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AN ALTERNATIVE METHODOLOGY OF ANALYSING PUBLIC INVESTMENTS EFFICIENCY

Abstract. *This paper introduces an alternative procedure of applying the multi-criteria analysis for estimating the efficiency of public investment projects. It allows considering correctly and completely the external effects associated to public investments and also introducing the intergenerational effect, the financing effect and the risk. The method is exemplified in the case of a local infrastructure investment project.*

Keywords*: H43 – Project Evaluation; Social Discount rate, H11 – Structure, Scope and Performance of Government, H21- Efficiency; Optimal Taxation, H23 – Externalities; Redistributive Effects; Environmental tax and subsidies, H54 – Infrastructures; Other Public Investment and Capital Stock.*

JEL Classification: H54

Introduction

The various external effects associated to public investments make necessary the definition of a new indicator in order to quantify the results, the methods used for private investments being inappropriate [9]. In this context, the literature introduces the concept of social benefit as an indicator quantifying the satisfaction of the beneficiary community from the exploitation of public investments. It takes into account the direct effects of the project, but also the positive externalities resulting from its exploitation.

To model the social benefit of public investment projects can be very difficult, due to various methodological issues [11].

The first one is that public investment projects have effects which can be measured only by specific indicators and the aggregation of the results is not simple. The present methodology grounds on the monetary quantification of all positive effects, allowing a simple procedure of aggregation in order to obtain an expression of the social benefit [7], [12]. On the other side, there are specialists considering that the measurement in monetary terms of the effects of public investments is not accurate and therefore not able to reflect the complexity of the results [6].

Secondly, the social benefit should allow comparison between public investment projects with different lifetime, meanwhile taking into account the nature of the effects of these projects when realising the aggregation of their results [5]. If measured in monetary units the social benefit can be easily introduced in a discount procedure, even though the choice of the discounting factor is still controversial [1]. If the quantification is made in physical units or using a qualitative scale allowing a better reflection of the effects of the project, the aggregation of these results can be difficult.

Thirdly, the social benefit should allow comparison of public investment projects of different types. This objective can be fulfilled only if social benefit is measured by the same indicator, no matter the nature of the project. Hence, a solution can be to introduce a method for valuing the efficiency of public investments which takes into account separately the social effect, the economic one and the impact of the project on the environment, resulting in an increase of the community's comfort and in an associate economic growth.

The estimation of the costs of a public investment project, although usually considered as an easier phase than measuring the social benefits presents several specificities. Hence, public investments generate also important negative externalities which have to be identified and measured in the valuation process. The social cost takes into account the direct, but also the external costs of a public investment.

The social cost function should fulfil the following requirements in order to allow a correct valuation of the public investments efficiency:

- to take into account correctly and completely the different costs of the project,
- to realize a correct aggregation of the direct and external costs indicators, usually different by nature,
- to correctly discount the costs becoming effective at different moments,
- to generate an indicator measuring the total cost of the project compatible to that of the social benefit.

Usually, an important part of direct costs of the investment projects can be easy measured in monetary terms on the base of technical and economical forecast documents. Another part of those costs, as well as the external ones can be quantified by physical of qualitative indicators, and their monetary measurement cannot reflect the economic reality. Therefore, expressing the costs of the project in monetary terms becomes often inadequate and requires the completion of the analysis by alternative methods allowing a correct valuation of non-monetary costs.

Modelling a social benefit function considering separately the social, economic and environmental impact of the public investment project

The idea of taking into account separately the three objectives is not new in the economic literature. Wen and Chen (2008) [10] invoke the necessity of considering the environmental effects of the economic growth and propose a net progress index in order to verify its sustainability. This index is supposed to be based on three aspects: economy, society and environment. Clarke and Islam

(2003) [4] introduce the concept of socio-ecological and economical system as a framework for measuring the social welfare and propose the cost-benefit adjusted GDP as an indicator for its measure, although an indirect one.

