NET PRESENT VALUE (NPV) VERSUS INTERNAL RATE OF RETURN (IRR) IN TAKING THE INVESTMENT DECISION FOR MUTUALLY EXCLUSIVE PROJECTS

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Abstract:

In current economic context, characterized by multiple challenges and uncertainties, it is extremely important taking investment decision to be rigorously founded. Due to fact that at base of its adoption are methods for evaluation of the investment projects, especially those indicators that use discounting technique for ranking investment process, Net Present Value (NPV) and Internal Rate of Return (IRR) require detailed analysis, especially for mutually exclusive *projects, because there are situations where the two methods leads to different decisions, such as: NPV indicates the adopting of one projects, whereas IRR choose another project.*

Keywords: *Investment decision, Net Present Value, Internal Rate of Return*

JEL classification: *G30, G31*

Introduction

Value of investment projects is crucial for any manager to correctly quantify, especially when a certain goal of a firm cannot be attained without having to *choose* between more than one investment project – i.e., to choose one investment project out of several ***mutually exclusive*** projects.

This, in turn, confronts the manager with yet another dilemma: which index should be used in measuring investment projects' value with, NPV (Net Present Value), IRR (Internal Rate of Return), or both? Historically, when NPV blatantly proved to be an imperfect index, or just a *part* of the answer(s) it had to come up with, economics came (so to speak) with IRR, but their (joint) use is a decision resting on less clear-cut foundations than this 'NPV gave way so IRR could rise' principle, and in the same time *must* be undertaken in certain circumstances, and under certain limitations, as will be argued further on.

Content

The NPV index, used – and developed – especially for evaluating investment projects' desirability, is built around discounted cash flow (DCF) technique, used through implementation of the following three main steps:

1. Present value of each cash flow is quantified – including all inflows and outflows, and *discounted* at the project's capital *cost*
2. All cash flows' present value are summed up – and that sum is defined as project's NPV
3. If NPV value is positive, the project should be accepted; consequently, if NPV value is negative, it should be rejected.

NPV formula is (where CF_1, …, CF_n are expected net cash flows at end of each year, CF_o initial investment outlay, i discount rate (minimum required rate of return on investment – in practical terms, this equals a given level of interest rate, i.e. interest rate market average[44]) and n project/investment's duration in years):

$$NPV = CF_0 + \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + \cdots \ldots \ldots + \frac{CF_n}{(1+i)^n}.$$

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[44] Maddala, G.S., Miller, E. (1989), p. 565

An NPV value *equaling zero* signifies project's cash-flow are only sufficiently high to repay the invested capital and to provide required rate of return on the capital; this, furthermore, means that:

(I) Costs proper incur whilst investment project is under way and stop being recorded (i.e. faced) when investment project is completed;

(II) Net cash flows (i.e. benefits) start being gained from the very moment investment project is completed, for a given number of years (n).

As per the object of our paper, if two or more projects with positive NPVs are *mutually exclusive*, the one with the higher NPV should be chosen.

On the other hand, IRR index is a necessary step forward from NPV level – which neither makes it an econometric 'waterproof good-for-all answer', nor renders NPV (at least, not in *all* cases) redundant. It is an index required by informational needs of a manager for running economic operations in long term, and thus, even on principle, *can* be used *along* with NPV.

This step forward is, in fact, the need to give the answer to a question any business plan has to deal with in its long-term version: are future benefits (of a given investment project) *at least* equal to its initial costs? This answer is obtained through quantitively determining several factors.

To some the main econometric reasoning up: whilst, from a theoretical perspective, a business seeks to find – arguably, especially in case of 'competing', i.e. mutually exclusive, investment projects – value of *discount rate for which future benefits equal initial costs*[45], more precise for which NPV=0, in practical terms, management must compute overall profitability of a project necessary so that $NPV \geq 0$.

In turn, what must be adequately measured is the present value of return rate of the project(s) – which is what a firm looks for, namely value of *internal* rate of return (IRR).

