METHODS INDICATORS EQUIVALENCE FOR ECONOMIC RESEARCH OF THE LONG-TERM CAPITAL INVESTMENT PROJECT

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ABSTRACT: *In economics, projects having an economical life more than a yearlong are considered log term investments. An economic study of these projects cannot skip over the fundamental criteria represented by the economic indicator known as the "invested capital return". The trend of merging of the most important methods for economic study of long term investment projects have led to defining four fundamental methods: the internal rate of return method; -the explicit reinvestment rate of return method; the annual value method; the present value method. We could demonstrate the equivalence of these indicators for projects that allow application of these four methods.*

KEY WORDS: *long-term capital investment projects, economic study, internal rate of return, explicite reinvestment rate of retourn, annual value, present value.*

JEL CLASSIFICATION: O16, O22

1. INTRODUCTION

A fundamental criterion for investment decisions of private companies, and public enterprises engaged in economic activity profitable, is the rate of return on invested capital (which shows as "wins" the annual monetary unit invested).

Consequently, any economic study of a project involving capital investment must be such as to include issues related to return on capital invested in the project will produce thought or you have to produce.

Projects are considered long-term capital investment, by convention, those projects that revenue streams, costs and profits are staggered current time for more than one year.

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Obviously, economic study of these projects should include issues related to return on capital invested.

The project approach to establish the fundamental economic indicator requires a mesh (often at a time of year) and scheduling of all cash flows over the entire economic life of the project.

Translated into a graphic form, the process of digitization and timing diagram takes the form of cash flow, after certain rules, are plotted all the cash flows on the project implementation and subsequent operation generates.

Using the convention of discrete placement at one year interval of arrows, at the start of the period, under axis for negative flows and at the end of period, above the axis, for positive flows, we can distinguish four models of representation of cash flows:

- the general model (figure 1): many periods with negative cash flows with different amount of money, investments in the first stage scheduled on many years, running in condition of net positive cash flow, even if some capital investments are performed;

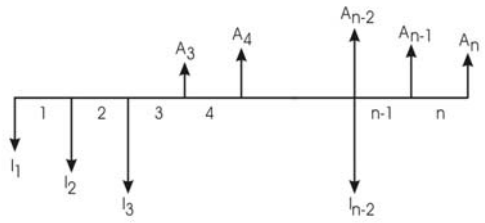

Figure 1.

- the particular model 1 (figure 2): after an initial stage which preserves the mode of repartition of money according to the general model, a first particular case appears, when the positive flows are uniform on the all period in which the assessment is preformed;

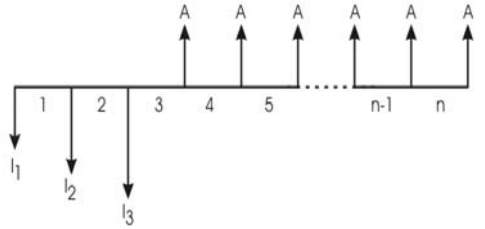

Figure 2.

- the particular model 2 (figure 3): the initial stage of investment is a particular case, the entire amount of cash is invested at the start of the first period, the present moment, and in the running stage the flows are no uniform , as in the general case;

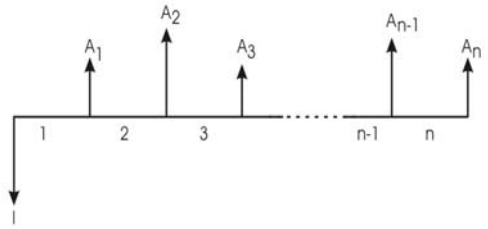

Figure 3.

- the particular model 3 (figure 4): the initial stage is as in the particular model 2 and in the running stage as in the particular stage case 1, After a unique investment in the e actual moment, at he beginning of the firs period, many periods follow at the end of which positive flow appears, the same for all the periods.

