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# SECŢIUNEA VI: INFORMATICĂ ŞI CIBERNETICĂ ECONOMICĂ

## ASPECTS OF SELECTING INVESTMENT iPROJECTS

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***Abstract***

*Comparative analyses of indices for the estimation of IT investment projects economic efficiency is made. Recommendations are developed on basic indices to be used to select projects in informatization according to their particular characteristics.*

**Key words:** *informatic projects, investments, efficiency criteria, basic indices, classification, comparative research.*

**JEL CLASSIFICATION: C61**

1. Introduction. In economic analysis of informatic products (i-products), the choice of indices for the appreciation of solution alternatives is of prime importance. The selection in question and the definition of restrictions are the prerogative of the beneficiary.

In various sources, it is recommended to use, for the assessment of economic efficiency of investment projects, such indices as: profit rate [1, 2], payback period on investment [2-4], net value [4], net present value [3-5], profitability index [3], internal rate of return [3-5], return on investment [4], economic return on investments [1, 6, 7], adjusted expenditure [6], total costs of ownership [6, 7] and so on.

The multitude of efficiency criteria for projects in informatization is caused by the diversity of aspects that characterize the respective situation-problems. Appropriate guidance in the multitude of investment project estimation indices may lead to more successful solutions in the field. A systematic description of 15 projects efficiency criteria in paper [8] is done. In this paper, quantitative indices of comparative analysis of investment projects will be examined.

2. General considerations. Depending on the research product and its field of use, the set of applied indices may be different. In a specific project, a small set of indices is usually applied. It is recommended to analyze 7 ± 2 indices in [91]. Typically, 1-3 core indices and a few auxiliary indices are used.

Moreover, the problem of creating or developing a product is often formulated as an optimization problem. It contains one optimization criterion, and the other factors are considered in the problem as restrictions. The optimization criterion itself may be a composite one, comprising several indices with a certain weight. As constraints, when creating i-products, they often use: the maximum admissible amount of investments, the minimum allowed payback period on investment, and so on.

The projects to be compared can be:

- with the same functional finalities (objectives) – alternative projects, only one of them will be implemented;

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- with different functional finalities – non-alternative projects, they are candidates for project portfolios.

According to the degree of uncertainty of the opportunity to implement the functional finalities, i-projects can be grouped in three categories:

1) projects with functional finalities, the opportunity of implementation of which at this stage is certain;
2) projects with functional finalities, the opportunity of implementation of which at this stage is uncertain, it will be decided basing on the examination of rigorous arguments;
3) projects with functional finalities, the inappropriate implementation of which at this stage is certain.

Of course, projects of the third category are not to be discussed – they are not implemented at this stage. As far as functional finalities of projects of the first category, they must be implemented at this stage, but only the most suitable, in sense of the efficiency criterion, project has to be chosen from the multitude of alternatives in question.

Examples of project finalities that might be referred to the first category: a) creating a Web site for a company that still does not have such a site; b) implementation of online voting for parliamentary elections in Moldova, given that more than one third of voters are outside the country; c) implementation of online programming at doctors in all consultative diagnostic centers in Chisinau.

The vast majority of projects, however, refer to the second category.

By the possibility of quantitative estimation of the revenue from implementation, projects can be grouped in two categories:

a) projects whose revenue is so difficult to quantify that it is not worth it;
b) projects whose revenues can be estimated quantitatively with reasonable efforts.

By combining the two classification criteria, the degree of uncertainty of the opportunity to implement functional finalities and the possibility of quantifying the income from implementation, i-projects can be grouped into four categories: 1a, 1b, 2a and 2b, respectively. It will also be considered that for all projects related to one of these four categories, all costs incurred in maintaining and using them can be determined.

3. Taking into account the time factor. In practice, there are many cases when a product is created/procured, implemented and subsequently used over several years. In such cases, it is appropriate to take into account in calculations also the time factor: investment and operational expenditure in different years are updated to the same time – the beginning of the reference year [9]. For this purpose, the expenditure and results of that year, incurred and obtained before the beginning of the reference year, shall be multiplied by the discount coefficient $d_n$, and those, incurred and obtained after the beginning of the reference year, shall be divided by that coefficient; here n is the number of years separating that year from the reference year.

When comparing new investment projects, as reference year it is appropriate to consider the year of the start of work on project. The procedure in question is called discounting, and the values of those indices – present [96] or discounted. For example: present value of investments, present value of profit, etc. The coefficient $d_n$ is determined according to formula [4]:

$$d_n = (1 + d)^n, \qquad (3.16)$$

where $n$ is the number of years separating the expenditure and the results of the year from the beginning of the reference year, and $d$ is the discount rate; here is considered that the discount rate is constant during the reference period, but in general case it can depend on $t$. So, an investment of \$1 at the moment is equivalent over $n$ years to a sum of \$$d_n$.

