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METHODS OF ANALYSIS OF THE EFFECTIVENESS OF PUBLIC SECTOR PROJECTS: FEATURES AND CONSTRAINTS

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Abstract. The *purpose* of the paper is to consider the main provisions of methods of analysis of the effectiveness of public sector projects. A number of issues remain controversial in the methodology of analysing costs and benefits. So, in addition to determining the costs and benefits to be included in the analysis, one should outline the problem of assessing in the monetary equivalent of the social effects that society receives from the project implementation. *Methodology*. The social nature and scale of tasks that are solved in the public sector deepen the issue of identification of social effects. Discounting costs and benefits and assessing the social effect in the cost-benefit analysis involves the application of the rate of time preference. The parameters of this rate are analysed and substantiated in the study. In addition to the CBA method, an attention is paid to other methods of efficiency analysis, in particular, the method of cost-effectiveness analysis, method of weighted cost-effectiveness analysis, method of cost-utility analysis. Each method has its own specific features and limitations that determine the direction of their application. *Results*. It is concluded that finding solutions in the direction of studying the relationship between the social rate of intergovernmental preferences and other methods of discounting will allow us to get an idea, in which range may be the value of social discount rate. The ability to determine the range will allow taking into account the specificity of the project being implemented.

Key words: cost-benefit analysis, social rate of discount, cost-effectiveness analysis, weighted cost-effectiveness analysis, cost-utility analysis.

JEL Classification: J00, K10, K20, K23

1. Introduction

The feature of projects in the public sector is that their implementation contributes to the growth of the welfare of society and is a prerequisite for its development. It is worth noting that public sector projects are often characterized by negative profitability and, therefore, cash flows do not generate a commercial effect. At the same time, the importance of implementing such projects is to increase the welfare of society and to promote economic growth, capital accumulation, and increase in the competitiveness of the national economy.

The benefits that society receives as a result of the implementation of public sector projects, due to their specificity, cannot be offered on the market and, therefore, market prices are not applied when evaluating such projects. In addition, during market failures, market prices do not reflect marginal benefits and costs (Atkinson, 1980). The ineffectiveness of the market mechanism for revenue generation is the reason that complicates the use of classical investment analysis tools to assess the effectiveness of public sector projects.

A classic method for analysing the effectiveness of public sector projects is the cost-benefit analysis method – CBA. The analysis is conducted by comparing the benefits (social effects or results), measured in monetary terms, and the costs incurred. Subsequently, the analysis tool was expanded. This led to the emergence of other methods for analysing the effectiveness of

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public sector projects, such as cost-effectiveness analysis – CEA, cost-utility analysis – CUA, weighted cost-effectiveness analysis – wCEA.

Despite the rather significant experience of using tools for analysing the effectiveness of public sector projects, issues remain controversial about the methodology for assessing the social effects derived from their implementation. The problem is that it is necessary to determine precisely whether the social and cultural changes in the social situation (positive or negative) have become a consequence or result of the project implemented (Williams, Giardina, 1993). However, it is rather difficult to identify the social effect as a result of the project implementation, without understanding the nature of its origin. This is related to the fact that the social effect can be defined as a social benefit and as an externality.

Social benefit is the benefit of any activity that includes the benefit of the entity that carries out activities, as well as benefits to people who do not pay for it. At the moment, we are talking about evaluating the benefits based on a willingness to pay indicator (WTP), which reflects the readiness of the individual to pay money for a certain social benefit. However, the definition of the value of the social benefit is also quite problematic. To solve this problem, it is suggested to use the ordered binary choice models (ordered logit model, ordered probit model) (Verbeek, 2008).