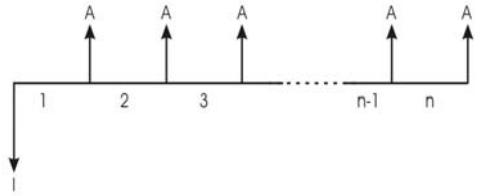

Figure 4.

In order to assess the economic efficiency of the project in which the influence of the factor time will be considered, a prediction of the scheduling of annual cash flows will be necessary, based on certain hypotheses which not are the subject of the present paper. We arrive then to associate to the project one of the models of scheduling, and related to it to adopt an appropriate method of assessment of capital return.

Economic evaluation of projects consider the following cash flows:

I_t - capital expenditures or investments (index t indicates that the investment is made at the beginning of t);

V_t - gross income in year t (actual cash inflows obtained by selling production achieved);

C_t - operating costs and maintenance in year t (actual cash outflows that do not include depreciation);

VS_n - residual salvage value at the end of the economic life of the project;

n - the economic life of the project (years).

Customizing complex decision situation is reached simplest cases.

Depending on the situation decision (embodied in some form of cash flow diagram) may apply different methods of economic study of the project.

In observance of the methods is recommended "to individual cases - simple methods; to complex cases - general methods".

Although economic study of capital investment projects using methods and especially indicators plentiful at present there is a strong tendency to unify these basic methods.

Anglo-Saxon economic literature can be found following four methods:

- internal rate of return method (return) IRR (The Internal Rate of Return);
- explicit reinvestment rate method, ERR (The Explicit Reinvestment Rate of Return);
- annual value method, AW (The Annual Worth);
- present value method, PW (The Present Worth).

The name comes from methods based indicator used to highlight the return to capital invested.

But all methods include the calculation relationships, estimates, statements and assumptions that are used to determine the basic indicator .

2. INTERNAL RATE OF RETURN METHOD (IRR)

It is the most general and most widely used in economic studies. Mathematically, the internal rate of return is the real solution of the equation

$$-\sum_{t=1}^{n} I_t (1+r)^{-(t-1)} + \sum_{t=1}^{n} (V_t - C_t)(1+r)^{-t} + \\ + VS_n (1+r)^{-n} = 0 \qquad (1)$$

To decide on the feasibility of the project analyzed RIR compares with a Rate of Return Minimum Permissible (RRMP).

If the project is feasible, and if the project is feasible.

3. EXPLICIT REINVESTMENT RATE METHOD (ERR)

Method is applicable only in particular conditions, for projects with a single initial capital investment (I), followed by uniform streams of income and expenditure gross annual operating and maintenance, ie

$$V_1 = V_2 = ... = V_t = ...V_n = V \qquad \text{and}$$
$$C_1 = C_2 = ... = C_t = ... = C_n = C$$

To calculate the indicator showing the return on investment capital using the following relations

$$ERR = \frac{B}{I} 100 \qquad [\%] \qquad (2)$$

$$B = V_b - \left[\left(C_e + C_m\right) + D\right] \tag{3}$$

$$D = \left(I - VS_n\right)\frac{r^*}{(1+r^*)^n - 1} \tag{4}$$

where: B - annual gross savings;

V_b - Annual gross income;

$\left(C_e + C_m\right)$ - annual operating expenses and maintenance;

D - annual depreciation of the capital invested in the project;

r^* - the rate of return to capital and reinvested recovered.

Feasibility of the project is assessed by comparing the ERR with RRMP. If the project is feasible, and if the project is feasible.

4. ANNUAL VALUE METHOD (AW)

It is a method applied in exactly the same conditions as explicit reinvestment rate method.

The annual value is determined by the relation

$$AW = V_b - \left[\left(C_e + C_m\right) + D + B^*\right] \tag{5}$$

where

$$B^* = I\frac{RRMA}{100} \tag{6}$$

represents the opportunity cost of capital.

Feasibility of the project is assessed by comparing AW with 0 (zero).

