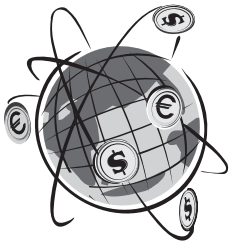

УДК 336.0

Noga B.

EFFECTIVENESS OF FINANCING TANGIBLE PUBLIC INVESTMENTS

В статті увагу було звернуто на два факти: матеріальні публічні інвестиції робляться тільки тоді, коли державний сектор має порівняльну перевагу в цьому відношенні над приватним сектором; матеріальні державні інвестиції в державному секторі можуть викликати ефект витіснення інвестицій в приватному секторі, що може призвести до зниження темпів економічного зростання й зростання ВВП.

Ключові слова: витрати-вигоди аналізу таксономічних методів, ефективність фінансування інвестицій

The attention in the article was drawn to two facts: tangible public investments are made only when the public sector has a comparative advantage in this respect over the private sector; tangible public investments made by the public sector may cause a crowding out effect on investments in the private sector which may decrease economic expansion and the growth of GDP.

Keywords: costs-benefits analysis, taxonomic methods, effectiveness of financing investments

Financing public investment is connected to budget expenses (of the central and self-government sectors) and has a defined impact on the budget deficit and the public debt. Today when the public debt decides about Poland's *rating,* the exchange rate and influences the economic growth of Poland measured in GDP, effectiveness of financing public investment, in particular tangible investments, is becoming vital as it should constitute a base for making investment decisions by public authorities.

In the private sector effectiveness of financing investments is most often measured by means of the Net Present Value (NPV) or the Internet Rate of Return (IRR). While making a decision about designing or realizing tangible investment in the private sector one may also use the CAPM model namely the capital asset pricing model of companies.

The above methods, in our opinion, may be modified so that they can be applied to the analysis of effectiveness of financing tangible public investments. It is worthwhile mentioning the following facts however:

a) Investments designed and realized by the public sector are considered to be public investments so they are as follows:
- state investment (government, federal)
- investment made by region al authorities, cantons, lands, provinces, departments etc.
- investment made by local self-governments, urban authorities, local communities, often referred to as municipal investments.

The financing source is an appropriate criterion to define public investments as they involve public funds in providing the entire or partial source of finance (investments realized according to public and private partnership formula).

b) tangible public investments are made only when the public sector has a comparative advantage in this respect over the private sector ;

c) tangible public investments made by the public sector may cause a crowding out effect on investments in the private sector which may decrease economic expansion and the growth of GDP.

The application of the NPV, IRR or CAPM methods for calculating effectiveness of financing tangible investment in the public sector entails an original benefits account e.g. value of life, time, the value of landscape etc. The specialist literature applies shadow prices analogically to the social discount rate (return rate) etc.

The analysis of effectiveness of financing tangible public investment most often applies the costs-benefits analysis-CBA method also called the social costs and benefits analysis. One has to pay attention to the following problems:

a) if we want to compare investment projects from the private and public sectors, we must apply the same analysis e.g. the social costs and benefits analysis then we will be able to answer which project has a comparative advantage;
b) public projects of tangible investments should calculate precisely all short, medium and long-term benefits. The measurement is however difficult.

That is why the authors of this paper put forward their own original methods of the social costs and benefits analysis where taxonomic methods have been applied to measure entire costs and benefits. This methods leads to the evaluation of effectiveness of tangible public investments as aimed by this paper.

In the private sector effectiveness of financing is evaluated by means of two methods: NPV and IRR [1, pp.476-477].

The NPV method defines the current value of all receipts and expenses of the investment both in the realization and exploitation phase of the project. NPV is calculated by discounting the balance of cash flows for each year and then summing them up. The NPV formula may be written as follows:

$$\text{NPV} = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - I_o$$

where: NPV- net present value; CF_t - cash flows in period t (benefits); r- discount rate; I_o - initial expenditure; t – subsequent periods (usually years) of investment realization.

In case of this method the investment should be realized if NPV >0 or at least NPV=0. This means that benefits exceed costs and investors receive the return of value they devoted to the investment.

The IRR method defines such a value of the discount rate, at which NPV is equal to 0. This is the discount method at which the present value of receipts is equal to expenditures related to realization and exploitation of the project. In this view IRR precisely indicates the minimum rate of return over which the project is profitable and should be realized [2, p. 420].

$$\sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} I_o = 0$$

Where: all notations in the NPV formula as above

The CAPN (capital asset pricing model) can be used to calculate effectiveness of financing tangible investments in the private sector. Its advantage lies in the fact that it is not based on historical data but on the present so as to forecast the activity risk. Its most common formula is as follows:

$$K_e = K_{rf} + (K_M - K_{rf}) \bullet \beta$$

where: K_e - rate of return on investment; K_{rf} - risk-free rate of return on investment; K_M - market rate of return; β- beta coefficient is defined by the level of market risk (systematic) of a particular investment [3, p.44].

