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Capital Budgeting Criteria and Project Selection by Net Present Value (NPV) vs. Internal Rate of Return (IRR)

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Abstract–Capital budgeting is crucial to the success of corporations. Capital projects, which make up the major portion of long- term assets on a balance sheet, can be so large, that sensible capital budgeting judgments on project selection and funding ultimately decide the future of many corporations.

Since, capital decisions cannot be reversed at a low cost, any capital budgeting mistakes are costly. The capital investments of corporation describe it better than its working capital or capital structures, which are intangible and tend to be similar across businesses.

Hence, capital budgeting, especially project selection decision criteria, is critical. Cost engineers across the industry use several important criteria to evaluate capital investments. The two most comprehensive measures of whether a project is profitable or not are the net present value (NPV) and internal rate of return (IRR). For mutually exclusive projects that are ranked differently by the NPV and IRR, it is economically sound to choose the project with the higher NPV.

The paper will illustrate why it is desirable for cost engineer to pick a capital project with a higher NPV compared to IRR and paper also illustrates the identification problems associated with the IRR rule.

The paper will illustrate other capital budgeting criteria's frequently used, and essential for cost engineer functions including funding decisions, as optimistic NPVs ideally boost the corporation value.

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Introduction

When cost engineers see the word capital in front of budgeting, they consider capital to be a specific allocation of funds to capital projects. Capital projects deal with the fixed asset section of a balance sheet. Hence, capital budgeting is a process that corporations use for decision making to fund a capital project.

The duration of such projects shall be at least one year. It is an essential field of knowledge for cost engineers that must be implemented, while working on decisions associated with funding the project.

Since-capital project decisions may not be cancelled on a low-cost basis, any error will cost the corporation a significant amount of capital. A company's true capital investment more accurately describes a company than its working capital or capital structure-, that are inviolable and tend to be the same for many companies. [3]

This paper focuses on how cost engineers select among a portfolio of projects, or what cost engineers will do given that the corporation must provide a certain return to cover the cost of the capital raised to execute the projects.

Project Selection Criteria of Capital Funding

The reason for the economic study is that there exists a scarcity, if there was no scarcity, then there would be no need for economics. A corporation must allocate funds to ranked projects because corporations only have so much capital to invest. This practice is also, referred to as capital rationing [3]. If corporations have enough funds to budget all projects, then project assessment and selection criteria for funding may not be essential.

For example, in the case of independent projects, the cash flows are unrelated to each other. Hence, selecting one project does not preclude the corporation from selecting another project. All of them can be selected as there is no conflict between selecting any of them. The cost engineer will not have any problems in ranking and selecting the projects, because each one is independent. So in each case if the net present value says yes for funding, cost engineers are going to find that IRR says yes for funding. So, both NPV and IRR will agree on funding.

Therefore, it is essential to understand the rationale behind each of these investment decision criteria and their strengths and limitations, including project categories and basic philosophies of capital budgeting.

Project Groupings for Capital Budgeting

Broadly, corporations group the capital projects in to five (5) categories for the budgeting process. The five categories are: 1) Brownfield Replacement, 2) Brownfield expansion, 3) Greenfield Projects, 4) Projects that meet government regulatory, safety or environmental or 5) Research and Development or other projects. The classification of projects varies by industry, geographical location, and size of the corporation.

1) Brownfield Replacement Projects

Project scope is related to the replacement of equipment or capacity, to maintain productive capacity, or to gain an efficiency or productivity improvement. The projects categorized as brownfield projects are essential, and therefore easier to implement a capital budgeting decision.

2) Brownfield Expansion Projects

The scope of projects under this category are brownfield and intended to increase the size and number of products of the business. The risk and uncertainties are high, resulting in a more careful consideration while deciding on capital budgeting strategy.

3) Greenfield Projects for New Products and Services

The scope of projects relates to the introduction of new products or services. The projects may need substantial funding and investment. This requirement can place the company at greater risk of uncertainty than expansion projects. Furthermore, Greenfield projects for new products and services are more complex because of uncertainties.