5. PRESENT VALUE METHOD (VP)

It is a general method, internal rate of return similar to the method (in fact, the first step in the application). The present value is determined by the relation

$$\begin{aligned} PW = &-\sum_{t=1}^{n} I_t\left(1+RRMA\right)^{-(t-1)} + \\ &+\sum_{t=1}^{n}\left(V_t - C_t\right)\left(1+RRMA\right)^{-t} + \\ &+VS_n\left(1+RRMA\right)^{-n} \end{aligned} \tag{7}$$

Feasibility of the project is assessed by comparing PW with 0 (zero).

6. DEMONSTRATION OF EQUIVALENCE INDICATORS OF FOUR METHODS

There are projects that can be applied to any of the four basic methods of economic study, final conclusions are identical.

There are also projects that due to the particularities posed regarding the timing of annual cash flows , require the use of only certain methods.

Applying a method that does not lend itself to the type of project contemplated may lead to erroneous conclusions and make wrong decisions.

But can demonstrate equivalence of the four basic methods (in fact, their indicators) for a project whose economic study can be done using any of these.

Equivalence indicators equivalence methods materializes conclusions arrived at by applying methods (whether it seeks to establish the feasibility and prepare a "ranking " of the project) .

To demonstrate equivalence study methods economic indicators projects with long-term capital investment starts from the relationship indicator "present value".

$$PW=-\sum_{t=1}^{n} I_t(1+r)^{-(t-1)}+\sum_{t=1}^{n}(V_t-C_t)(1+r)^{-t}+VS_n(1+r)^{-n}$$

which can be rewritten as

$$PW=-I-\sum_{t=2}^{n} I_t(1+r)^{-(t-1)}+\sum_{t=1}^{n}(V_t-C_t)(1+r)^{-t}+VS_n(1+r)^{-n}$$

where I is the investment made at the beginning of the first year of the economic life of n years of the project.

It is noted that $PW = f(r)$ and is obtained by summing algebraically all the cash flows of the project, made at the present time (date), the discount rate is a minimum rate of return permisible (RRMP).

If recovery means that the project provides capital, an annual return on capital remains invested in the project (equal to r), and an annual overprofit, the present value (at a rate r) of these supraprofituri is just the present value calculated.

PW amount is therefore an indicator of the additional attractiveness of the project.

Based on this finding, which reflects the essence of the issue efficiency of investment, gradually, it can lead to other interpretations.

If the mean annual percentage gain is achieved r capital invested in the project remained fully recover invested capital.

The discount rate r used in this case is just a project internal rate of return (IRR was defined as the discount rate of the cash flows generated by the project for which the algebraic sum of their present values is equal to zero).

It means therefore that the PW position can be reached immediately IRR condition requiring $PW = 0$ and solving the equation in r thus obtained.

This proves the equivalence of two methods general fundamental indicators: internal rate of return method and present value method.

To demonstrate the equivalence of all four indicators (IRR, ERR, AW, PW) required three simplifying assumptions (generated by the conditions of application of the methods explicit reinvestment rate and annual), namely:

- rescue residual values at the end of the economic life of the project are zero, ie $VS_n = 0$

- the project requires an initial investment capital alone (the beginning of the first year), potential replacements and maintenance capacity after realizing the sinking fund account, so $\mathrm{I_t} = 0$ where $\mathrm{t} \in [2; \mathrm{n}]$

- period of the project is very short, insignificant in relation to its economic life, and after commissioning, every year, there is the same gross revenue streams and operating expenses, ie

$$\mathrm{V_1} = \mathrm{V_2} = ... = \mathrm{V_t} = ...\mathrm{V_n} = \mathrm{V} \quad \text{and}$$
$$\mathrm{C_1} = \mathrm{C_2} = ... = \mathrm{C_t} = ... = \mathrm{C_n} = \mathrm{C}$$

so

$$\mathrm{B_1} = \mathrm{B_2} = ... = \mathrm{B_t} = ... = \mathrm{B_n} = \mathrm{B}$$

where: $B = V - C$

Based on these assumptions, the relationship indicator PW takes the form

$$PW = -I + (V - C)\sum_{t=1}^{n}(1+r)^{-t}$$

But

$$\sum_{t=1}^{n}(1+r)^{-t} = \frac{(1+r)^n - 1}{r(1+r)^n} = \frac{1}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

