post, at the increased business volumes induced thanks to reduced travel times for freight.

The approach of evaluating long-term effects requires careful considerations of the attribution of the causality link. In fact, the observed welfare change may have been caused by a mix of factors not fully attributable to the project only. Again, in the example of the drinking water treatment, the observed reduced morbidity may be the consequence of a mix of factors, including –but not exclusively – the project. Therefore the analyst must single out the costs for hospitalization saved due only to reduced morbidity of a water quality-related disease. Similarly, in the other example, a new road is likely to contribute to the creation of new businesses in its area of influence but other factors may be important too.

Revealed preference approach are more suitable in an ex-post situation than stated preference methods because they infer non market benefits with data on observed behaviours. Instead, contingent evaluation is based on hypothetical questions on future behaviour, therefore it is more appropriate when assessing the desirability of a policy option rather than assessing the actual effects of it. An ex-post contingent valuation would imply gathering opinions based on actual knowledge and direct experience of the effects of an already taken decision rather than on hypothetical guess. However, ignoring a known outcome while recreating a decision is a difficult cognitive task. In this case the contingent valuation could rather address a willingness to accept for, as instance, giving up to the received benefits.

Comparisons of ex-ante with ex-post willingness to pay provides interesting results (see for example Whitehead and Cherry 2004). Experimental results in social psychology show the tendency for hypothetical willingness to pay to overestimate real willingness to pay. This is usually addressed with corrections in the survey design like for example reminding the budget constraints or trusting only the most certain respondents.

The ex-post knowledge influences the calculations of benefits and costs also because perceptions and information evolving over time impacts on the actual willingness to pay of users. For example, ex-post valuation of non-market effects is based on a better knowledge about the factors to which users attribute value, as shown in Bråthen and Hervik (1997) reporting the underestimation ex-ante of the willingness-to-pay due to omitted factors (e.g. the inconvenience costs of travel flexibility in case of a fixed link with fixed-scheduled operations).

4.6. Shadow prices

To reflect the opportunity cost of inputs, also in the ex-post evaluation, the cost items of financial analysis should be converted into shadow prices, by means of appropriate conversion factors. In the application of this methodology, the following methods should be adopted:

- whenever possible, specific conversions factors for each category of cost should be derived from national guidance documents. In the absence thereof, conversions factors should be estimated on the basis of expert opinion.
- When the above approach is not possible, country-specific Standard Conversion Factors shall be used.
- For labour, regional-specific shadow wages available in the literature should be adopted. However, where considered more appropriate, country-specific shadow wages, calculated on the basis of a formula for which the conversion factor is inversely correlated to the level of unemployment, could be used.

One of the main issues concerning shadow prices and specific to the ex-post evaluation is that two sets of conversion factors can be developed for the two levels of analysis (past and future). Given the twofold nature of the analysis adopted, as for the Social Discount Rate and other parameters, developing two different sets of conversion factors (one backward and one forward) would be appropriate. This is because the social opportunity cost of a good or service can change over time, as a reflection of changes in fiscal requirements, levels of administered tariffs, composition of non-efficient markets, and so on.

However, such an approach in the context of the EU-15, where markets can be considered relatively stable, and definitely less dynamic than for instance in developing countries, would produce negligible effects on the final results of the evaluation. Thus, the application of one set of conversion factors throughout the whole time horizon is justifiable.

Another issue is that, given the use of aggregated cost-items, many conversion factors also have to be aggregated. In these cases, when the accounted item is a combination of other primary items, the conversion factor is calculated as a weighted average of the factors calculated.

4.7. The social discount rates

In order to calculate the economic performance indicators from today's point of view, appropriate Discount Rates should be adopted in the analysis so as to capitalise the cash flows of the past and discount those of the future. In line with the definition provided in the European Commission (2008), according to which "the social discount rate reflects the social view on how future benefits and costs should be valued against present ones and [...] is based on estimates of long-term growth potentials" of a given country, it is reasonable to have a dual approach. Recognizing that economic growth is not uniform between countries, different rates for different countries should be used and, within each country, two rates adopted for future and past values. The following backward- and forward-discounting rates have been calculated and used in the ex-post evaluation on the basis of data collected from Eurostat, the IMF and OECD (see Table 11.2).

To verify the robustness of these values, for each project, an uncertainty analysis¹⁸ should test different assumptions for the SDR and explicitly consider the social opportunity cost of capital approach to verify the robustness of the model adopted.

