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Cost-benefit analysis represents the most frequent technique used for a rational allocation of resources. This modality of evaluating the expenditure programs is an attempt to measure the costs and gains of a community as a result of running the evaluated program. It is not a direct decision making tool, but one that leads to a decision that is better focused, if it is accurate. The aim of this paper is to present the methodological issues involved in achieving a cost-benefit analysis for the investment projects financed from public funds.

Key words: cost-benefit analysis, social benefits, investment project, public funds, sensitivity analysis.

JEL code: G11, G17

1. Introduction: cost – benefit analysis evolution and purpose

The development of an investment project (transport infrastructure, waste management system, research center, land improvements, production or distribution of electricity) may cause benefic effects such as local or regional economical development, transport flows optimization, pollution reduction, improving the performance of soil, but it can also have negative effects such as the demolition of properties, displacement of population, decommissioning of land, noise, environmental modification. For most types of projects, their impact on the environment (natural and anthropogenic, in all its components) causes the creation of an *intrinsic economic value*. Therefore, in order to select the optimal variant of an investment project (from both constructive and operational aspects) it is necessary to accurately estimate the investment's costs and benefits, not only through financial performance, but also through the economic - social one, whose effects are transmitted in the development of the region in which the project is implemented.

In literature and in current practice, a methodology highlighting the feasibility of investment projects in terms of economic and social impact is the cost - benefit analysis (1). Its main purpose is to help decision-making for realizing a project from the economic, financial and social criteria, facilitating a more efficient allocation of the society's resources (2). Otherwise formulated, the purpose of the cost-benefit analysis is to highlight the fact that the impact is not greater than the net benefit of society (7, 8). The society's net benefit is the amount of cash and non-monetary benefits given by a rational exploitation of the environment determined by the relationship (2):

$$SNB = \Delta CB + \Delta PB + \Delta BR \quad (1)$$

where ΔCB, ΔPB, ΔBR represent variations in consumers' benefits, producers' benefits and in budget revenues resulting from the project's implementation. Since all these three sizes can be both negative and positive, the social net benefit can also be positive or negative.

Cost-Benefit Analysis (CBA) estimates and totals up the equivalent money value of the benefits and costs to the community of projects to establish whether they are worthwhile. The idea of this economic accounting originated with Jules Dupuit, a French engineer. The British economist, Alfred Marshall, formulated some of the formal concepts that are at the foundation of CBA. But the practical development of CBA came as a result of the impetus provided by the Federal Navigation Act of 1936. This act required that the U.S. Corps of Engineers carry out projects for the improvement of the waterway system when the total benefits of a project to whomsoever they accrue exceed the costs of that project. Thus, the Corps of Engineers had created systematic methods for measuring such benefits and costs. The engineers of the Corps did this without much, if any, assistance from the economics profession. It wasn't until about twenty years later in the 1950's that economists tried to provide a rigorous, consistent set of methods for measuring benefits and costs and deciding whether a project is worthwhile. Some technical issues of CBA have not been wholly resolved even now but the fundamental presented in the following are well established (3). If until the '60, cost benefit analysis (CBA) was used to assess investment projects such as water management plant (using water as a resource or as a means of transport - to prevent flooding, hydroelectric works, water supply, sewers, hydro-transport, etc.), since the 1970s, the method has been translated and used in other projects with public funding (and not only), which generates an impact on the environment (1).

In conclusion, we can say that cost-benefit analysis is presently among the most widely used techniques for the rational allocation of resources. It is essentially an attempt to measure costs and gains of a community following the implementation of the program or project. In itself, CBA is not a direct decision making procedure, but one that leads to a decision that is better focused, if its compliance (4).

2. Methodology to achieve a cost benefit analysis: steps, approaches and limitations

The cost - benefit analysis has two temporal variants. Thus, the ex-ante CBA (its usual meaning) is performed during the period of project studies, when the opportunity to start and implement the project is analyzed, the desirability of resource allocation (limited) to run. Ex-post CBA is done after the project's finish, when all resources are allocated and used to achieve it, and it will determine how the initial forecasted opportunity materialized. The informational value of ex-post CBA is greater, but less direct, providing information not only about the project itself but also about the manner in which similar types of projects would be appropriate. Besides these two variants, a CBA during the project's life (in media res) may be conducted, certain elements of it are similar to those of ex-ante analysis (therefore projective), and others are similar with an ex - post analysis. There is a fourth option, which compares an ante with an ex-post CBA (or, eventually with an in media res) for the same project (2).