The formula concludes that the rate of return on investment is influenced by: the risk-free rate of return on investment (K_{rf})which refers to government securities such as Treasury bonds, Treasury bills and central bank money bills. The return rate on these investments is constituted by interest on these securities; risk premium defined as:

$$(K_M - K_{rf}) \bullet \beta$$

K_M market rate of return is expressed by the average rate of return on business activity in a particular country. One may assume the rate of return on investment on the Stock Exchange. Depending on the period assumed for calculations one has to take into account the inflation rate in this period and use both nominal as well as real return rates.

The beta coefficient (β) measures the level of risk in a given industry. It is connected to changeability of the business cycle. In general terms it defines dependency between the risk of a particular type of investment (activity) and the risk of the entire economy [3, p. 46].

In each economy there are types of businesses which suffer from greater changeability in profitability (return rates) as compared to changeability of the return rate in the entire economy and thus they are exposed to a greater market risk. We may have a reverse situation namely there are businesses exposed to a lower market risk in the entire economy. The beta coefficient for the entire economy amounts to 1,0 [4, p. 293].

The level of β coefficients is calculated as a correlation between changes to return rates on a particular share and the average return rate on all shares listed in the same market. This correlation is divided by the variation of average rates of return on all listed shares in the same market. Thus a dependency between a change to profitability of a particular share and a change to profitability to all listed shares in the same market is established (on the Stock Exchange) [3, p. 47].

How can the CAPM be used for calculating effectiveness of financing tangible investments in the private sector?

At first we calculate the number of years needed for the return on capital invested according to the formula:

$$\lambda = \frac{100}{K_e}$$

where: λ -number of years needed for receiving a return on invested capital; K_e - rate of return during the year calculated by means of CAPM

The lambda (λ) established that way indicates a minimum level of the annual profit that must be attained by a particular investment project if the annual profit (period t) amounts to:

$$K_e \bullet I_0 = Z_t$$

then the following condition must be met:

$$I_o = \sum_{t=1}^{\lambda} Z_t \bullet \lambda$$

where: I_o - overall costs of the investment project; Z_t - profit in period t (within one year); λ - period of paying off the investment project.

If a business plan shows an annual profit lower than Z_t then the investment project should not be realized.

The costs-benefits analysis (CBA) is used for calculating tangible public investments. The CBA method may be applied to evaluate investment decisions made both in the private sector as well as the public sector.

There are two very significant differences between the costs-benefits analysis carried out from the social point of view and the analysis carried out from the private point of view.

Firstly, the social costs-benefits analysis considers a wider range of impact on the environment made by an undertaking not only the amount of profits.

Secondly, the social costs-benefits analysis does not evaluate some of expenditures and effects according to market prices as such prices do not express marginal social costs and benefits due to fallibility of the market mechanism [5, p.330].

The criterion of accepting an investment project with benefits B and costs C is as follows:

$$B>C$$

In other words the relation between benefits and costs must be greater than one;

$$\frac{B}{C} > 1$$

In case of public projects, the state must make a choice between many variants of an undertaking. One project with different structures of benefits and costs can be realized in a particular place. Then a project whose sum of net benefits namely a surplus of benefits over costs is the greatest not the greatest coefficient of the benefits and costs relation [5, p. 332].

Undoubtedly, the costs-benefits analysis (CBA) may comprise the calculation of NPV. Thus for the purposes of evaluating effectiveness of financing tangible public investment, in our opinion, the NPV method can be applied. However it is difficult to calculate all benefits in case of investments such as a school, a hospital, a crèche, a road, a bridge etc.

The application of the NPV method to evaluation of effectiveness of financing tangible public investments involves the following scientific problems to be solved:

1. how to evaluate the so called non-monetary costs and benefits e.g. the value of time, life, natural resources etc.
2. in cases where the market mechanism fails, market prices cannot reflect the real value of social marginal costs and benefits. Then economists try to evaluate the actual value of social and marginal costs and benefits related to e.g. employing an additional worker or imports and exports of additional goods. They use calculation prices called shadow prices which do not occur in reality but express the real social dimension of costs and benefits.
3. What should a social discount rate look like and how should it be calculated [6].

J. Stiglitz states that the most interesting problem related to evaluation of effectiveness of financing public investments consists in defining the social discount rate which in case of US government projects amounts 7%. Stiglitz says that three views on the social discount rate can be discussed:

1. A social discount rate expresses a preference rate relating to consumption in time (an interest rate of a consumption loan);
2. A social discount rate expresses alternative cost of capital (an interest rate on loans taken by manufacturers);
3. A social discount rate may not reflect preferences for current consumption nor an alternative cost. This is the case of long-term undertakings whose effects concern a lot of generations. In such situations where there is a lack of inter-generation redistribution of income, a social valuation of consumption value in particular generations may not be connected to real interest rates occurring in the market [5, p. 345].

S.Kasiewicz and W.Rogowski state that one can differentiate three different approaches to valuation of the social discount rate where the first two agree with J.Stiglitz's view [6, p. 345]. However the third approach is called experimental and they initiate surveying methods such as: method of choice; method of association and completion; pricing method; rating method.