Table 2 Social discount rates for ex-post evaluation

COUNTRY	ADOPTED VALUE FOR THE BACKWARD SDR (up to 2011)	ADOPTED VALUE FOR THE FORWARD SDR (from 2012)
Ireland	9.1	4.0
Italy	2.9	2.4
Spain	5.4	3.3
Greece	6.1	3.2
Portugal	4.2	2.9

Source: European Commission (2012)

The application of this methodology put some hints for reflection, especially when there is a large difference between the backward and the forward SDRs. As the SDR is a summary statistics for the social opportunity cost of capital, it is a variable depending upon the growth opportunities of the country. This is also true for several other shadow prices, which are instead usually treated as parameters in CBA. While treating shadow prices as parameters at any given point in the timeline is generally the most sensible approach, the SDR is too intimately related to growth prospects to ignore structural breaks in the country growth prospects.

In case of significant global economic crisis, the pragmatic baseline approach is to acknowledge this fact by using a backward and forward SDR, with in fact the latter being considerably lower than the former. In so doing, two subtle and interesting issues arise. First, it may be the case that the forward SDR is a more realistic estimate of the social opportunity cost of the capital for an economy, as the previous growth rate was unsustainable, for example because inflated by an asset bubble or excessive debt. Hence, one should use a unique rate, the backward one being estimated by the forward one. This, however, may underestimate the potential of the economy, as the current growth prospects are hampered by structural unbalances, which manifest themselves in high unemployment rate and low utilised capacity. Using the two rates seems a realistic compromise between two possible errors in opposite directions. An alternative would be to use an average SDR, and the impact of the different assumptions can be tested by an uncertainty analysis.

A second issue that arises when the SDR forward is lower than backward is the following one. The capitalised backward flows include most of the investment costs, and in initial years will typically be negative. The discounted future flows are made up of mostly operation flows, and are typically positive. A lower discount rate would necessarily increase the Net Present Value of the project. This may seem a paradox, as the crisis has a positive impact on the project performance. This counter-intuitive result is, however, consistent with the fact that the low utilisation of real capital in the economy makes it less valuable, hence future flows need to be discounted less.

¹⁸ The uncertainty analysis aims at testing the elasticity of the project economic performance to some methodological assumptions. In contrast to the sensitivity analysis, it does not relate to the hypotheses made on the future trend of certain variables but it is aimed at testing the robustness of some assumptions and parameters used in the economic analysis, including the Social Discount Rates. It is therefore a sort of test of the methodology used, where variations in the parameters are not the result of the uncertainty about the future but relates to methodological choices made.

To sum up, since the SDR depends on economic growth potentials, the timing of an ex-post evaluation in terms of economic cycle affects the value of the discount rates. In particular, the recent worsening of the economic situation in the EU countries, by influencing the forecasts about the future economic growth rates, affects the results of the CBA through the estimation of a suitable SDR and it may generate an increase in the economic viability of the projects. This can be accepted overall, however, consideration should be given to the realism of SDRs adopted, which values should be always tested in an uncertainty analysis to verify that assumptions based on country macro-economic conditions are not distorting the results of the analysis.

The above mentioned considerations can be misleading if one does not adopt a critical perspective on the suitability of the past data as a reliable indicator of the economic growth of the country. In fact, the value used for the backward discounting, calculated upon the average GDP growth rate reported for Greece between 2003 and 2007 (equal to 4.01%, according to the IMF), has been revealed to be unrealistic in real economic terms. It was in reality an unsustainable trajectory ending up in depression.

To a smaller extent, this situation is present also in the case of the two Irish projects of the considered sample, for which a decrease of the SDR from 9.1% to 4.0% has been adopted. Fluctuations of these assumptions, as tested in the uncertainty analysis, did not generate a negative ENPV, but the overall effect of a decreased forward SDR was that of boosting the economic performance of the projects. Again, the question is to see whether the available data about pre-crisis growth should be considered as a good indicator of the real economic growth of the country or not, and then choose the rates considered most appropriate.

Without entering into a complex debate about to what extent the economic growths reported in the past years for some EU countries are based on a solid economic trajectory rather than asset bubbles, it is worth here highlighting that:

- the choice of the two SDRs affects the results of the CBA analysis;
- the adoption of country-specific reference values guarantees consistency across projects implemented in the same Member State;
- given the possible unrealism of the statistical indicators upon which SDRs are calculated, the latter should always be tested in an uncertainty analysis to verify the robustness of the model and, in case results show high sensitivity to the choice made, additional analysis should be carried out to identify the most appropriate values.

4.8. Interpretation and intuition

Ex post evaluation is not about discovering deviations from forecasts per se, but understanding the causes behind the deviations. While CBA is a useful tool to measure what has been achieved by the project, there is a step forward that needs to be done in a useful ex-post evaluation.

The logic of CBA (identification of objectives, options analysis, demand analysis, forecasting and measuring financial outflows and inflows, forecasting and measuring cost and benefits on social welfare, aggregating and, by discounting, calculating a synthetic index) is a good framework to disentangle single important aspects expected to influence the project performance and final outcome. However, the experience tells us that the outcomes of development projects are the result of a unique combination between incidental environmental, socio-economic, institutional and cultural circumstances as well as the way the project reacts to them.