The realization of a thorough CBA involves eight steps (2):

1. *Identifying the scenarios and the set of alternative options for the project.* In a broad sense, the project is a set of tasks and activities related and indivisible economically, with identifiable goals and a set of allocated resources. For each project, three possible scenarios should be considered:

- The alternative to doing nothing, to be considered at least to compare the situations with or without the project, being also called the initial scenario, or status quo;
- The alternative to do a minimum, to improve an existing situation (for example, to strengthen the high-speed European highway connecting two localities)

- The alternative to realize the project, based on a concept or a technological alternative (eg, to link the two cities by a motorway).
For the project, there are more alternative options, which in some cases are extremely numerous and with reference to the constructive, technological and operational aspects.
Typical examples of options are (6):
- different routes, or different construction timing, or different technologies considered for transport projects (for example, for a highway: the material used for the running surface, the number of lanes);
- large hospital structures rather than a more widespread offer of health services through local clinics (for the healthcare public programs);
- the location of a production plant in area A, nearer to the end markets, versus area B, nearer to the suppliers;
- different peak-load arrangements for energy supply;
- energy efficiency improvements rather than (or in addition to) the construction of new power plants.
In general, when dealing with options, pricing policy is often a decision variable – and will have an impact on the performance of the investment, not least through influencing demand. Thus, the relationship between each option and the assumptions on tariffs, or other prices, should be explored. The combinations of locations, investment expenditures, operating costs, pricing policies, etc., may amount to a large number of feasible alternatives, but usually only some of them are promising and worth detailed appraisal (6).
2. *Identifying the entities that will receive the benefits and those who will bear the costs.* They form the stakeholders of the project; their impact is dependent on the extent and relevance of the project (local, regional, national). Stakeholders are defined as persons, groups of individuals, institutions, organizations, companies etc. which may be related, directly or indirectly, with the project or program. In order to maximize social and institutional benefits of the project or program and to minimize the negative impact, in the analysis of the stakeholders, all the factors which could influence the project either positively or negatively are identified. Actually, the stakeholders' analysis must take place at an early stage, the stages of identification and formulation of the project or program (9).
3. *Impact evaluation and selection of measurement indicators*. Impact, in general, means inputs (resources needed for the project in terms of costs) and outputs (results of the project in terms of revenue). Significant impacts are divided into benefits and costs for which indicators and measurement units are established to use in quantifying impacts. In order to reach a conclusion as to the desirability of a project all aspects of the project, positive and negative, must be expressed in terms of a common unit. The following categories of costs are considered in a cost-benefit analysis (1):
- Direct costs (eg project cost, consultancy cost, land cost, construction costs, technology costs, operating costs, management costs, training, financing costs, etc.).
- Indirect costs, from externalities which can in turn be addressed in terms of: i) the market price (property value decrease, costs for environmental rehabilitation, costs of pollution prevention, recycling costs, costs of population transmutation, costs of health caused by pollution or hostile environment, the replacement cost of productivity losses in tourism or agriculture, etc.). ii) the shadow price (the opportunity cost of goods, sometimes different from current market prices and from regulated tariffs, they are used in the economic analysis to better reflect the real costs of inputs to society, and the real benefits of the outputs).
These types of costs are related to benefits such as:
- Direct benefits, grouped in: i) financial benefits (profit) - Revenue from sales of goods and services, ii) economic benefits (economic development, local, regional, national – especially in infrastructure development projects, economy of resources used in manufacturing, the

organization's image and its position's strengthening on the internal and external market towards its customers and suppliers) iii) social benefits (increasing of employment and strengthening social stability);

- Indirect benefits, generated by externalities grouped in: i) market benefits (increased property value, lower public health expenditures, avoiding the costs of pollution prevention, increased productivity in some sectors like tourism, agriculture, fisheries, economy of cost achieved by decreasing the level of environmental taxes - for projects of environmental infrastructure); ii) Benefits due to the shadow price (environment and eco-system conservation, reducing noise, emissions and effluent pollution, natural habitat conservation, historic, cultural and recreational sites preservation, public and private services quality increase etc.).