Another problem when analysing the effectiveness of public sector projects is the need to take into account the externalities associated with the results or effects of the project being implemented. In this case, there are issues regarding their identification by the form of manifestation. For example, if the implementation of the project contributed to the transfer of demand from one producer to another, then society as a whole has no gain or loss. Here we are talking about the redistribution of cash resources within a single market. Taking into account such monetary externalities for determining the costs and benefits does not make sense. However, there may be another situation. For example, project implementation has the consequence of saving or increasing resources for a group of producers or degrading or improving the environmental status of the region. It is clear that under such conditions there are real effects that maximize or minimize the volume of social benefits. The actual (technical) externalities affect the estimation of costs and benefits of the project. The problem is the choice of a range of the most significant externalities; moreover, it is necessary to distinguish those that do not have a redistributive character. This is a rather difficult task since the externalities can be manifested in the same processes but have different nature of occurrence. In addition, it makes no sense to take into account all externalities. Therefore, in practice, there are certain limitations to take into account real externalities to determine the costs and benefits of the project. The first limitation concerns the consideration of only indirect externalities; the second one is that costs and benefits of the project should be assessed from the perspective of the impact of externalities on the development of society. Thus, for a public comparator, the task is to maximize the difference between social benefits and social costs.

Public sector projects are not implemented right away. They have a certain period of life. Therefore, when assessing the social effect, it is necessary to take into account changes in costs and benefits in time, that is, lead costs and benefits to the initial or final period. It is this aspect that determines the problem of choosing discounting methods for public sector projects. The complexity of the matter is that the public emphasis of public sector projects, the scale of tasks that are being solved, require the study of a wide range of factors for assessing the social effect. Scientists agree that the social discount rate should be positive, but there are discussions about the choice of methods for estimating this rate. Differences in the views of different researchers in determining the social rate of discount create a certain debate and encourage further research.

The purpose of the article is to identify specific features and limitations of the methods used to analyse the effectiveness of public sector projects and to substantiate recommendations for their practical application.

In order to achieve this purpose, it is necessary: to study the methodology of the analysis of the effectiveness of public sector projects based on comparing costs and benefits, focusing on approaches to determining the social discount rate; define the limits of application of the method of CEA analysis and its modifications; compare existing methodologies for analysing the effectiveness of public sector projects to determine their specificities and areas of application.

The research used the following methods: the method of comparative analysis – to identify advantages and limitations in the study of methodology for analysing the effectiveness of public sector projects; method of generalization – when analysing the accumulated experience in applying the methodology of the analysis of the effectiveness of public sector projects; scientific abstraction method to reveal the essence of social discounts; mathematical statistics for determining parameters of estimation of discount rate.

2. Method of analysis of cost-benefit efficiency

For the analysis of projects in the public sector, a system of methods based on a cost-benefit analysis (CBA) is developed. However, as pointed out by researchers, for the analysis of costs and benefits, there is a significant gap between the theory and the practical application of analysis tools (Dreze, 1985). The issue of the need to reduce this gap was considered in works

of Boardman A. (Boardman, 2006), Dasgupta A. K. (Dasgupta, 1978). The reasons lie in the complexity of determining the social effect of project implementation.

The issue of determining the social effect is quite controversial. In science, there are various approaches to its justification. These approaches have diverse, ambiguous, and conditional interpretations, although the essence of the social effect is understandable at the intuitive level of perception. F. Vanclay (Vanclay, 2003) substantiated a number of principles which, in his opinion, are fundamental to the identification of the social effect. The author emphasizes, firstly, that it is necessary to clearly understand the nature of the origin of the social effect, that is, only the effects, which have become a consequence of the project (for example, as a result of the project, the cost of working time to produce a unit of production reduces or the social situation improves). Secondly, as F. Vanclay points out, the indicator of improving the quality of life (public welfare) should be used as the basic indicator of the social effect. Thirdly, it is necessary to take into account the opinion of society. Through the survey, determine the degree of utility that society identifies with the resulting effect. As you can see, the costs and benefits of the project should be evaluated from the standpoint of the whole society. So, maximizing the difference between social costs and social benefits will determine the increase in social benefits.

$$NB=B-C \quad (1)$$

where NB – net present benefit; B – present benefit (social effect);

C – costs in the current period.