The method proposed hereafter bases on the arbitrage between present and future satisfaction, determining the following expression of the social benefit:

BS = a*Present comfort index + b*Future comfort index + c*Economic growth index + d*Environmental protection index.

The coefficients a,b,c,d are parameters allowing to introduce the beneficiary community's preferences on the four types of effects.

The present comfort index considers the non-monetary production, psychological, social and human capital effects acting during the implementation of the investment project and quantifies them using relevant information from statistical studies on the beneficiary community in order to determine their importance for the present comfort of the population.

The index will be modelled by a function chosen to adapt the best to the particularities of the public investment project. For example, two such functions are presented, in the hypothesis that three external effects occur and they are measured by the most relevant indicators (x_1, x_2, x_3). Index for each external effect can be computed as follows:

$I_{x1}= x_{1\text{with project}}/x_{1\text{ without project}}$.

The aggregation of these indexes will be made by a function taking into account the relative importance of each factor in establishing the present comfort level, as follows:

Present comfort index $= I_{x1}*c_1 + I_{x2}*c_2 + I_{x3}*c_3 + I_{\text{other factors}}*c_4$,

Where $I_{\text{other factors}}$ reflect the importance on the present comfort of the other factors, not taken into account in the analysis, this index being equal to 1, and c_1, c_2, c_3, c_4 represent coefficients depending on the relative importance of the different factors in establishing the present comfort level. Their sum equals 1.

Other possibility to aggregate the indexes is to build a function as follows:

Present comfort index $= I_{x1}^{\alpha}*I_{x2}^{\beta}*I_{x3}^{\gamma}*I_{\text{alți fctori}}^{\delta}$,

Where α, β, γ, δ are coefficients reflecting the relative importance of the variables in establishing the present comfort level of the beneficiary community.

The future comfort index is an indicator allowing considering and aggregating the non-monetary effects acting in the future periods, using information in relevant statistical studies. Supposing again three types of effects generated by the exploitation of the project, quantified by the indicators y_1, y_2, y_3, the I_{y1}, I_{y2}, I_{y3}, $I_{\text{other factors}}$ indexes will be computed and aggregated by functions such those presented for the present comfort index.

The economic growth index identifies the effect of the project on the future income of the community and its synergic effects and allows considering them in determining the social benefit function. Hence, the public investments can also be seen as instruments for regulating the economy. The c coefficient associated to the economic growth index is related to the community's perception or that of the public decision makers on the importance of maintaining or impulsing the economic growth. The index will quantify the monetary effects of the project, discounted in order to allow their comparison with the monetary costs of the project.

The environmental protection index measures the amelioration of the different parameters of the environmental quality, which are aggregated in such manner to best reflect the beneficiary community's preferences in the environmental protection field.

This procedure of determining the social benefit offers the possibility to measure the effects of investments resulting only in increasing the future comfort, the environmental protection degree or rising economic growth. However, next remark imposes. The last category of investments should be financed by co-financing the private investments rather than by classical public investment funds, at least for the next period.

The advantages of this method are related to:

- the possibility of taking into account separately the effect of public investments on local, regional or national economic growth, according to the dimension of the beneficiary community considered,
- the possibility of comparing projects of different types,
- the possibility of consider the synergic effects of the public investment project analysed,
- the possibility of using this analysis framework for investment projects with a high degree of originality influencing both the present and the future welfare.

The disadvantages of the method related to:

- the difficulty of the statistical calibration of the model,
- the impossibility of introducing changes in the beneficiary community's preferences over time,
- its basing on subjective individual measures of the social benefit, which induces difficulties in the aggregation of the results.

The social benefit valuation method proposed is general. The form of the functions may be changed in order to best adapt to the characteristics of the public investment projects analysed. The method is important for having enlarged the traditional framework for valuing the efficiency of public investments by considering other types of effects induced by investment projects, which otherwise cannot be taken into account and therefore escape to the valuation process. Bigger is the project, deeper is the effect mentioned above. Therefore, the analysis of complex public investments should always be completed by using a method for valuing the non-monetary effects.