The project has a direct impact on users, workers, investors, suppliers, etc. but also indirect impacts on third parties. The risk of double counting project benefits should be carefully considered. In general, indirect impacts in secondary markets should not be included in the economic appraisal, whenever an appropriate shadow price has been given for the benefits and costs. For instance, the impact of a highway on the local tourism sector, e.g. through the additional employment or additional added value should not be included in the CBA when an appropriate shadow wage has been used. As a general rule, market effects (quantity or price changes) in undistorted secondary markets should be ignored, assuming that the appraisal has considered (6)

4. *Forecasting quantitative effects throughout the project's life*. Investment projects generate continuous effects through time, respectively over the life of the project's outcome of the reference period. This CBA step involves quantifying all the effects for each project alternative for the entire lifetime. For example, in a highway construction project, it will be necessary to assess the number of vehicles that cross the highway, the number of vehicles that cross the old routes, the proportions of passengers on different categories of vehicles (trucks, buses, automobiles, personal automobiles) and, using statistical information, to estimate the reduction of carburant consumption, the saved time of travel, the number of accidents avoided, the number of lives saved (a new highway will save lives for two reasons: it is shorter therefore the total number of accidents is lower, and it is safer, so the average number of fatal accidents per km will decrease). At this stage, it is very important to establish the correct reference period, which is the maximum number of years for which forecasts are provided. Forecasts about the future project should be made for a period of time close to its economic lifetime and long enough to cover its medium and long term impact. The sector reference period for projects financed from structural funds, based on Commission recommendations, is presented in Table 1 (6). These limits are considered to be relevant in most cases, but specific time horizons may be used, determined according to the particular characteristics of the analyzed project, when an appropriate justification is. In such cases, the analysis must accordingly justify the choice of a different reference period.

Table 1. The reference period for CBA through different sectors

Sector	**Reference period (years)**
Energy	15-25
Water and environment	30
Railways	30
Ports/airports	30
Transport infrastructure	25-30
Industrial production facilities	10
Other services	15

5. *Determining monetary value of the effects*. In order to be comparable, the effects should be expressed in the same measurement unit. The most convenient common unit is money. This means that all benefits and costs of the project should be measured in terms of their equivalent money value. A program may provide benefits which are not directly expressed in terms of money but there is some amount of money the recipients of the benefits would consider just as good as the project's benefits. For example, a project may provide for the elderly in an area of free monthly visit to a doctor. The value of that benefit to an elderly recipient is the minimum amount of money that would take that container instead of the medical care. This could be less than the market value of the medical care provided. It is assumed that more esoteric from benefits such as preserving open space or historic sites have a finite equivalent money value to the public.
The project's costs, from an economic point of view (in addition to the financial ones), are measured in terms of their opportunity costs, representing the society's loss of opportunity caused by the use of limited economic resources compared to an alternative use of funds in other purposes. Similarly, the economic benefits of the project can be measured in terms of avoided costs, as a result of project implementation, or in terms of external benefits resulted from the project's implementation and which are not included in a simple financial analysis.
Compared to the financial flows of a classical financial analysis, the monetary flows included in the CBA use two corrections (10):
- Fiscal correction and price conversion. Fiscal adjustments are needed for those elements of the prices that are not related to the content of the opportunity costs of involved resources. From this standpoint, the corrections will include deducting indirect taxes (eg VAT), subsidies and simple transfers (eg, payment of social security). Once the tax adjustments are considered, it is necessary to use those prices that reflect adequately the economic value of the envisaged resources. The project's cost conversion from market prices to accounting prices involves detailing costs in different categories, applying a specific treatment for each case (eg for a land to be used by default in the project, even when no financial cost is included in the project's cost, the land being made available without cost by the beneficiary of the project, the costs correction aims the net product adjustment that would have been obtained on the specific land if it had not been used for the project; in the case where the land has been acquired at market value, the conversion factor applicable is 1, if it is considered that the market value reflects the present value of future achievements, otherwise, the adjustments to reflect economic costs will be calculated in each case).
- Externalities integration / monetization. Externalities (positive and negative) are present in all proposed actions and depend on the specifics of the projects. It is therefore necessary to identify externalities case by case when the CBA is done. The most difficult part is their monetization and inclusion in the analysis, since it will lead to their transformation into economic terms by assigning a price or a cost. The difficulty is that, by definition, externalities do not have a price determined by the market, it is therefore necessary to use approximations to convert them into economic terms. But, to avoid distortion, it is necessary to restrict the analysis at those externalities for which there is a strong economic justification and for which a monetization or a realistic estimate is possible. In other cases, when monetization is difficult to justify, the identified externalities may be introduced as part of a multiple criteria analysis, for example in the selection of options.
6. *Upgrading the benefits and costs*. To evaluate and compare the programmed costs that lead to future costs and benefits, it is necessary to obtain their present value, using the update of these amounts (4):