Since long-term impacts of major infrastructure projects are multi-dimensional in essence they may be difficult to apprehend in overall quantitative terms. The level of analysis of project performance ranges from economic and technological aspects to organisational and administrative arrangements until socio-political and environmental dimensions. Projects' long-term contributions to economic development and quality of life may include effects of very different nature: macro-economic results on GDP and employment, institutional learning of key stakeholders, improvement in the living standards of the affected citizens, social inclusion outcome, political awareness and many others. The latter are difficult to translate into monetary terms. Moreover, by definition a development project is a socially and culturally embedded process, hence aspects of the performance of the project, such as the contractual arrangements, the ownership structures, the social acceptability or the sharing of responsibilities within the main stakeholders, are not captured with a traditional CBA approach. For all these reasons, it is advisable to build on the CBA result and expand the analysis to more qualitative information.

Historical reconstruction has to be used to understand causal pathways and answer the key evaluation questions related to the reasons behind a given performance. If the ultimate goal of the ex-post evaluation of complex project is really to understand 'how things work', a methodology combining direct observation, interviews to key players and field visits, bringing as much viewpoints as possible from the ground need to be implemented, combined with acute interpretation.

A master example of this comprehensive methodological approach to ex-post evaluation is the inspiring work of A.O. Hirschman in its book *Development Projects Observed* (Hirschman, 1967), where he reports about the results of a number of investment projects financed by the World Bank all over the planet. In this unsurpassed exercise of ex-post evaluation of individual projects, the author points on the one hand to the different nature of sources of uncertainty (ranging from technological problems to religious aspects) challenging the project performance during its lifetime, and on the other hand to the mechanisms motivating the key actors to undertake achievement-oriented behaviours.

In the emerging picture, the most informative aspects, more than the appraisal of the actual results achieved, are the description of the process through which such results were achieved and behaviours of the different actors. In particular, without denying the importance of scientific approach to investment choices, he unveils the importance of aspects that cannot be straightforwardly treated in technical terms, which are sometimes the determinants of success and failures of a project. He uses the expression of the 'hiding hand' to stress how the obvious unfeasibility to predict every future state of the world, which translates in a systematic underestimation of the costs or difficulties of a project, may be beneficial, being indeed the occasion for creative solutions and unplanned resources and energies to be put in place during the course of the project that otherwise would have not materialised. Clearly being something of a provocation, and without singing the praises of non scientific approaches to investment choices, his observations suggest that a key success factor of a project is its capacity of promptly adjust to unpredicted events (resilience) and to manage the sources of uncertainty.

Disentangling the impact of economic change from a number of concurring forces is intellectually challenging. A combination of qualitative and quantitative analysis is necessary but usually not sufficient, and in most cases there is the need to conjecture on the drivers of history and of counterfactual histories. This evaluation work is similar to digging different layers of ground to discover buried structures. When a long-term perspective is adopted, ex-post evaluation is far from being based on hard facts alone. It needs a dose of intuition, if not creativity, in trying to distil lessons learned.

CBA and the decision making process

There is no reason to think that the outcome of a development project will be exactly what was predicted in advance. There are a number of reasons explaining ex-ante/ex-post deviations, but the key consideration is if they are of an endogenous (e.g. errors or inaccuracies made ex-ante or during project implementation¹⁹) or exogenous nature (e.g. change to the external environment caused by the materialisation of unpredictable events). Project evaluation can do anything in relation to external shocks, being they hardly predictable and outside the control of the project management. Instead, there is large scope to reduce endogenous source of risks influencing project performance. The main idea here is that endogenous forecasting error is a matter of cost, effort, or incentives of the ex-ante evaluation.

A vast literature exists providing evidence of systematic underestimation of investment costs and overestimation of demand in ex-ante CBA of large infrastructure projects (see Flyvbjerg et al. 2003). Following Flyvbjerg (2007) there are three broad categories of explanations for this:

- technical explanations: errors and pitfalls in forecasting techniques,
- psychological explanations: planning fallacy and optimism bias,
- political-economic explanations: planners and promoters may deliberately and strategically overestimate benefits and underestimate costs when forecasting the outcomes of projects.

Not only systematic ex-post CBA can do a lot to improve forecasting techniques and mitigate optimism bias, but there is also scope for minimising strategic misrepresentation in project appraisal. This arguments has to do with the institutional setting of the decision-making process and the role of CBA in it.

While standard CBA theory virtually offers a solid framework for project planning and evaluation, the information and incentive structure surrounding these activities is often such that it undermines the credibility of CBA itself.