IRR formula, consequently, is (where CF stands for cash-flows recorded by firm – CF_0 being costs generated by a project being implemented and CF_1, …, CF_N benefits received by firm through project materialization)[46]:

$$NPV = 0 = CF_0 + \frac{CF_1}{(1+RIR)^1} + \ldots + \frac{CF_N}{(1+RIR)^N} \Leftrightarrow$$

$$\Leftrightarrow CF_0 + \frac{CF_1}{(1+RIR)^1} + \ldots + \frac{CF_N}{(1+RIR)^N} = 0$$

From this point of view, decision to *invest* in order to materialize *an* (as per mutually exclusive projects paradigm – i.e., *one* project and not *any other* project) investment project will be adopted only *if* opportunity cost of capital (i.e. interest rate - *r*) is smaller than internal rate of return[47]; to put this is another light, IRR is equal to maximum cost of capital a firm *can* afford.

There are circumstances in which IRR index is not good enough for determining profitability of investment projects, and the need to choose between mutually exclusive projects is one of most important[48]. Why? Because, for a firm's investment strategy, mutually exclusive projects are those investment projects which, given their financial perspectives (i.e. cash flows), on one hand, and financial requirements (i.e., costs), on the other hand, are not *close* in quantitative terms, and therefor *are* not practically comparable.

Because of this, IRR index is unable to prove useful – in this case –, considering whatever value IRR takes each of the mutual exclusive projects, *any* of these projects can prove, in the long run, more profitable than any other.

It should be observed all this conflict issue of using NPV and, respectively, IRR for determining optimal solution project out of al least two mutually exclusive investment project stems from a fundamental economic perspective principle – that of reinvestment of (investment project's) cash flows; for, it might be useful to generate cash flows *sooner* rather than later:

1. According to NPV methodology, rate at which cash flows can be reinvested is the cost of capital;
2. Conversely, according to IRR methodology, the firm can reinvest (i.e. project's cash flows) at IRR;

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[45] Ehrhardt, M.C., Brigham, E.F. (2011), p. 387.
[46] Ibid.
[47] Ibid., p. 117.
[48] Brealey, R.A., Myers, S.C., Allen, F. (2014), pp. 130-131.

3. According to a number of observations of *average* firm behavior, the 'best' assumption is that project's cash flows can be reinvested at the cost of capital, from which *would* be inferred NPV method is more reliable.

Pondering about what is to be obtained out of said average firm behavior observations, there is a way out of this NPV vs. IRR 'tug of war' quandary – that is, an index which is able to point out *which* project is the winner, in the unenviable situation when according to NPV and, respectively, to IRR not *the same* project is found out to be the best choice; this index is known as the ***crossover rate***[49].

Crossover rate is the rate of return at which the Net Present Values (NPV) of two or more projects are equal – in other words, at which net present value profile of one project intersects the net present value profile of (an)other project(s).

If the cost of capital is less than the crossover rate, the NPV method ranks a project, but the IRR method indicates the other project. Thus, a conflict exists if the cost of capital is less than the crossover rate. Basic practical economic logic suggests NPV method is better, because it selects the project that adds the most to the shareholder wealth.

To clarify this, in the table below are data illustrating in a quantitative approach the relationship between two (in this example) mutually exclusive projects – named PROJECT ALFA and PROJECT BETA – and NPV and IRR indices.

Processing both projects' data yields following results (assuming discount rate i = 5%, i.e. an *average* interest rate in a typical developed market economy, and n = 6):

PROJECT NAME	**ALFA**	**BETA**	***GAMMA***
CF_0	-20500	-48000	*27500*
CF_1	4500	11000	*-6500*
CF_2	3200	9000	*-5800*
CF_3	3800	9200	*-5400*
CF_4	4200	9600	*-5400*
CF_5	5500	11200	*-5700*
CF_6	6000	12000	*-6000*
NPV	***$2,212.83***	***$4,214.78***	**($2,001.96)**
IRR	***8.06%***	***7.63%***	**7.28%**

Our case is fit for illustrating the difficult times managers involved in convoluted decision making involved identifying 'best' investment project from a set of *mutually exclusive* projects have to deal with (in real life). For, assuming that i = 5%, both projects – ALFA and BETA – *would be* acceptable (i.e., could be equally chosen) because:

I. on one hand, NPV(ALFA) and NPV(BETA) are both positive, and, with NPV(BETA) > NPV(ALFA), investment project of choice will be BETA project;

II. on the other hand, IRR methodology has two conditions to be fulfilled simultaneously:
   a. IRR(ALFA) > i
   b. IRR(BETA) > i, and we have:
      - 8.06% > 5.00% ⇔ TRUE
      - 7.63% > 5.00% ⇔ TRUE

   ⇨ Conditions fulfilled.