The method of CBA is of scientific interest to many researchers. The theoretical foundations of CBA are rather thoroughly described in the economic literature by Squire and Layard (Squire, 1989; Layard, Glaister, 1994). No significant achievement is the study of Lomborg (Lomborg, 2007), which developed a methodology for the use of CBA for various sectors of the economy.

An analysis of costs and benefits helps to assess whether a project is effective in terms of improving social well-being. This analysis is applied when full market assessments of consequences or outcomes of public sector projects cannot be identified over the inability to adequately describe individual components of total costs or full benefits with price indices, how much to take into account externalities and social benefits. This is the main advantage of the CBA method. With the help of the CBA methodology, it is possible to assess the impact of the project on changes in public welfare.

The advantages of CBA are, firstly, the ability to assess the aggregated long-term effect on the basis of bringing the net benefit indicator by discounting to the present moment, and secondly, the ability to compare projects between themselves and in time.

The classical CBA approach involves evaluating the effect through the definition of net present benefits brought to a certain point in time

$$NB=\sum_{t=0}^{n}\frac{B_t-C_t}{(1+SDR)^t}, \quad (2)$$

where NB – net present benefit;

B_t – benefits at time t;

C_t – costs at time t;

SDR – social rate of discount;

n – life cycle of the project.

However, the methodological issue of determining the discount rate inevitably arises. The necessity of its application follows from the fact that the main volume of investments, as a rule, occurs at the initial stage of the project implementation, and the expected social effects appear only after its implementation. However, in a situation where market prices do not reflect the marginal benefits and costs for society (as a consequence of market failures), the market discount rate cannot be applied. This market failure is solved only under conditions of state intervention. Consequently, it is impossible to estimate the social discount rate as a return on alternative projects given that the alternative yields of these projects are unobserved.

The choice of SDR relates both to the timing (future benefits) and the size of the social distance (benefits to others). This is precisely what determines different approaches in the estimation of the discount rate. In the case of discounting time, decision-makers estimate the remuneration available at different times (the choice is made over a period of time, so the choice is intertemporal). In terms of social discounts, the choice raises concerns about remuneration for people who have different positions along the axis of social distance (choices are made within the social distance, so the choice is interpersonal). Persons are distributed along the social distance axis according to A. Karbowski's criterion of closeness to the decision makers (Karbowski, 2016).

Social rate of time preferences (*SRTP*) reflects the willingness of society to abandon consumption at the present time in order to obtain certain benefits after project implementation. Researchers focus on SRTP establishment issues. Some argue for the need to differentiate the social discount rate (Baumol (Baumol, 1952), Pierce D. (Pearce, 1985, 2003), Sen A. K. (Sen, 1961, 1967, 1982)), others – believe that a single discount rate should be used to discount public sector projects in a particular country (Kula E. (Kula, 1985), Evans D. (Evans, 2004), Lopez (2008)).

The calculation of *SRTP* is based on the solution of the problem of maximizing the public utility function, which is drawn on the utilitarian approach, which is based on the assumption that for the society the significance of the welfare of all members of society is

the same. As a public function of utility, a function with constant elasticity is selected:

$$U(C_t)=\frac{1}{1-\mu}\cdot C_t^{1-\mu}, \quad (3)$$

where $U(C_t)$ – utility derived from consumption;

C_t – consumption at time point;

μ – parameter of public utility function on consumption.

The goal of maximizing utility, which reflects the individual's choice for today's consumption or deferred consumption for tomorrow, is determined for two periods:

$$\begin{aligned} &U(C_t)=U(C_1)+\frac{U(C_2)}{1+\rho}\rightarrow \max(C_1;C_2)\\ &C_1+\frac{C_2}{1+SRTP}=1 \end{aligned} \quad (4)$$

where C_1; C_2 – consumption in different periods of time;

$U(C_t)$ – public utility function of consumption;

p – individual rate of time preference;

SRTP – the social rate of time preference.