$$\text{UPB} = \sum_{t=0}^{n} \frac{B_t}{(1+a)^t} \qquad (2)$$

$$\text{UPC} = \sum_{t=0}^{n} \frac{C_t}{(1+a)^t} \quad (3)$$

where UPB - the updated total project benefits, UPC - the current total cost of project, a - the rate of update (financial, for the financial analysis, social – for the economic analysis), n - the reference period of the project (years) Bt - benefit of the t year, Ct - cost of t year (which includes both investment costs and operational ones).

Choosing the most suitable update rate is still a controversial subject. If for the financial analysis as part of the CBA, choosing the financial update rate is not so difficult, for choosing the social update rate the debates between theorists and practitioners are still far from a consensus. Therefore, the social update rate is one of the important variables in the sensitivity analysis. For projects financed by EU funds (structural instruments or complementary actions), update rates are determined a priori: 5% for financial analysis and 5.5% for the economic.

7. *Calculating economic net present value for the project*. For each alternative of a project there is determined the net present value:

$$ENPV = UPB - UPC \quad (4),$$

The project is accepted if ENPV> 0. When for a project there are several alternatives, the alternative that generates the largest ENPV (assuming there is a positive ENPV) is selected. If there isn't a positive ENPV, then no project alternative is higher than the inertial scenario (status quo), which should therefore remain unchanged. Certainly, the financial analysis also calculates a financial net present value (NPV), but publicly funded projects relate more to ENPV than NPV since the stakeholders are not just financers, for which NPV counts.

8. *Sensitivity and risk analysis*. Its objective is to assess the stability and performance of the indicators of project feasibility. The sensitivity analysis seeks to identify critical variables and to determine their potential impact on the project's performance indicators, and risk analysis aims to estimate the likelihood that these changes occurred, the results of these analysis are expressed as estimated mean and standard deviation of the indicators mentioned. The relevant performance indicators considered in a risk and sensitivity analysis are RFR/C (rate of financial return reported in the invested capital) and NPV for the financial analysis, ERR (economic rate of return) and ENPV for the economic analysis.

The sensitivity and risk analysis is performed in three steps (10):

- Identifying the critical variables and establishing those variables that are considered critical to the performance indicators of the project, achieved by changing the percentage of + / - 1% of a set of variables of the project and calculating the value of performance indicators. Any project variable for which the variation of 1% will produce a change by more than 5% in the basic NPV or ENPV amount will be considered a critical variable;
- Calculating switching values of critical variables, which represent the variation (in percent) of the critical variable that makes the NPV or ENPV performance indicator analyzed to pass through zero;
- Estimating the probability distribution for the indicators of profitability - this step involves a qualitative assessment of relevant factors that may affect the critical variables values and the measures already included in the project in order to reduce the impact of these factors.

Consequently, there are two options for quantifying the values' level of safety calculated for the performance indicators:

- If there is reasonable information to determine the critical variables probability distribution, then it is possible to use the Monte Carlo statistical method or similar ones, which assigns simultaneously random values for the critical variables (in the expected distribution) for a large enough number to obtain a distribution probability for each of the performance indicators, therefore each performance indicator is expressed as mean and standard deviation of all variables obtained by repetition;

- If there is no reasonable information to determine the probability distribution of critical variables, then the risk analysis will be done by defining the optimistic, neutral and pessimistic scenario that includes all critical variables and calculating three extreme values for the performance indicators based on the three scenarios.

3. Conclusions

The cost benefit analysis is focused on how the resources should be allocated, being therefore indicative. It is not a positive or descriptive theory, about how to take decisions on resources allocation, but only one element, an entry date into the decision making process. It is merely an analytical tool (mostly effective), used to estimate (in terms of benefits and costs) the social and economic impact due to the implementation of certain actions and / or projects. The impact must be assessed in comparison with the predetermined objectives, taking into account all the entities affected, directly or indirectly, by the action. The decision, at least when using public funds, is taken in the political and administrative environments, including other criteria in resources allocation.

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