Modelling the social cost taking into account separately the economic, social and environmental effects of the investment project

As for the social benefit, depending on the nature and the impact of the production and exploitation costs of public investment projects, cost indexes can be computed in order to determine the effects of the projects on the economic growth in the region, but also in the neighbouring ones (studying the research investments, Roper, Hewitt-Dundas and Love (2004) [8] and Cainelli, Mancinelli and Mazzanti (2007) [2] demonstrate that depending on the region implementing the research investment different distribution of the resources and results can occur, influencing the aggregation of social costs and benefits), the perception on the negative influence of the investment on the environment, but also on the present and future comfort of the beneficiary community.

Hence, a cost function can be modelled as follows:

CS = a*Present comfort cost index + b*Future comfort cost index + c*Economic growth cost index + d*environmental cost index.

The estimation of the mentioned indexes grounds on identifying the negative effects on the above mentioned aspects associated to the investment project, measuring them and including them in the correct class. The indexes will further be computed using coefficients and functions to reflect the beneficiary community's preferences, in the same manner as for the social benefit.

A specific difficulty is to eliminate the synergic effects or the correlation between the different cost categories by factorial analysis or to choose the correct function to reflect the costs.

Case study

A case study will be realized for an infrastructure project computing the social cost and benefit as indexes considering economic, social and environmental effects of the project.

The main results of the traditional ex-ante cost-benefit analysis are listed below.

The investment takes place in a resort and consists in rebuilding the central park, where lay the thermal springs and the river course which systematically had produced floods in the neighbourhood, but also the main streets. A part of the public services resulting from the investment will not be charged, whereas another part of these services will be taxed on the grounds of a marketing study on a relevant sample. The implementation duration is 20 months, the project being estimated to be achieved at the end of the year 2008, and the exploitation period is estimated at 25 years.

The direct cost of the investment is 3112073 euro, according to the total investment budget breakdown. The project is financed 80% from European funds, and 20% by bank loan with an interest rate of 10% and a payment delay of 2 years. The cost-benefit analysis did not identify external costs and produced the following results: financial internal return rate = 5.73%, internal rate of return on invested capital = 11,91% demonstrating the sustainability of the bank loan, economic internal rate of return = 18.28%.

Hereafter, the return and the risk of the public investment project will be estimated by applying the modelling of social cost and benefit taking into account the economic, social and environmental effects of the project. The beneficiary community is formed by 3000 inhabitants and 50000 tourists per year staying in average 5.7 days in the resort.

The choice of this method bases on the following ideas:

- the project has effects in all subsystems mentioned above,
- the ex-ante analysis of the project which is to be completed by this alternative method was conceived as a cost-benefit analysis and the information gathered is best adapted for this type of analysis. A supposed questionnaire at the present moment would distort the results of the ex-ante analysis and would make the results impossible to compare. The optimal use of the gathered information is by applying the method of modelling the social cost and benefit by taking into account the economic, social and environmental effect,
- this method is well adapted for deep ex-ante analyses of public investment projects,
- the method allows the correspondence between social cost and benefit and supplies a form of the return comparable to the one in the cost-benefit analysis.

Due to the impossibility of a questionnaire on the beneficiary community, the risk of the variables in the analysis will be introduced as a normal distribution between certain limits considered normal for the evolution of the variables. The aggregation of these variables will be made in such a way to best reflect their relative importance for the satisfaction of the beneficiary community. Social cost and benefit indexes will be built in order to reflect the differences from the status-quo for which the indexes are equal to 1.

Determining the social benefit

The indexes composing the social benefit – present comfort index, future comfort index, economic growth index, environmental protection index – will be computed basing on identifying the direct and external benefits of the project, their measurement and comparison to the status-quo and on the preferences of the beneficiary community.

The present comfort index

The following production positive external effects have been identified:

- the psychical comfort of the population knowing that the centre of the resort will be modernized (x1),
- the comfort of the employees' families members on the period of the realisation of the project (x2),
- the psychical comfort of the unemployed based on their hope to be employed when the project will be implemented (x3).

