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Conflicting Result between NPV and IRR: Which one is better?

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Abstract- *Both NPV and IRR are popular techniques of capital budgeting. The NPV of a project is exactly the same as the increase in shareholders' wealth. This fact makes it the correct decision rule for capital budgeting purposes. IRR is the rate of return on invested capital that the project is returning to the firm. Sometimes the NPV and IRR can favor conflicting project choices. Such conflicts may be dealt with by considering the mutuality of the project, value additivity principle ,multiple rates of return and reinvestment rate assumption. In reality, using the IRR method could lead to investment decisions that increase, but do not maximize wealth. Another reason for which IRR approach might not be usable-this is when projects have unconventional cash flow patterns.*

Key words- *Net Present Value(NPV;, Internal Rate Of Return(IRR); Cost of capital; Value; Wealth maximization*

1. LITERATURE REVIEW

A number of researchers in finance and accounting have examined corporate capital budgeting practices. Many of these articles survey corporate managers and report the frequency with which various evaluation methods, such as payback, internal rate of return (IRR), net present value (NPV), discounted payback, profitability index (PI), or average return on book value are used. The best known field studies about the practices of corporate finance are Gitman and Forrester's (1977) study of Capital Budgeting Techniques Used by Major U.S. Firms, Porwal's (1976) study on Capital Budgeting Techniques and Profitability and Grahamand Harvey's (2001) study on capital budgeting, cost of capital, and capital structure.It is believed that the findings of this study in the context of India are useful to academia and practitioners in learning how corporate India operates, developing new theories, and identifying areas where finance theory is not implemented. What are the capital budgeting tools and techniques being practiced by the industry and how popular are they? Do firms use methods that help to maximize the firm value? The review of empirical surveys and studies help to find answers to these questions. The changes in capital budgeting procedures over the decades have been well documented in prior studies. The research of Canada and Miller, Fremgen, Gitman and Forrester, Kim and Farragher, Stanley Block all indicate that increasingly sophisticated capital budgeting procedures have been put in practice.

However, a generalization that more sophisticated practices take place across all industries is subject to investigation and challenge. This consideration is important because an analyst within a given industry may be intending on following industry norms but misled by general observation that relate to the studies cited above. Just as there are different valuation procedures or financing norms between industries, there may also be different capital budgeting procedures.Rosenblatt and Jucker (1979) and Scott and Petty (1984) summarize several of these surveys. They show that from 1955 to 1978 the use of techniques which recognize the time value of money (i.e., IRR, NPV, PI and discounted payback) by sample firms rose from .09 to around .80. However, many survey authors express surprise that a greater percentage of the respondents did not use techniques which discounted future cash flows. A number of textbooks have similar concerns.

No significant work has been conducted in Bangladesh on the conflict between NPV and IRR which is the concern of my paper. So, there are a lot of opportunities to conduct research on this subject matter.

2. DISCUSSION

2.1 Net Present Value

The NPV method 'discounts' operating cash flows at a rate that captures the cost of capital (i.e. the capital used/contributed to generate cash flows). The NPV method aims to capture the amount available after meeting the cost of all capital contributors (all claimholders). In fact, the NPV method is what leads to the concept of value creation through Economic Profit. Thus even if the IRR of Project A is better than Project B, a relatively lower Cost of Capital may swing the decision in favor of Project B.A positive NPV is a must and the higher the better.

The NPV method is used for evaluating the desirability of investments or projects.

$$NPV = \frac{C_1}{I+\gamma} + \frac{C_1}{(I+\gamma)^2} + \frac{C_1}{(I+\gamma)^3} + \cdots \frac{C_1}{(I+\gamma)^n} - I_0$$

$$\sum_{t=1}^{n} \frac{C_t}{(I+\gamma)^t} - I_0$$

where:

C_t = the net cash receipt at the end of year t

I_0 = the initial investment outlay
r = the discount rate/the required minimum rate of return on investment
n = the project/investment's duration in years.
The discount factor r can be calculated using:

$$q(t,i) = \frac{1}{(1+i)^t}$$

Examples:

$$q(1,10\%) = \frac{1}{(1.1)^1} = 0.909$$

$$q(2,10\%) = \frac{1}{(1.1)^2} = 0.8264$$

$$q(3,10\%) = \frac{1}{(1.1)^3} = 0.7513$$

Decision rule:
If NPV is positive (+): accept the project
If NPV is negative(-): reject the project