In the questionnaires the surveyed people complete tasks which realize goals resulting from the above methods that had been previously assumed by the author.

As we have already said in the introduction, for the purposes of evaluating effectiveness of public tangible investments we propose taxonomic methods. The NPV calculation pattern, the first part expresses benefits for the private sector defined as time discounted cash flows according to a defined discount rate. In case of tangible public investments we propose the following solution:

1. Benefits generated by a particular tangible public investment will be measured by means of a taxonomic method [7]. Phenomena (effects) characterize benefits in broad terms, in the proposed method may be expressed be means of natural units and monetary units as well as contractual units. This way there will be a set of variables describing benefits from the evaluated investment. These variables have a various impact on the researched benefits. They can constitute stimulants, destimulants or nominants. Variables describing benefits from the realized investment should be standardized or normalized for the purposes of calculating the total of benefits [7]. While standardizing the variables describing benefits from public investments we treat them equally important. A different concept of designing a taxonomic measurement of benefits is based on normalized values of diagnostic features (variables). Normalization as opposed to standardization maintains variants of particular diagnostic features and thus assigns them with varied meanings. Moreover normalization of diagnostic features is much easier than standardization in term of accounting. It also avoids inconveniences related to negative standardized values. In such a case all features should constitute stimulants even if there are destimulants that must be transformed into stimulants. Normalization of diagnostic features (variables) of benefits from tangible public investments may be conducted according to the following formula:

$$Z_{ik} = \frac{x_{ik}}{x_{ok}} (k = 1,2,...,K; i = 1,2,...,N)$$

where: Z_{ik} - normalized diagnostics feature of benefits; x_{ik} -diagnostic feature chosen for the purposes of describing benefits from tangible public investments; x_{ok} - basis for normalization of diagnostic feature of x_k

The basis for normalization of diagnostics feature x_{ok} may be established in various ways. In our opinion the formula below is the best solution in normalizing a diagnostic feature:

$$x_{ok} = \frac{1}{N}\sum_{k=1}^{N} x_{ik} \quad ,$$

which would involve referring original values (real) of variables to arithmetic averages.

By applying this normalization method of diagnostic features one may design a taxonomic measurement of benefits from tangible public investment (TMK) as follows:

$$TMK = \sum_{k=1}^{K} Z_{ik}$$

In the above approach a taxonomic measurement of benefits from tangible public investment TMK is a function:

$$TMK = \int (x_1, x_2, ..., x_k)$$

transforming an observation matrix **x** into a vector **z** with dimensions [N x 1], comprising variables describing benefits from tangible public investments which have already been normalized.

Taxonomic methods may be used for measuring a distance of a calculated taxonomic measurement from the pattern model or another reference point namely a non-patterned model. In case of evaluation of effectiveness of financing tangible public investment it is better to apply a non-patterned model and the reference point will be constituted by a taxonomic measurement of benefits from tangible public investment realized before the projected investment. By applying appropriate mathematical methods we calculate distances between two taxonomic measurements according to the following formula:

$$dk = TMK_t - TMK_{t-1}$$

where: dk- distance TMK from the reference point TMK_{t-1}; TMK_t - taxonomic measurement of a benefit from tangible public investment of the evaluated project to be realized; TMK_{t-1} - taxonomic measurement of a benefit from tangible public investment already functioning.

2. Costs in the second part of the NPV formula are expresses in values (in money). For the purposes of defining the NPV where benefits will be presented by means of an abstract number defining a distance between two taxonomic measurements also costs must be presented as a relation between costs of a projected object already functioning by means of an abstract number. It is essential to present here a cost account considering the inflation and real costs. We will come up with the following scalar:

$$dc = \frac{K_{rt}}{K_{rt-1}}$$

where: dc- relation of real costs of a projected tangible public investment (K_{rt}) and real costs of already functioning tangible public investment (K_{rt-1}).

3. Just like in the NPV formula, a special example of the costs and benefits analysis (CBA), also in our taxonomic method one may present the following formula of effectiveness of financing tangible public investment:

$$ERIP_{takson} = dk - dc$$

where: dk, dc- as described above; $ERIP_{takson}$ - effectiveness of tangible public investment calculated by means of taxonomic methods.

Tangible public investment may be realized only when the $ERIP_{takson}$ is greater than 0 or at least equal to 0.

Evaluation of effectiveness of financing tangible public investment is an unusually important scientific problem that must be solved when the majority of countries have budget deficits and a public debt is growing at a fast pace. The construction of public facilities that will satisfy public needs may be realized by means of various projects and that is why public authorities must have tools for choosing the most sensible way of investing which is connected with rationality of spending public money. The $ERIP_{takson}$ method that we propose to use in evaluation of effectiveness of financing tangible public investment favours objectivity of public authorities in this respect. Moreover in our method benefits may be expressed in the wider and more complete perspective as compared to previous methods as variables which describe benefits must be expressed by means in money terms, in natural units, in relative terms e.g. percentage or as agreed.

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Рекомендовано до публікації
д.е.н., Галушко О.С. 21.09.12

Надійшла до редакції
05.10.2012