The present comfort index will be computed as follows:

Present comfort index = $\mathbf{I_{x1}*c_1 + I_{x2}*c_2 + I_{x3}*c_3 + I_{other\ factors}*c_4}$, where c_1, c_2, c_3, c_4 are coefficients representing the relative importance of the different factors identified on the satisfaction of the beneficiary community.

The x1 index will be computed basing on the population's perception regarding the project. Having no direct information on a population relevant for the whole community, the result of the questionnaire realised on a population of the tourists will be used. The question regarding the preferred investment objectives in the resort was answered by 135 from the 150 members questioned by naming one of the objectives of the investment project proposed. The index value will be (135/150 +1) = 1,9.

The x2 index refers to the increase of the social comfort of the families of the 85 persons to be employed for implementing the project. Considering that the average family inhabiting the resort has three members, as the local authorities attest, this index measures the comfort increase for 255 members of the community. If estimating an increase of the family income by 100% and considering the limited period of employment and the opportunities for future employment , the index is computed as follows 1+ 0,6*255/3000 = 1,051.

The x3 index regarding the psychical comfort of the unemployed of the community, it depends on the number of persons to be employed for the exploitation of the project which is 57, on the number of unemployed persons in the community which is 396, on the value of the time and the delay until the exploitation. The increase in comfort is estimated at 25%. The index is computed by the formula (1+0.25*396/1500) =1,066, 1500 being the number of the persons who can work in the community.

The coefficients regarding the preferences of the community are estimated as follows c_1=0,05, c_2=0,4 and c_3=0,1 basing on questions on similar populations.

Hence, the present comfort index becomes:

Present comfort index = 0,05*1,9+0,4*1,051+0,1*1,066+ 0,45 =1,072.

Future comfort index

The following positive external effects during the exploitation have been identified as determining changes of the future comfort of the beneficiary community:

- the comfort of the inhabitants and tourists due to the multiplication of leisure facilities (y1),
- the increase of the comfort using the thermal infrastructure (y2),
- the increase of the comfort of the population because of better streets and the reduction of the driving stress (y3),

- the increase of the psychical comfort of the 25 families whose houses are in the neighbourhood of the river(y4).

The future comfort index will be computed according to the following function:

Future comfort index = $I_{y1}*b_1 + I_{y2}*b_2 + I_{y3}*b_3 + I_{y4}*b_4 + I_{other\ factors}*b_5$,

where b_1, b_2, b_3, b_4, b_5 are coefficients representing the relative importance of the factors in establishing the satisfaction level of the community.

The y1 index was computed starting from the answers in the questionnaire regarding the acceptance of the facilities to be built in the park. The idea was appreciated as very good by 30 persons, good by 80, indifferent by 20, not good by 15 and bad by 5.

Applying coefficients from 2 to -2 according to Likert scale we obtain: 30*2+80*1+20*0-15*1-5*2= 115, a positive value reflecting the existence of a demand for the services offered. Comparing this value to the maximal which is 2*150=300, the index will be (1+115/300)= 1,3833 and the result will be considered relevant for the entire community.

The y2 index measures the increase of the comfort using the thermal infrastructure basing on the following question included in the questionnaire:

"How attractive do you consider the resort from the point of view of the thermal infrastructure on a scale from 1 to 5?"

The answers were: 1- 60, 2 – 45, 3 – 30, 4- 15, 5 -0, reflecting that the objective is considered necessary by all respondents. The total of 300/750 shows the necessity of the investment. Knowing that the project will improve 80% from the total thermal infrastructure the index will be computed as:

I_{y2}= 750/300*0,8 = 2.

The y3 index measures the increase of the psychical comfort of the population due to streets improvement. The question "On a scale from 1 to 5 how do you characterize the streets of the resort?" tried to estimate the public demand for streets improvement. The answers were: 1 – 35, 2 – 70, 3 – 20, 4 – 15, 5 – 10.

Hence, the total was 345/750 meaning less than half, suggesting a need for improving the streets of the resort. The index will be computed as: 750/345=2,17.