4) Projects to meet the Government Regulatory, Safety or Environmental Requirements

The scope of projects related to meet the requirements of the external party including federal, provincial and municipal authority. These projects may not meet the corporation revenue criteria. The corporation will take the necessary investment and continue to operate. If the costs of the project are too high, then the company can terminate the project. In certain cases, project-related activities may be suspended.

5) R&D Project and Other

The other projects including R&D are considered pet projects or outside of the capital budget analysis process, due to high risks associated.

Basic Philosophies of Capital Budgeting

The capital budgeting decisions are based on application of basic principles. The assumptions under these principals are essential for the corporation to implement across all project budgeting platforms.

Below are some of the common principals applied across the industry:

1. The capital budgeting decisions are not influenced by net income or operating income. Decisions are purely based on Incremental cash flows. Incremental cash flow is cash flow, which includes the additional cash realized because of a decision. So, an incremental cash flow is the cash flow, with the decision, less the cash flow, and without the decision.
2. Capital budget decision and analysis ignores the sunk costs, while includes the opportunity costs. Sunk costs are the costs that cannot be recovered, and in capital budgeting those costs are ignored. While opportunity costs are the losses of other alternatives when one alternative is chosen.
3. Reputation and branding effects cannot be objectified with any dollar amounts, and therefore are ignored under the capital budgeting decision and analysis task.
4. The core principle of cash flow is that the faster the cash flow is spent over time, the higher the cash flow value. So, the timing of cash flows are crucial and considered under the capital budgeting decision and analysis task.
5. Cash flows are based on opportunity costs and after-tax basis.
6. Financing costs are ignored. But discounting of interest payments is included in the rate-of-return calculation.

Ranking Investment Decision Criteria

There are three (3) commonly used formulas for evaluating capital budgeting proposals:

a. Net-present value (NPV)
b. Internal rate-of-return (IRR)
c. Payback method

The internal rate-of-return and the net present value methods provide a more accurate basis on which to apply investment or expansion decisions relating to the capital budgets. NPV and IRR calculations are the two most wide-ranging measures of whether a project is profitable or unprofitable.

Net Present Value

NPV is simply the sum of all the cashflows divided by the discount rate for that period minus the initial outlay because the outlay occurs at time T = 0. Cost engineers do not discount cash that occurs at T = 0. The cash flows are on an after tax basis.

$$\text{NPV} = \sum_{t=1}^{n} \frac{\text{CF}_t}{(1+r)^t} - \text{Outlay}$$

where

$$\begin{aligned} CF_t &= \text{after-tax cash flow at time } t \\ r &= \text{required rate of return for the investment} \\ \text{Outlay} &= \text{investment cash flow at time zero} \end{aligned}$$

Equation 1[3]

Example 1

Assume that a corporation is modeling a conventional cash flow for Project A. This investment represents a $100 million investment with a discount rate of 10%. The anticipated after-tax cash flows for six years computed are in the below table and graph.

Year count	Anticipated Cashflow after tax
Year 1	$25M
Year 2	$55M
Year 3	$15M
Year 4	$25M
Year 5	$25M
Year 6	$50M