2.2 The internal rate of return (IRR)

Internal Rate of Return measures the return generated by an asset assuming that the reinvestment rate of cash flows thus generated, is the same as the IRR itself. IRR is an iterative process where reinvestment rate is the same as the IRR itself!
The IRR is the discount rate at which the NPV for a project equals zero. This rate means that the present value of the cash inflows for the project would equal the present value of its outflows.
Ultimately, IRR gives an investor the means to compare alternative investments based on their yield. Mathematically, the IRR can be found by setting the above NPV equation equal to zero (0) and solving for the rate of return (IRR).
· The IRR is the break-even discount rate.
· The IRR is found by trial and error.

Calculation

$$\boldsymbol{IRR} = \sum_{t=1}^{n} \frac{\boldsymbol{C_t}}{(\boldsymbol{I}+\boldsymbol{\gamma})^t} - \boldsymbol{I_0}$$

Example:
What is the IRR of an equal annual income of $20 per annum which accrues for 7 years and costs $120?

$$Q(7,r) = \frac{\$120}{20} = 6$$

From the tables = 4%
Economic rationale for IRR:
If IRR exceeds cost of capital, project is worthwhile, i.e. it is profitable to undertake.

2.3 Similarities in results under NPV and IRR

Both NPV and IRR will give up the same result (i.e., acceptance or rejection) regarding an investment proposal in following cases:

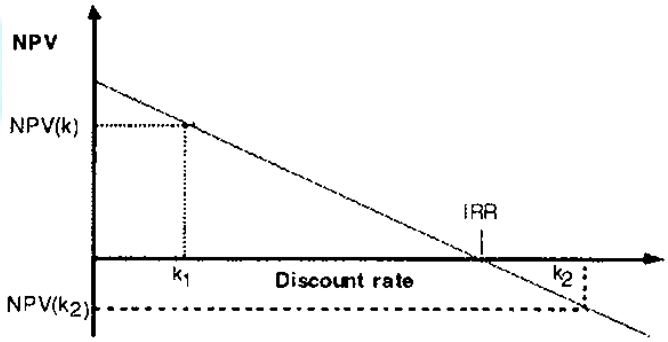
i. Projects involving conventional cash flows, i.e., when an initial outflow is followed by a series of inflows.
ii. Independent investment proposals, i.e., proposals the acceptance of which does not preclude the acceptance of others.

The reason for similarity in results in the above cases is simple. In case of NPV method, a proposal is acceptable if its NPV is positive. NPV will be positive only when the actual return on investment is more than the cut-off rate. In case of IRR method a proposal is acceptable only when the IRR is higher than the cut-off rate. Thus, both methods will give consistent results since the acceptance or rejection of this proposal under both of them is based on the actual return being higher than the cut-off rate.
In case of projects requiring different cash outlays, the problem can also be resolved by adopting incremental approach, a modified form of IRR method. According to this approach in case of two mutually exclusive projects requiring different cash outlays, the IRR of incremental outlay of the project requiring a higher investment is calculated. In case this IRR is higher than the required rate of return, the project having greater non-discounted cash flows should be accepted otherwise it should be rejected

2.4 Net present value vs internal rate of return

Independent vs dependent projects
NPV and IRR methods are closely related because:
i) both are time-adjusted measures of profitability, and
ii) their mathematical formulas are almost identical.
So, which method leads to an optimal decision: IRR or NPV?

NPV vs IRR: Independent projects
Independent project: Selecting one project does not preclude the choosing of the other.
With conventional cash flows (-|+|+) no conflict in decision arises; in this case both NPV and IRR lead to the same accept/reject decisions.



If cash flows are discounted at k1, NPV is positive and IRR > k1: accept project.
If cash flows are discounted at k2, NPV is negative and IRR < k2: reject the project.
Mathematical proof: for a project to be acceptable, the NPV must be positive, i.e.

$$\sum_{t=1}^{n} \frac{\boldsymbol{C_t}}{(\boldsymbol{I}+\boldsymbol{k})^t} - \boldsymbol{I_0} > \mathbf{0}$$

Or

$$\sum_{t=1}^{n} \frac{C_t}{(I+k)^t} - I_0 > I_0$$

Similarly for the same project to be acceptable:

$$\sum_{t=1}^{n} \frac{C_t}{(I+R)^t} = I_0$$

where R is the IRR.