The equality of the unit of the amount of discounted flows in equation (4) is based on the assumption that there is no preservation, that is, the entire available volume of consumption is distributed between two periods.

The result of solving the system of equations is the expression:

$$SPTR=(1+g)^{\mu}(1+\rho), \quad (5)$$

where ρ – the rate of time preference;

g – the rate of consumption growth per capita;

μ – parameter of public utility function on consumption.

To estimate the rate of time preference, the approaches that are formalized in (6) are used (Evans, Kula, 2011). In essence, the resulting formula is a linear approximation of formula (2).

$$\begin{aligned} &1+SRTP=(1+g)^{\mu}(1+\rho),\\ &\ln(1+SRTP)=\ln((1+g)^{\mu}(1+\rho)),\\ &\ln(SRTP+1)=\mu\ln(1+g)+\ln(1+\rho),\\ &SRTP=\mu\cdot g+\rho \end{aligned} \quad (6)$$

By analysing the parameters of the final expression (5), it can be concluded that SRTP is additive and includes such components (ρ) that reflect time preference of the population and (μ·g) – the growth of public utility derived from consumption by society.

In turn, the rate of time preference is the sum of the net rate of time preference and the parameter that reflects the risk to life.

$$\rho=\delta+L, \quad (7)$$

where δ – "net rate" of time preference; L – the level of risk to life or catastrophe risk.

The "net rate" parameter (δ) in many techniques equates to zero, based on ethical considerations, so as not to undermine the welfare of future generations, that is, the benefits are not provided to any generation. However, M. Olson and M. Bailey (Olson, Bailey, 1981) state that when setting the zero discount rate, the probability of shifting time preferences in favour of future generations, that is, increasing one generation's poverty in order to increase the welfare of the following, appears. It is believed that this parameter of the social rate of time preference is not subject to empirical analysis. For different approaches, the range of this rate is set from 0% to 0.5%.

Parameter (L) is interpreted as a catastrophe risk (life risk). This implies that there is a probability of events that all project achievements will void or radically and unexpectedly change. In the life risk assessment as a basis, the risk of a shortfall in income from the project implementation in the future is taken.

When calculating parameter (L), it is necessary to pay attention to the fact that its value varies considerably. Therefore, the ratio of total deaths to population is usually used in methodologies.

The elasticity of the marginal public utility value or (μ) is determined by some methods based on the average saving rate. However, there is no unanimous opinion among the world scientific community. This indicator is quite varied by different methodologies.

Since the social discount rate is intended to identify benefits in the future, it is considered expedient to use the projected values of growth rates of consumption per capita (g) during the calculation. The growth rate of per capita consumption reflects the potential for more consumption in the future, which is achieved through the introduction of innovations and the development of technical progress (Pearce, Ulph, 1995). It is necessary to find out what horizons of forecasting should be applied during the calculations. However, it should be borne in mind that forecasts are more acceptable only in the short run.

The problem of determining the social discount rate has a fairly wide range of judgments and requires a more in-depth study but in a separate format. Based on the task, the emphasis, first of all, is on the justification of advantages and limitations of the CBA methodology. In the defined context, CBA limitations can also be considered as the disadvantages of social discounting.

3. Cost-effectiveness analysis method

The method of cost-effectiveness analysis (CEA) has a significant distinguishing feature, which is that the benefits are not measured in monetary terms, but in physical units (Kahn, 1969). The issue regarding the use of the CEA methodology is rather controversial, so the comparison of different approaches is complicated, and thus the generalization of different opinions is difficult.