The y4 index measures the comfort of the 25 families in the neighbourhood of the river. Considering 5 the index value for the 25 families and knowing that the community has 987 families, the index is (5*25+962)/987 = 1,101.

Based on sociological studies realized on similar communities, the following coefficients were estimated: b_1=0,1, b_2=0,21, b_3=0,15, b_4=0,2, b_5=0,34.

Future comfort index = 1,3833*0,1 + 2*0,21 +2,17*0,15 + 1,101*0,2+ 1*0,34 = 1,444.

Economic growth index

According to the information from the cost-benefit analysis, the direct monetary benefits of the project were estimated as 129600 euro in 2008, 298080 euro in 2009, 327888 euro in 2009, 360678 euro in 2010, 396744 euro in 2011, 436422 euro in 2012, 480060 euro in 2013, 528066 euro in 2014, 580872 euro in 2015, 638964 euro in 2016, 702852 in 2017 and 725004 then.

The discount rate recommended by the European Commission was 5%. In order to best reflect the economic reality in Romania in the sector of the project, the discount rate chosen was 7%. Hence, the direct benefits of the project were of 5978850 euro.

External benefits estimated from reducing the maintenance costs of the vehicles were of 50000 euro yearly, which discounted with the 7% rate is estimated to 563609 euro.

The external benefits determined by the increase of the tourists' number and of the staying period are of 2141340 euro after discounting with a rate of 15%, computed as the return on assets in the touristic private sector in Romania. Knowing the turnover in the touristic sector of 2780870 euro without project and that 90% of the local turnover is from tourism, the annual turnover is estimated to 3089856 euro, with an increase of 5% in the following 10 years and constant after, or a discounted value of 23981864 euro.

Hence, the economic growth index is
(23981864+2141340+563609+5978850)/23981864 = 1,362.

The environment protection index

The environmental protection index was computed starting from estimations made by the local public authorities regarding the environmental issues and their relative importance.

An alternative would be to use information obtained for larger communities or even for European Union, adjusted to the reality of the local community or by direct questionnaire, if the environmental culture of the community is developed.

The data from the public authorities show that 35% of environmental problems in the community are related to waste management, 25% to water pollution, 20% to air pollution and 20% to soil pollution.

For each class of environmental problems an index will be computed to reflect the effect of the investment project. Due to the low environmental culture of the community, the interview with the local authorities was used in order to establish the for indexes.

The waste management index is supposed to increase to 1,4 due to river course management by the project, and the water pollution index rise to 1,15, the other indexes remaining stable. The environmental index will be :

Environmental index = 0,35*1,4+ 0,25*1,1+0,2+0,2 = 1,165.

Determining the importance of the four types of effects in establishing the satisfaction level of the beneficiary community

Generally, the correct composition of the social benefit index must consider at least the following factors: the objectives defined as local and regional priorities, the age of the population, the needs identified locally, the exploitation period.

Taking into consideration these elements leaded to identify the following coefficients of the social benefit structure by a questionnaire on a comparable population:

- 0,15 the coefficient reflecting the present comfort,
- 0,33 the coefficient reflecting the future comfort,

- 0,25 the coefficient of the economic growth
- 0,27 the coefficient reflecting the environmental protection.

Hence, the social benefit index is **BS=0,15*1,072 + 0,33*1,444 + 0,25*1,362 + 0,27*1,165 =1,29237.**

Determining the social cost

Using the same methodology as for the social benefit, economic, social and environmental cost indexes will be computed and aggregated using the coefficients in the social benefit index.

From a methodological point of view, the cost indexes will be computed in order to reflect the cost increase compared to the status-quo.

The social cost index will be computed by the formula:

CS = a*present comfort cost index + b*social comfort cost index + c*economic growth cost index + d*environmental cost index.