Since the numerators Ct are identical and positive in both instances:

- implicitly/intuitively R must be greater than k (R > k);
- If NPV = 0 then R = k: the company is indifferent to such a project;
- Hence, IRR and NPV lead to the same decision in this case.

NPV vs IRR: Dependent projects

NPV clashes with IRR where mutually exclusive projects exist.

Example:

Agritex is considering building either a one-storey (Project A) or five-storey (Project B) block of offices on a prime site. The following information is available:

	Initial Investment Outlay	Net Inflow at the Year end
Project A	-9,500	11,500
Project B	-15,000	18,000

Assume k = 10%, which project should Agritex undertake?

$$NPV_A = \frac{\$11{,}500}{1.1} - \$9{,}500$$

=$954.55

$$NPV_B = \frac{\$18{,}000}{1.1} - \$1{,}5000$$

= $1,363.64

$$\frac{\$11{,}500}{1+R_A} = \$9{,}500$$

$$\frac{\$11{,}500}{\$9{,}500} = 1 + R_A$$

$$R_A = 1.21 - 1$$

therefore IRRA = 21%

IRRB:

$$\frac{\$18{,}000}{1+R_B} = \$1{,}5000$$

$$R_B = 1.2 - 1$$

therefore IRRB = 20%

Decision:

Assuming that k = 10%, both projects are acceptable because:

NPVA and NPVB are both positive

IRRA > k AND IRRB > k

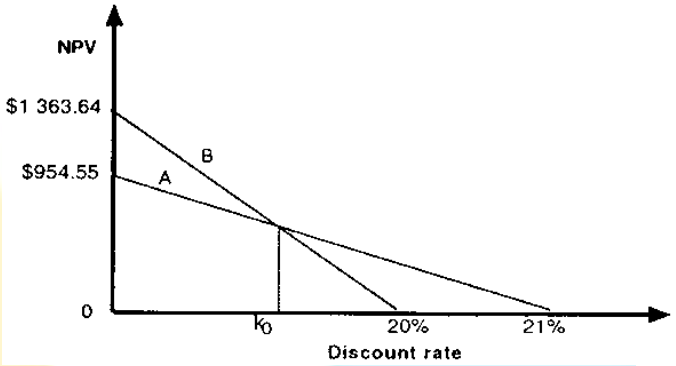
Which project is a "better option" for Agritex?

If we use the NPV method:

NPVB ($1,363.64) > NPVA ($954.55): Agritex should choose Project B.

If we use the IRR method:

IRRA (21%) > IRRB (20%): Agritex should choose Project A.



Up to a discount rate of ko: project B is superior to project A, therefore project B is preferred to project A.

Beyond the point ko: project A is superior to project B, therefore project A is preferred to project B

The two methods do not rank the projects the same.

2.5 Conflict Between NPV and IRR

When you are analyzing a single conventional project, both NPV and IRR will provide you the same indicator about whether to accept the project or not. However, when comparing two projects, the NPV and IRR may provide conflicting results. It may be so that one project has higher NPV while the other has a higher IRR. This difference could occur because of the different cash flow patterns in the two projects.

The following example illustrates this point.

	Project A	Project B
Year 0	-5000	-5000
Year 1	2000	0
Year 2	2000	0
Year 3	2000	0
Year 4	2000	0
Year 5	2000	15000
NPV	**$2,581.57**	**$4,313.82**
IRR	**29%**	**25%**

The above example assumes a discount rate of 10%. As you can see, Project A has higher IRR, while Project B has higher NPV.

If these two projects were independent, it wouldn't matter much because the firm can accept both the projects. However, in case of mutually exclusive projects, the firm needs to decide one of the two projects to invest in.

When facing such a situation, the project with a higher NPV should be chosen because there is an inherent reinvestment assumption. In our calculation, there is an

assumption that the cash flows will be reinvested at the same discount rate at which they are discounted. In the NPV calculation, the implicit assumption for reinvestment rate is 10%. In IRR, the implicit reinvestment rate assumption is of 29% or 25%. The reinvestment rate of 29% or 25% in IRR is quite unrealistic compared to NPV. This makes the NPV results superior to the IRR results. In this example, project B should be chosen.