   We have 8.06%>7.63%, so IRR(ALFA) > IRR(BETA) – which means per IRR methodology investment project of choice will be ALFA project.

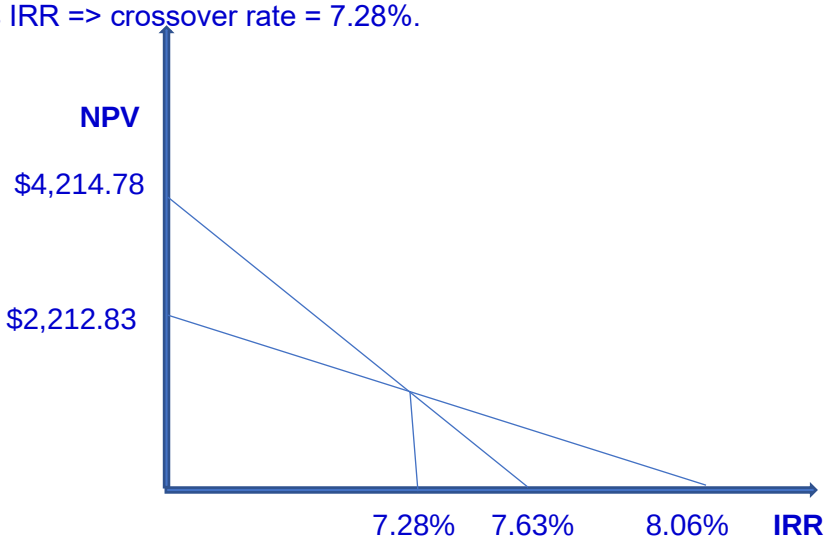
In this situation, when, according to NPV and, respectively, to IRR methodologies, not *the same* project *is* found out to be the best choice, we make use of crossover rate. This is computed in following two steps:

(1) Firstly, we calculate the difference in cash flows of both investment projects for each year;

[49] https://corporatefinanceinstitute.com/resources/knowledge/valuation/crossover-rate/.

(2) Then, we determine the IRR of resulting 'adjusted' investment project – which is the crossover rate.

In our case, 'adjusted' investment project is GAMMA project, and the crossover rate is GAMMA project's IRR => crossover rate = 7.28%.



r < 7,28%: NPV BETA> NPV ALFA; IRR ALFA> IRR BETA ⇒ CONFLICT

r > 7,28%: NPV ALFA > NPV BETA; IRR ALFA> IRR BETA ⇒ NO CONFLICT

It can be noticed in the figure that if the cost of capital is lower (r) than the crossover rate (7.28%), the NPV method indicates the project BETA, but the IRR method ranks the project ALFA and thus, there is a conflict. As long as the cost of capital is higher than the crossover rate both NPV and IRR will lead to the same decision.

Conclusions

Relevant literature is coherent enough to strongly state that, if cost of capital is less than crossover rate, the NPV method ranks a project, but the IRR method indicates the other project. Thus, a conflict exists if the cost of capital is less than the crossover rate.

In the matter of evaluating mutually exclusive projects, especially those that differ in scale and/or timing, the NPV method should be used, basis of this being the assumption project's cash flows can be reinvested at the cost of capital – from which is inferred NPV method is more reliable.

Thus, crossover rate is *the* tool to use for assessing (highest) value of mutually exclusive projects, as the rate of return at which Net Present Values (NPV) of two or more projects are equal.

Bibliography

1. Brealey, R.A., Myers, S.C., Allen, F., "Principles of Corporate Finance (11th Global Edition)", McGraw-Hill Education (UK), 2014
2. Ehrhardt, M.C., Brigham, E.F., "Corporate Finance: A Focused Approach (4th Edition)", South-Western, 2011
3. Maddala, G.S., Miller, E., "Microeconomics: Theory and Applications", The McGraw-Hill Companies, Inc., U.S.A., 1989

https://corporatefinanceinstitute.com/resources/knowledge/valuation/crossover-rate/