Table 1–After-tax Cashflow Example 1

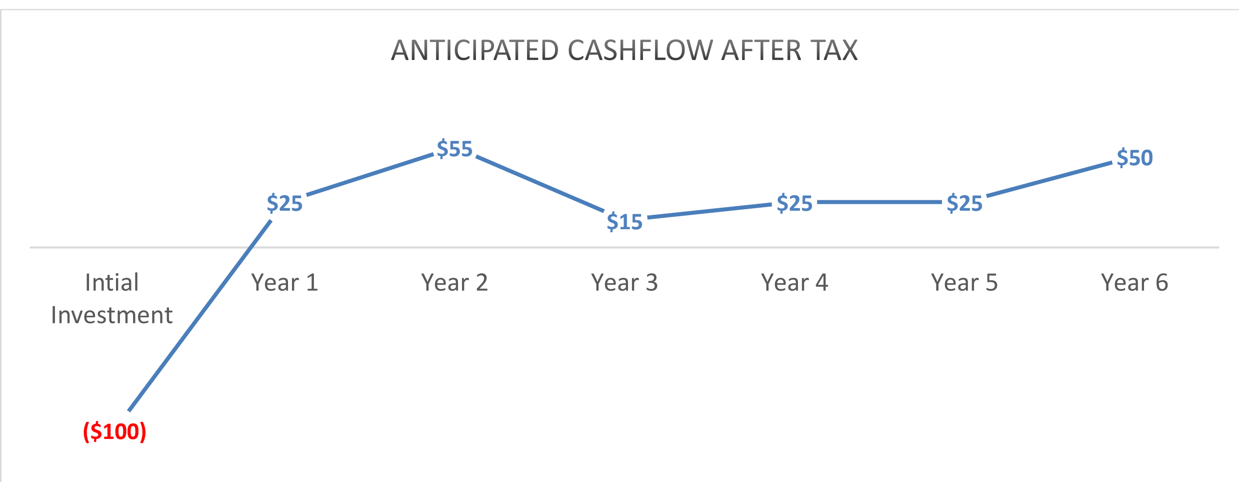

Figure 1–After-tax Cashflow Example 1

Project A - Net-present value (NPV) Analysis:

- The NPV is computed by taking the present value of all cash flows and net it out.

$\sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}$	**$140.3M**
CF_0	**$100M**
$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - \text{Outlay}$	
NPV=	**$40.3M**

- The NPV of project A is $40.3M, which indicates project A returns its entire investment. Project A returns its required rate of return because the calculated net present value is positive.
- If the outcome of project A's NPV was ZERO. Project A returns the required rate of return but nothing more. In other words, Project A would return accounting profit, but it will not return any economic profit. The economic profit for project A is $40.3M, and any profit resulting when the corporation makes more than the required rate of return on the investment.
- Decision criteria for net present value: Corporation would invest in net present value is greater than zero.

Invest if	$NPV > 0$
Do not invest if	$NPV < 0$

Equation-2 [3]

Internal Rate of Return

The internal rate-of-return (IRR) method calculates the interest rate that equates the cash outflows (cost) of an investment with subsequent cash inflows. Simply stated, IRR calculates the net present value at zero discount rate of the projects. The discount rate of IRR is zero net present value.

$$\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = \text{Outlay}$$

Equation-3[3]

The internal rate of return (IRR) is one of the most frequently used concepts in capital budgeting analysis. The IRR, written out in equation form, the IRR solves this equation:

The Equation-3 rearranged as Equation 4.

$$\sum_{t=1}^{n} \frac{CF_t}{(1 + \text{IRR})^t} - \text{Outlay} = 0$$

Equation 4[3]

The nature of the formula is such that there is no analytical way to calculate the IRR. The Cost Engineer must use the guess and check approach to find the IRR value.

Example 2:
Assume that a corporation is contemplating a conventional cash flow for Project B. It is an investment of $100 million with a discount rate of 10%. The anticipated after-tax cash flows for four years are computed in the following table and graph.

Period	Cashflow after-tax	PV
Initial Investment	- $100M	$(100M)
Year 1	$40M	$127M
Year 2	$40M	
Year 3	$40M	
Year 4	$40M	
	Rate	**10.00%**
	NPV	**$ 27M**

Table 2–After-tax Cashflow, IRR 10% and NPV $27M Example 2

Project B - Internal rate-of-return (IRR) Analysis:

The decision rule for the IRR is to invest if the IRR exceeds the required rate of return for a project:

Period	Cashflow	PV
Initial Investment	- $100M	$ (100M)
Year 1	$40M	$100M
Year 2	$40M	
Year 3	$40M	
Year 4	$40M	
Rate		21.86%
NPV		$ 0