From where

$$PW = -I + B\frac{1}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

the possible interpretations below.

a) If the limit, it means that give

$$I = B\frac{1}{r}\left[1-\frac{1}{(1+r)^n}\right]$$

term of the right side of this equality representing annual profits amount updated economic lifetime of the project in years.

The relationship shows that the maximum investment an investor is willing to accept to achieve an annual B throughout the economic life of the project.

b). If the means to give $PW + I = B\frac{1}{r}\left[1-\frac{1}{(1+r)^n}\right]$ relationship showing that the "can support" for an investment greater than the sum I (determined by the project), the difference (PW) is just the present value of the project.

If the hypothesis is accepted perpetuity (theoretical, practical, years) as

$$\lim_{n\to\infty}\left[1-\frac{1}{(1+r)^n}\right]=1$$

for PW indicator it is obtained the following relationship

$$PW = -I + \frac{B}{r}$$

which can be interpreted as follows.

b_1). If, at the limit $PW = 0$, it means $r = IRR$, so $PW = B\frac{1}{IRR}$

This result allows us to interpret the significance of the relationship between IRR and RRMP size and highlight the links between the internal rate of return method and explicit reinvestment rate method.

1/IRR report represents a period of recovery for the period (in years) the initial investment will be recovered on account of annual profits constant B of the project.

1/RRMP report shows the number of years the initial investment would be recovered if it had done every year on capital invested, a return equal to RRMP.

If $IRR > RRMP$, $\frac{1}{IRR} < \frac{1}{RRMP}$, invested capital is recovered in a shorter period, which means that a longer economic life of the project only works for profit, which makes their discounted amount is greater than a project same economic life, but with a rate of return equal to RRMP.

The relation $I = B\frac{1}{IRR}$, can be also written as $IRR = \frac{B}{I}$, hence the conclusion that, being thus put out the equivalence of the two fundamental indicators.

b_2.) If $PW > 0$, it means that $RRMP = r < IRR$,being available the following relation $PW + I = \frac{B}{r}$, from which we have $PW = \frac{B}{r} - I$ or $PW = \frac{B - rI}{r}$ and $AW = B - rI$

The relation of present value becomes $PW = \frac{VA}{r}$, thus showing that the present value (PV) is nothing but the sum of all updated over profits made the whole economic life of the project.

7. CONCLUSIONS

Fundamental to approximate the preliminary assessment of a project is the relationship $\mathrm{I} = \frac{\mathrm{B}}{\mathrm{r}}$ (also known as "cap testing") which interpretation allows a three-fold, namely:

- if r has the meaning of a minimum return rate allowed, then B shows that annual profits to be made, the entire economic life of the project so as to be justified in terms of a rational investor, the total investment I;

- if the minimum allowable rate of return an investor is r, I show the maximum investment that he is willing to do to earn each year, throughout the economic life of the project, profit B.

Every year, when the entire economic life of the project, obtain a profit B, the initial investment is I, r designates the rate of return on invested capital, operational feasibility of the project is assessed by comparing the rate of return r minimum allowable .

Relationship "test cap" established under some simplifying assumptions, the interpretations that are suitable, once put out equivalent study methods economic indicators projects with long-term capital investment, but only for those projects that can be addressed by any of the four methods.

If such a multiple approach is not possible, the equivalence of the four indicators is reduced to the equivalent of only two: internal rate of return and present value, corresponding to the general economic study methods.

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