Present comfort cost index

In order to determine this index, the non-monetary external negative effects deriving from the project implementation will be taken into account. Knowing the localization of the park, the river course and the streets to be modernized, the discomfort during the implementation being the only one negative external effect is important and affects the whole community. We can consider it having the same impact on all the members of the community. Hence, the *x'1 index* will be computed starting from the question "On a scale from 1 to 5 choose the degree of discomfort that you think yo will feel during the implementation of the project." The answers were 1 – 45, 2 – 50, 3 – 30, 4 – 20, 5 – 5. The aggregation of these answers leads to a total of 340/750, the index being computed as follows (1+340/750) = **1,453.**

The present comfort cost index will be computed as:

Present comfort cost index= $\mathbf{a'_1 * I_{x'1} + a'_2 * I_{other\ factors}}$**.**

The coefficient a'_1 was estimated at 0,2 basing on statistical studies on comparable populations, the present comfort cost index thus being 1,0906.

Future comfort cost index

The future comfort cost index reflects the negative non-monetary external effects of the project exploitation. In the case analysed there were no such effects had been identified, the level of the index being thus settled at 1.

The economic growth cost index

This index quantifies the monetary production and exploitation costs of the investment project.

Most of these costs are direct and refer to the total cost of implementing and exploiting the project and to the amounts paid for the credit contracted by the local authority.

The total initial cost of the project is estimated at 3112073 euro, 80% of this amount, respectively 2489658,4 euro being obtained from other sources than the financing of the local authority.

The cost of the credit will be computed by discounting the future payments using a discount rate of 7%, as settled in the methodology of determining the social benefit. It equals 510040 euro.

The exploitation cost of the project is computed by discounting the annual amounts estimated in the cost/benefit analysis using the same discount rate of 7% and represents 2822670 euro.

There is no external monetary cost of the investment project, so the economic social cost index is computed as follows:

$\mathbf{I_{economic\ growth\ cost} = (2489658{,}4+510040+2822670)/\ 23981864+1 = 1{,}243,}$
23981864 euro representing the annual commercial turnover of the economic agents in the resort during the exploitation period, discounted according to the methodology presented for the social benefit.

The environmental cost index

This index considers the pollution effects of the investment project. As described in the feasibility study, the implementation of the project will fulfill the legal regulation regarding environment protection. Nevertheless, the implementation will determine the rise of the environmental cost indexes as follows: waste management cost index – 1,1, water pollution cost index – 1,03, air pollution cost index and soil pollution cost index – 1,02, according to the estimations realized by the local authority.

According to the coefficients above and the environmental protection regulation, the environmental social cost index is computed as follows:

$\mathbf{I_{environmental\ cost} = 0{,}35*1{,}1 + 0{,}25*1{,}03 + 0{,}2*1{,}02 + 0{,}2*1{,}02 = 1{,}0505.}$

The social cost index

In computing the social cost index will be used the same coefficients as for the social benefit: a= 0,15, b=0,33, c=0,25, d=0,27.

$\mathbf{CS=0{,}15*1{,}0906 + 0{,}33*1+0{,}25*1{,}243+ 0{,}27*1{,}0505 =1{,}0880.}$

Determining the risk of the public investment project analysed

Because the present analysis grounds on indirect indicators measuring the various effects, it is impossible to obtain the correct probability distributions of the variables analysed.

Hence, the only possibility to introduce the risk is by using the Monte Carlo technique. The following hypotheses had been considered in order to establish the variation intervals of the variables and coefficients used in the analysis:

- The x1 index measuring the psychological comfort of the population determined by the investment project varies between 1,8 and 2, following a normal probability distribution;
- The x2 index measuring the comfort of the workers' families employed for the implementation of the project was estimated to be 1,051, the variation interval being (1,049; 1,053);
- The x3 index referring to the psychological comfort of the unemployed persons in the community related to the hope of finding a job in the project exploitation was estimated at 1,066, the variation interval being (1,056; 1,076);
- The c1 coefficient having the value of 0.05 varies between 0.049 and 0.051;