The application of the method of cost-effectiveness analysis is not complicated by the need to assess the

social effect in monetary terms, as in CBA. However, there is a problem in comparing the results of the analysis of interventions that are different in nature. The high degree of sensitivity of results to the change in the indicator, which reflects the social effect received as a result of interventions, limits the positive characteristics of the CEA method. This attracts a constant interest in the development of various variants of its modification.

For a reasoned comparison of alternatives, it is necessary to compare not only the costs and results but the cost changes in relation to the change of results. Consequently, in the case of CEA, an incremental cost-effectiveness analysis (ICEA) is carried out (Tan-Torres Edejer, 2003).

$$ICER = \frac{\Delta C}{\Delta E}, \quad (8)$$

where *ICER* – (Incremental cost-effectiveness ratio) – an indicator of the ratio of increase in costs and productivity gains; ΔC – an increase of costs as a result of interventions; ΔE – increase in the effectiveness (social effect) as a result of interventions.

The analysis of indicators of formula (2) allows concluding that the lower the value of *ICER*, the lower costs are directed to achieving a certain level of effectiveness, and the more effective the considered variant of intervention. As a limit, there is WTP (willingness-to-pay), which reflects the inclination of the financial decision-maker to pay for the corresponding project (Levin, McEwan, 2001).

In practice, the CEA method is the most appropriate for use in choosing alternatives in the healthcare system, since its toolkit allows for project analysis and choosing the most appropriate option in case of achieving a goal, for example, to increase life expectancy. In the broad sense, CEA is used, firstly, if it is necessary to decide on the choice of alternative, mainly when there is a need for intervention to determine the degree of intervention. Secondly, when it comes to the generalization of health policy (Jamison, 2009).

As CEA is not measured by cost indicators, the result is expressed in such aggregated non-financial indicators as, for example, Quality Adjusted Life Years – QALY (an indicator expressed in years of life, adjusted for quality), or Disability Adjusted Life Years – DALY (an indicator expressed in years of life, adjusted for the degree of disability). However, limitations can determine some distortion of qualitative assessments. For example, it is difficult to take into account the impact of changes in the ecological environment on disease. Such results are difficult to take into account in DALY or QALY indicators.

There are certain preconditions and restrictions associated with the use of CEA, in particular: the limitation of comparing interventions that have a different social effect; the complexity of taking into account time-based costs and effects; a high degree of sensitivity to the choice of indicator that reflects the social effect.

Undoubtedly, the analysis of CBA is wider than the cost-effectiveness analysis, since all benefits at the time of application of the first one have cost estimates, and therefore, the effects of different projects can be compared. This is a fairly substantial statement for a public comparator, based on the premise of the social nature of the tasks being solved. The CEA method can be used to make decisions when comparing projects whose effects are defined as homogeneous or can be measured in terms of key results. Consequently, the limitation of CBA analysis does not make it possible to decide if it is necessary to choose the option of investing resources of the public sector in different spheres of activity. The problem is the disparity of effects between themselves.

4. Methods of weighted cost-effectiveness analysis

There are cases when it becomes necessary to analyse the effectiveness of the project to combine several different social results that do not have a monetary equivalent. In such situations, it is necessary to evaluate the importance of each of them and to find a single composite mark. To obtain a single composite estimate, we use the method of weighted cost-effectiveness analysis– wCEA (Belli, 1996). This method is one of the modifications of the CEA method. As a social effect, it is its conditional expression through an aggregate indicator, which includes various characteristics of the object of evaluation. To determine the final effect, it is necessary to assign certain weights to the indicators that collectively formulate the target.

$$wCE = \frac{затрати}{\sum_{i=1}^{n} w_i \times E_i}, \quad (9)$$

where w_j – the weight of the *i*-th effect; E_i – *i*-th effect.

The method of wCEA is characterized by weaknesses in expert analysis, that is, dependence on subjective thought. However, this method is widely used in assessing the effectiveness of educational programs and healthcare programs, since the benefits that society receives from such programs cannot be measured in monetary terms.