The above example illustrated the conflicting results of NPV and IRR due to differing cash flow patterns. The conflicting results can also occur because of the size and investment of the projects. A small project may have low NPV but higher IRR.

Project A	Project B	
Year 0	-5000	-20000
Year 1	2000	7000
Year 2	2000	7000
Year 3	2000	7000
Year 4	2000	7000
Year 5	2000	7000
NPV	**$2,581.57**	**$6,535.51**
IRR	**29%**	**22%**

In this case, Project A has lower NPV compared to Project B but has higher IRR. Again, if these were mutually exclusive projects, we should choose the one with higher NPV, that is, project B.

One way to understand the preference of NPV over IRR, more generally, is to recognize that NPV uses the "correct" rate, i.e., the cost of capital, to discount the cash flows, rather than an "arbitrary" rate, i.e., the IRR, that makes NPV =0.

Another way to understand the superiority of the NPV rule is that the discounting process inherent in both the IRR and NPV techniques implicitly assumes the reinvestment of the cash flows at whatever discount rate is used, either IRR or the cost of capital. When the IRR is very high relative to the cost of capital it is unrealistic to assume reinvestment at that high rate. This is especially damaging when comparing two investments with very different timing of cash flows. We will revisit this reinvestment assumption later, under our discussion of yield to maturity on coupon bonds, where its meaningwill become clearer.

2.6 Quantitative Example of NPV vs IRR

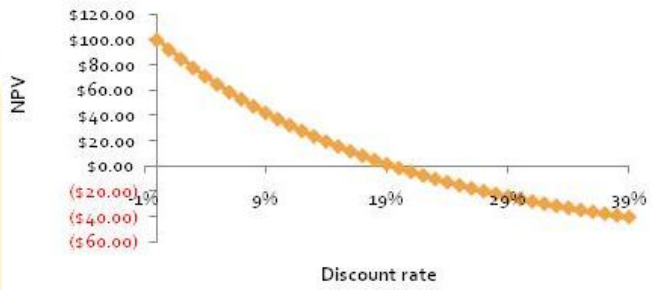
Consider a property with expected future net cash flows of $30,000 per year for the next five years (starting one year from now). If you expect to sell the property 5 years from now for a price 10 times the net cash flow at that time, what is the value of the property if the required return is 12%?

Plugging in the $30,000 net cash flows for five years into the NPV equation above along with the 12% discount rate, you'll find that the net present value is $278,371. You can also find all of the formulas and answers to these questions in this spreadsheet we put together:

The relationship between NPV and IRR is that "IRR is the rate at which NPV = Zero"

When Cost of Capital is more than IRR the NPV will be Negative

If we graph NPV versus discount rate, we can see the IRR as the x-axis intercept.



3. WHY NPV IS BETTER

The relationship between NPV and IRR is that "IRR is the rate at which NPV = Zero" When Cost of Capital is more than IRR the NPV will be Negative. Both the Net Present Value Method and Internal Rate of Return Method proceed on this presumption that cash inflows can be reinvested at the discounting rate in the new projects. However, reinvestment of funds at the cut-off rate i.e cost of capita is more possible than at the internal rate of return. Hence, Net Present Value Method is more reliable than the Internal Rate of Return Method for ranking two or more capital investment projects.

4. CONCLUSION

The IRR answers the question "what rate of return will I achieve, given the following stream of cash flows?", while the NPV answers the question "what is the following stream of cash flows worth at a particular discount rate, in today's dollars? NPV is calculated in cash, the IRR is a percentage value expected in return from a capital project.

The IRR rule errs in several ways-First, it doesn't obey the value- additivity principle and consequently managers who use the IRR can't consider projects independently of each other. Second,the IRR rule assumes that funds invested in projects have opportunity costs equal to the IRR of the project. This implicit reinvestment rate assumption violates the requirement that cash flows be discounted at the market-determined opportunity cost of capital. Finally,the IRR rule can lead to multiple rates of return whenever the sign of cash flows changes more than once. The NPV rule avoids all the problems the IRR is heir to.

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