¹⁹ Boardman et al (1994) distinguishes between omission errors, forecasting errors, measurement errors, and valuation errors.

Empirical literature shows that the decision to implement a certain project is often taken by the authorities before an ex ante analysis is actually carried out. In these cases, such appraisal respond more to the need to justify a decision already taken than to understand the best decision to take²⁰.

When assessing the complexity of the stakeholders' maps there could be the recognition of possible conflicting objectives during decision making process. The functioning and the interests of the different levels of public administration and other stakeholders can make the decision making processes slow and open to mismanagement, therefore causing delays that influence the project costs negatively. When opportunistic or myopic behaviors are at play, the decision making process will necessarily depart from the rationale of social welfare maximization. Not only there are different 'bureaucratic lenses' to watch at the CBA²¹ due to organisation and political pressures (for example competition for scarce funds), but there are often hidden agendas and clear economic or political interests in disregarding and even manipulating the CBA results. For example: central funding agencies may follow an expenditure-driven approach also to raise political consensus and have different constituencies than line departments or local administrators; line agencies compete for scarce funds; private companies tend to adopt the cheapest technology to maximize their profit; project analysts may be willing to praise the client rather than critically scrutinize the projects in order to get additional assignments in the future, or not invest in sophisticated and reliable but costly forecasting techniques.

The problems described above may be mitigated or exacerbated by specific features of the institutional setting or the funding mechanism. For example, Florio and Vignetti (2005) and Florio (2007) show the incentives at play to strategic misrepresentation in the EU Cohesion Policy framework, characterized by a multi-level governance setting with information asymmetries and potentially not aligned strategic objectives of the different institutional layers as well as a funding mechanism designed in order to co-funding the financial gap in investment costs rather than rewarding the best performing projects in terms of expected development effects. In this setting there may be incentives for national and regional authorities to maximizing the absorption of funds and promote ready to implement, low risk and consensus-driven investment projects. In addition, since CBA results are used to decide on co-financing and determine the grant amount, there is an incentive to overestimate both investment costs and social benefits.

In the same vein, Gómez-Lobo (2012) illustrates how a consistent framework for identifying, coordinating, evaluating and implementing public investments project, as embedded in the Chile's National Public Investment System (SNI), including, among others, i) a legal requirement to evaluate all investment initiatives; ii) a system of "checks and balances" by separating the institution that reviews and approves the appraisal of projects from the institutions promoting projects; iii) multistage evaluations with various filters and supervisory and quality control mechanisms; iv) a system of norms, procedures and methodological support including the centralized definition of social prices, v) ex-post evaluation.

Conclusions

Evidence from international practices shows that ex-post CBA is not as widespread as its potential role in terms of policy learning would recommend. The European Commission recently promoted re-appraisals in the transport and environment sectors of samples of projects financed within the 2000-2006 programming period, as well as a pilot study assessing long-term effects of a sample of ten projects financed in the 94-99 period.

CBA can be performed at different points in time of project time horizon. Accordingly, it can have different nature in scope and rationale, ranging from resource allocation to project restructuring until policy learning and provision of feedback to the ex-ante stage. Ex-post or mid term CBA implies having a backward looking perspective. While in principle this means using actual instead of forecasted values on the same methodological approach of the ex-ante stage, in practice there are a number of considerations that are typical of the ex-post perspective.

Mechanisms to generate better evaluation and planning revolves around the proposal that information on ex-ante and ex-post project returns be accumulated within the institutions, and be used to establish benchmarks and incentives for best performers.

²⁰ Flyvberg, 2007, calls it the 'survival of the unfittest', that is to say that it is not the best projects that are built, but the most misrepresented ones

²¹ Boardman et al. (2006) identifies 'guardians' (i.e. central budgetary agencies which tend to have a bottom-line budgetary orientation, with controllership or accounting functions within line agencies) and 'spenders' (i.e. line departments managing expenditure programmes, with a tendency to regard expenditures on constituencies as benefits rather than costs) as opposed to analysts.

When ex post evaluation is part of the project cycle and the decision making process, it can improve the ex ante appraisal and project management by speeding-up the process and taking corrective actions enhancing a result-oriented behaviour. Besides helping to make more realistic estimates in the future, ex post evaluation can be even more useful to take corrective actions and to build confidence in the appraisal process by introducing the concept of linking the access to funds to the conditionality of achieving the targets initially set. This is achieved by formalising the process of deciding on the allocation of funds in such a way that availability of the funds is conditional to the achievement of results, as described by a set of performance indicators.

Ex-post CBA is more effective if incentives at different points of the decision-making process are introduced to promote rationality in the ex ante analysis of the project's future performance, strengthening budget constraints and financial responsibilities. The incentive mechanism should be designed in such a way that a bond between who takes the decision and who will be responsible for it in the long term is ensured.

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