- The c2 coefficient estimated at 0,4 varies between 0,35 and 0,45;
- The c3 coefficient estimated to 0,1 varies in the interval (0,09, 0,11);
- The y1 index measuring the comfort of the community as a result of new opportunities of relaxing was estimated at 1,3833, the variation interval being (1,3333;1,4333);
- The y2 index reflecting the comfort generated by improving the thermal infrastructure estimated at 2, varies between 1,8 and 2,2;
- The y3 index measuring the psychological comfort due to the improvement of the street infrastructure estimated at 2,17 varies between 1,97 and 2,37;
- The y4 index measures the comfort due to the decrease of flood danger for the 25 families inhabiting the neighbourhood of the river is estimated at 1,101 and varies between 1,081 and 1,121;
- The b1 coefficient of 0,1 will vary in the interval (0,09;0,11);
- The b2 coefficient established at 0,21 will vary between 0,19 and 0,23;
- The b3 coefficient was estimated at 0,15 and due to the importance of the street infrastructure, the variation interval is narrower: (0,14;0,16);
- The b4 coefficient is 0,2 and the variation interval is (0,19; 0,21);
- The economic growth index is determined by 4 variables: the commercial turnover of the project varying in the limits of 10%, the supplementary turnover of the economic agents in the resort varying in the limits of 15%, the vehicles reparation costs reduction varying in the limits of 10% and the total commercial turnover in the resort varying in the limits of 10%.
- The waste management index of 1,4 varies between 1,35 and 1,45;
- The water pollution index of 1,1 varies in the interval (1,09;1,11);
- The coefficient showing the importance of waste management varies in the interval (0,33, 0,37) and that of the water pollution in the interval (0,23, 0,27);
- The cost index regarding the present comfort estimated at 1,453 varies between 1,403 and 1,503 and its coefficient varies in the interval (0,15; 0,25),
- The economic growth cost index variation grounds on a 3% variation of the direct costs, 2% variation of the credit cost and a 10% variation o the exploitation costs;
- The waste management cost index of 1,1 is estimated to vary between 1,09 and 1,11;
- The water pollution cost index estimated at 1,03 is supposed to vary between 1.025 and 1,035;
- The cost indexes regarding air and soil pollution are estimated to vary between 1.018 and 1,022;
- The coefficient of the present comfort of 0,15 varies between 0,125 and 0,175;
- The coefficient of the future comfort of 0,33 varies between 0,305 and 0,355;
- The economic growth coefficient varies between 0,225 and 0,275, the estimation being 0,25.

Applying Monte Carlo technique for 10000 observations, the averages and standard deviations in table 1 are obtained.

The economic return on investment

Based on the social cost and benefit indexes, the economic return of the project is:

Economic return on investment = (SB-SC)/SC =(1,29237-1,088)/1,088= 18,784%.

Compared to economic return obtained by the cost/benefit analysis, this return rate considering the social, economic and environmental effects is higher, the difference being of 0,5% and resulting from taking into consideration a wider range of non-monetary effects which escaped from the cost/benefit analysis, due to the impossibility of quantifying them monetarily. The results of Monte Carlo technique lead to an average economic return of 18,79%, with a standard deviation of 1,273%.

Table 1. Results of Monte Carlo analysis

Indicator	Average	Standard deviation
Present comfort index	1.071988	1.82E-05
Future comfort index	1.444405	0.001115
Economic growth index	1.363677	0.000709
Environmental index	1.164878	0.000126
Social benefit	**1.292814**	**0.0002**
Present comfort cost index	1.090713	0.000204
Economic growth cost index	1.243643	0.000248
Environmental cost index	1.050463	5.48E-06
Social cost	**1.0882**	**2.88E-05**

Conclusions

The paper introduces an alternative for the classical methods of valuing the efficiency of public investment projects, allowing to consider the non-monetary external effects which otherwise would escape the valuation process or be taken into account inappropriately.

The method allows comparing different investment projects and also dealing with the intergenerational effect, the financing effect and the risk in the valuation process.

The application of the method for the real case of a local infrastructure investment project proved its ability of considering external effects otherwise not taken into account, but also its applicability. These are good reasons for recommending it to be introduced in the valuation framework for public investment projects complementary to the classical approaches.

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