5. Method of cost-utility analysis

In the case where a project is subject to evaluation that is described by a spectrum of results or if the results differ not only in quantity but also in quality, it is expedient to apply a cost-utility analysis (CUA) method. In essence, this method is a slightly complicated modification of the cost-effectiveness analysis. Originally, it called generalized CEA (Torrance, 1971), and later – utility maximization method (Torrance, 1972). Now, this method is singled out as an independent one. CUA

is distinguished by the fact that during the analysis, conventionally, similar quality results are used. The estimation of utility coefficients is carried out through expert assessments, which have methodological difficulties related to the qualification of experts, a clear statement of tasks, subjectivity of evaluations, and the complexity of processing information.

$$CUA = \frac{C}{U}, \quad (10)$$

where C – costs; U – utility.

It is advisable to use the CUA method in cases where it is necessary to determine the result, taking into account side effects, whether it is necessary to determine a single criterion for comparing costs and benefits, whether there is a need for ranking the results for weighting, or whether decisions are made on choosing alternatives.

6. Comparative characteristics of the methods of efficiency analysis

The comparative characteristics of the methods used to analyse the effectiveness of public sector projects are given in Table 1.

The study of methods for analysing the effectiveness of public sector projects showed that, notwithstanding certain features of each of the considered methods, the main approaches to measuring costs, benefits, and results are based on a single theoretical basis. In this context, existing limitations in all methods of analysing the effectiveness of public sector projects reveal significant prospects for further research and improvement.

7. Conclusions

The investigated methods of analysis: cost-benefit, cost-effectiveness, weighted cost-effectiveness, cost-utility are a very important basis for making grounded decisions by public comparators regarding the direction of investment in the most demanded sectors of the economy. Using the tools of efficiency analysis methods, they can distribute limited public resources according to policy priorities.

One or more methods of analysis of efficiency can be used to analyse the effectiveness of public sector projects that are implemented within a single industry. The main thing is to determine in which units the result is evaluated. If the result can be estimated in cost units, then it is advisable to use the methods of CBA and CUA, and in other cases – the methods of analysis of CEA and wCEA.

Choosing a social discount rate is a difficult task, as it involves assessing, among other things, the future benefits that other people may receive. A broad debate on determining the social discount rate has led to the formation of different views on the need to establish or differentiate the social discount rate or to determine its single value within a single country. When evaluating public sector projects, it is necessary to decide whether to use a single discount rate for the country as a whole and for all projects, or differentiated depending on the nature of the project. In general, discussions are about determining the size of the discount rate.

In existing studies, as a rule, the method of time preference is mainly studied. In this case, an attention is not paid to the study of the relationship between the social rate of time preference and other methods of discounting. Finding solutions in this direction will allow getting an idea of what range the social discount rate may be. The ability to determine the range will allow taking into account the specificity of the project being implemented.

Table 1
Characteristic features of methods for analysing the effectiveness of public sector projects

Method of analysis	Characteristics	Applicability of the method of analysis
Cost-benefit analysis	Provides a comparison of aggregated benefits in monetary terms and public expenditures in a specific direction.	It is used to compare different results in different fields of activity.
Cost-effectiveness analysis	Provides an assessment of benefits that do not have monetary value, but are expressed in physical terms as a result or consequence of the project implementation. Allows you to determine public spending on the realization of a specific result and identify an alternative to its achievement.	It is expedient to apply when public spending limits are determined and it is necessary to determine the ways of their best use in a certain direction.
Weighted cost-effectiveness analysis	The multiplicity of benefits from the use of public expenditures, which cannot be measured in monetary units, is estimated.	Applicable when the project involves the acquisition of multiple social effects.
Cost-utility analysis	Results can be expressed in different units of measure because the costs and utility are compared. Provides the use of a conditional comparative indicator close to the nature of results by using weight coefficients.	Applicable when analysing the effectiveness of the project, which involves a significant number of effects from the use of public funds.

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