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Depending on case, the discount rate $d$ may be: the inflation-adjusted average interest rate plus a risk premium, the average rate of return on the investment sector or weighted average cost of capital (WACC). Usually the interest rate plus a risk premium is chosen [3].

To note that the update interval does not necessarily have one year. It can be of another duration, for example: one semester, one month, one decade, one day, etc. If this range tilts to zero, we talk about the continuous update with a continuous discount rate $s$. The ratio between the discrete discounted rate $d$ and the continuous discounted rate $s$ is determined by relation [9]:

$$1 + d = e^s, \tag{3.20}$$

or

$$s = \ln(1 + d), \tag{3.21}$$

where $e$ = 2,73… . From relation (3.20), it can be easily observed that if $d = 0$, then $s = 0$, and if $d > 0$, then $s < d$; at the same time, if $d$ is small, then the difference between $d$ and $s$ is also small.

The case with outdated values of indices is a particular one of the case with updated (discounted) values and can be obtained, if necessary, from the last one, considering the discount rate equal to 0. For these reasons, we will investigate, unless specifically mentioned, only the case with discounted values of indices.

Thus, the indices for assessing the efficiency of investment projects can be static – indices that do not take into account the time factor, and can be dynamic – indices that take into account the time factor. Static indices are typically used to estimate the effectiveness of projects with a duration not exceeding one year. In other cases, dynamic indices are used, these being more accurate.

4. Comparing projects with unequal lives. An important aspect, when comparing investment projects, is the duration of use of the implemented product. It may influence the appropriate criteria for selecting the expected project. Such a situation is caused, firstly, by the fact that some indices are absolute, characterizing certain absolute values, and others are relative in time, characterizing certain relative values on certain periods of time, mainly one year. Of the 15 indices, described in [93], to absolute in time ones refer the following: the profit, payback period (PP), net value (NV), net present value (NPV), adjusted expenditures ($C^{EN}$) and the total costs of ownership (TCO), and to relative in time ones – the indices: profit rate (PR), return on investment (ROI), internal rate of return (IRR), accounting return on investment, annual economic effect (E), annual adjusted expenditure ($C^{E}$) and annual average costs of ownership (ATCO). To note that the economic return on investment and the profitability indices are also relative ones but with respect to the volume of investment, not to time.

In case of direct use of absolute in time indices for the comparison of projects, the decision may be influenced by the duration of respective products use. Therefore, for the appropriate comparison of projects with different lifetimes, special methods are applied: the equivalent annual value method or the replacement chain method. More convenient in use is the first of these two methods.

The ***equivalent annual value method*** (EAV) puts in an adequate correspondence to the updated summary value over a period of time of an index of a value over a shorter period, e.g. one year, thus allowing comparative analysis of projects with different lifetimes of their products. If the method applies to NPV index, it is also called the ***equivalent annual cost method*** (EAC) [10]. It is based on ***capital recovery factor*** (CRF), which represents the ratio between a constant annuity and the discounted value of the receiver of this annuity for a certain period of time. The CRF can be interpreted as the value to be received each year during the product use, so that the actual total value of all these equal payments be equivalent to an one current monetary unit payment.

Taking into account (3.16), the CRF value, in case of duration $D$ of product use, is determined as

$$\text{CRF} = \left[\sum_{t=1}^{D} \frac{1}{(1+d)^t}\right]^{-1} = \frac{d(1+d)^D}{(1+d)^D - 1}, \tag{3.60}$$

from where CRF($D$=1) = $d$ + 1, and CRF($D\to\infty$) = $d$; thus, $d \le \text{CRF} < d + 1$.

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For index XX, which characterizes a certain absolute value for the entire period $D$ of the product use, the equivalent annual value will be noted EAXX and is determined as

$$\text{EAXX} = \text{CRF} \times \text{XX}. \qquad (3.61)$$

For example, between EAC and CRF indices, the relationship EAC = EANPV = CRF × NPV occur. When comparing two projects, their EAXX values are compared. In such cases it is of interest the character of function $f(x, D_{\text{I}}, D_{\text{II}}) = \sum_{t=D_{\text{II}}+1}^{D_{\text{I}}} \frac{1}{(1+x)^t}$, where $D_{\text{I}}$ and $D_{\text{II}}$ are the lifetimes of projects I and II products, and $x$ is the discount rate or the internal rate of return. It is easy to identify that the function $f(x,D_{\text{I}},D_{\text{II}})$ is decreasing with respect to $x$ and $D_{\text{II}}$ and is increasing relative to $D_{\text{I}}$. Some $x^{(1)}$ values of $x$, for which $f(x,D_{\text{I}},D_{\text{II}}) \approx 1$, are shown in Table 1.

**Table 1 Values $x^{(1)}(D_{\text{I}},D_{\text{II}})$ of $x$, for which $f(x,D_{\text{I}},D_{\text{II}}) \approx 1$**

| $D_{\text{I}}$ | $D_{\text{II}}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | - | - | - | - | - | - | - | - | - |
| 2 | 0,6180 | - | - | - | - | - | - | - | - |
| 3 | 0,8392 | 0,3247 | - | - | - | - | - | - | - |
| 4 | 0,9276 | 0,4658 | 0,2207 | - | - | - | - | - | - |
| 5 | 0,9659 | 0,5342 | 0,3247 | 0,1673 | - | - | - | - | - |
| 6 | 0,9836 | 0,5701 | 0,3803 | 0,2499 | 0,1347 | - | - | - | - |
| 7 | 0,9919 | 0,5900 | 0,4122 | 0,2965 | 0,2032 | 0,1128 | - | - | - |
| 8 | 0,9960 | 0,6013 | 0,4313 | 0,3247 | 0,2433 | 0,1713 | 0,0970 | - | - |
| 9 | 0,9980 | 0,6080 | 0,4433 | 0,3426 | 0,2686 | 0,2065 | 0,1481 | 0,0851 | - |
| 10 | 0,9990 | 0,6119 | 0,4509 | 0,3544 | 0,2852 | 0,2293 | 0,1795 | 0,1305 | 0,0758 |

For example, at known values of $D_{\text{I}}$ and $D_{\text{II}}$ sizes, using data from Table 1, the lower limit of the $\text{IRR}_{\text{I}}$ value, which leads to inequality

$$1 \Big/ \sum_{t=D_{\text{II}}+1}^{D_{\text{I}}} \frac{1}{(1+\text{IRR}_{\text{I}})^t} > 1,$$

basing on condition $\text{IRR}_{\text{I}} > x^{(1)}(D_{\text{I}},D_{\text{II}})$ can be determined. Thus, at $D_{\text{I}} = 8$ and $D_{\text{II}} = 5$, we have $\text{IRR}_{\text{I}} > 0.1713$.

5. Preliminary reduction of the number of base indices. Reducing the number of core indices would facilitate the comparative analyses of investment projects. It can be done, for example, on the basis of:

1) identifying the correlation of indices;
2) taking into account the time factor (dynamic vs. static indices);
3) taking into account the different duration of projects;
4) the range and importance of aspects characterized by indices.

Systematization of information on economic efficiency indices that could be used to make the creation and use of i-products more efficient and to reduce the use of 15 well known indices to one, namely to minimize the volume $I^{\text{C}}$ of investment, when comparing the alternatives of solutions under certain conditions [8], considerably simplifies the problem.

It may also be useful the identification of similarity and the results of mutual comparison of total costs of ownership and adjusted expenditures indices done in [8], largely similar and frequently used to compare i-projects. With regard to these, the conditions in which their use leads to different solutions were determined. If these conditions are met, then the use of $C^{\text{EN}}$ instead of TCO in projects evaluation leads to another solution – a project with a higher production costs and a lower investment volume.

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From indices described in [8], the payback period $T$ index is inversely to the return on investment $R^{\mathrm{N}}$, and the discounted PP $T_d$ is opposite to the discounted ROI $R_{\mathrm{d}}^{\mathrm{I}}$, the first two being static, and the last two being dynamic. At $T \leq 1$ year, the equations $T = T_d$ and $R^{\mathrm{N}} = R_{\mathrm{d}}^{\mathrm{I}}$ take place, and at $T > 1$ the dynamic indices are more accurate. So, from these four indices, it is appropriate to use the $T_d$ or the $R_{\mathrm{d}}^{\mathrm{I}}$. In the following it will be used the $R_{\mathrm{d}}^{\mathrm{I}}$ index. Because the dynamic indices are more accurate, of the net value and net present value indices it would be preferable to use the NPV.

Similarly, between the annual adjusted expenditure $C^{\mathrm{E}}$ and adjusted expenditure $C^{\mathrm{EN}}$ indices occurs the relationship

$$C^{\mathrm{EN}} = C^{\mathrm{E}} T^{\mathrm{N}}, \tag{3.46}$$

where $T^{\mathrm{N}}$ is the normative payback period.

Therefore, if the normative payback period on investments for the compared projects is the same, then either of these two indices can be used, let be $C^{\mathrm{EN}}$. Of course, for i-projects this period is the same. Otherwise, the EAV method (s. 4) for comparison purposes may be used.

Although accounting rate of return is an annual index, it does not take into account the time value of money. Thus, it cannot serve as base criterion of project economic efficiency.

Also, when determining the profit rate, the volume $I^{\mathrm{C}}$ of investments with the product is not taken into account. That is why the PR index could usually be used only as an auxiliary index.

It is obvious that, in conjunction with the AEV method, of TCO and TACO ones it is preferable to use the TCO (EATCO) index.

Of course, in specific cases the beneficiary may be interested also in the use of other indices, especially as auxiliaries. One of these is the annual economic effect index. Thus, the number of core indices for comparative analysis of projects, out of the 15 described in [8], is reducing to 7, eventually in conjunction with the EAV method: $R_{\mathrm{d}}^{\mathrm{I}}$, $R^{\mathrm{EI}}$, NPV, IRR, PI, $C^{\mathrm{EN}}$ and TCO.

**6. Particularities of alternative projects.** In case of alternative projects, their functional objectives and finalities are the same. This leads to certain peculiarities of alternative projects, defined by Hypotheses 1-3. Of course, there may also be alternative projects that do not fit into any or all of these three hypotheses.

- *Hypothesis 1*. in Case 1 of s. 2, the revenues from the implementation of alternative projects are approximately equal.

Indeed, revenue from the implementation of a project is mainly determined by the functional finalities of the product/service concerned. At the same time, in Case 1, all alternative projects have the same functional finalities.

- *Hypothesis 2*. In Case 1 of s. 2, the duration of the acquisition of investments is approximately equal for all alternative projects.

Indeed, in Case 1, all alternative projects have the same functional finalities. That is why it is unlikely that the duration of the acquisition of investments will differ considerably from one project to another.

- *Hypothesis 3*. In Case 1 of s. 2, the duration $D$ of the implemented product use is approximately equal for all alternative projects.

Although, usually to a lesser extent, but for the same reasons as those in support of Hypothesis 2, Hypothesis 3 also occurs.

**7. Criteria to be used when comparing i-projects in pairs.** It is shown, as in section 6, and in needed cases it is proofed that in the comparative analysis of two projects, starting with the product launch in operation, as basic economic efficiency indices it is appropriate to use:

a) TCO index – for Category 1a or 2a projects of the same duration, the revenue from implementation of which is so difficult to estimate quantitatively that it is not worth it. Category 2a projects can only be accepted if $D > T^{\mathrm{N}}$;

b) EATCO index – for Category 1a or 2a projects of a different duration. Category 2a projects can only be accepted if $D > T^{\mathrm{N}}$;

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c) for Category 1b or 2b two projects of the same duration, the revenue from which can be estimated quantitatively with reasonable effort – the NPV index and any of the PI, EAPI and IRR indices, easier to calculate from the last three being the PI index. Category 2b projects can only be accepted if NPV > 0;

d) for Category 1b or 2b two projects of a different duration – EANPV and EAPI indices. Category 2b projects can only be accepted only if EANPV > 0.

**CONCLUSIONS**

The multi-aspectual characterization of indexes for the estimation of investment projects economic efficiency is given, including by categories: (a) basic, auxiliary; (b) static, dynamic; (c) absolute, relative. Based on their comparative analyses, the respective preferences are identified. Similarly, a specific classification of investment projects is proposed according: (a) the set of functional finalities of their products – alternative, non-alternative; (b) the degree of uncertainty of the opportunity to implement the functional finalities – certain positive, uncertain and definitely negative; (c) the possibility of quantitative estimate of income from implementation – so difficult that it is not worth it, of reasonable difficulty.

The characterization and classifications concerned allowed for a wider comparative analysis of indices and the identification of the opportunity to use certain indices as basic ones for the selection of investment projects. In some situations, the TCO index is preferred, in others – EATCO, in others – VAN along with any of the PI, EAPI or IRR indices, and in others – EANPV and EAPI

Of course, along with basic indexes, when selecting projects, it may be appropriate to use as auxiliaries other indexes. Moreover, the recommendations described in section 7 are obtained under certain conditions that may not, to a greater or lesser extent, be satisfied in real situations. For example, in case of projects of a different duration, it is important to take into account the related risks, etc. Therefore, the recommendations in question can usually only serve as broad guidelines in the respective problem situations.

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