Table 3–After-tax Cashflow, IRR 21.86% and NPV $0 Example 2

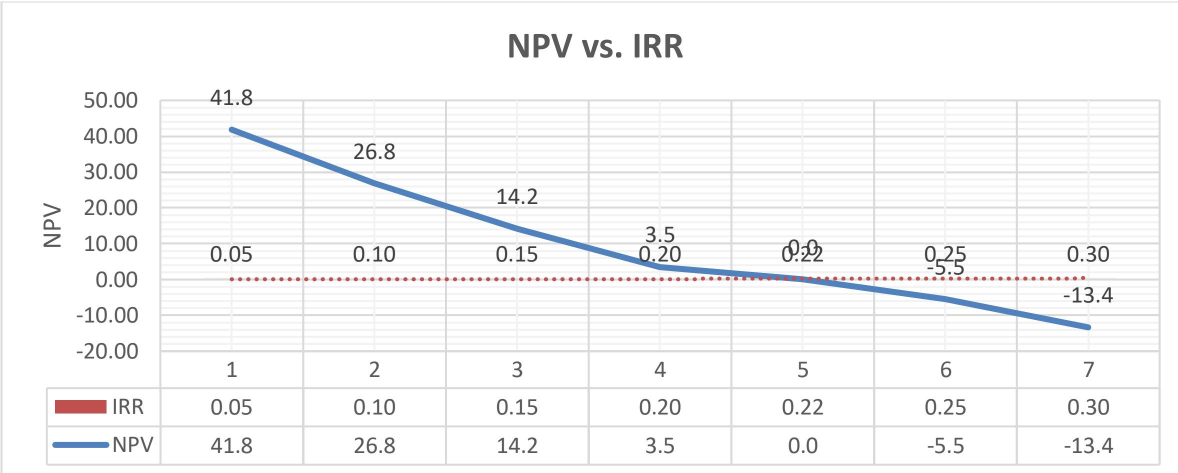

Figure 2–NPV vs. IRR Example 2

Project B's discount rate is 21.86% at which the net present value (NPV) of the project equals 0. So the cost engineers are finding all the net present value of all the cash flows so that it equals the outlay.

Meanwhile, the cost engineer recommends investing because the internal rate of return is greater than the discount rate required. If the internal rate of return on the project is greater than the cost of capital, the cost engineer recommends to invest, otherwise investing in the project is not recommended.

Invest if IRR > r!
Do not invest if IRR < r. [3]

Payback Period

The payback method is rarely used by cost engineers to make financial decisions as it does not provide a valid basis for most decisions; because the payback method ignores all returns after the initial investment has been recovered. The payback period method is simple to apply and easy to interpret.

The payback period process is a naive process with the following shortfalls:

- The problem is the payback period ignores the time value of money.
- It does not concern itself with when the cash flows occur.
- It is not discounted then, so it is also ignores risk.
- It ignores the cashflow after the payback period.

Conflicts between NPV and IRR

For a single conventional project, the NPV and IRR would agree on whether to invest or to not invest. For independent, conventional projects. No conflict exists between the decision rules for the NPV and IRR, but in the case of two mutually exclusive projects, the two criteria will sometimes disagree. Example 3 will highlight the two criteria with a decision on how to select a project. [3]

Example 3:

Project A and Project B are shown with cashflow, NPV and IRR. Both projects need an initial outlay of $100M. However, both projects differ in their cashflows.

Project B has the higher net present value, but Project A has the higher IRR. So, the cost engineer can select the project.

- Based on a discount rate of 10%, Project A's NPV is $27, while Project B's NPV is higher at $37.
- Project A's IRR is higher at 21.86%, while Project B's IRR is 18.92%.
- At 15.09% both projects have the same IRR and NPV. For anything greater than 15.09%, Project A is superior.

Project #	Cashflow					NPV	IRR%
	0	1	2	3	4		
Project A	$(100)	$ 40	$ 40	$ 40	$ 40	$ 27	21.86
Project B	$(100)	$ -	$ -	$ -	$ 200	$ 37	18.92

Table 3–After-tax Cashflow, IRR and NPV - Example 3

IRR	Project A NPV	Project B NPV
0.0%	60.0	100.0
5.0%	41.8	64.5
10.0%	26.8	36.6
15.0%	14.2	14.4
15.1%	14.0	14.0
18.9%	5.7	0.0
20.0%	3.5	-3.5
21.9%	0.0	-9.3
25.0%	-5.5	-18.1
30.0%	-13.4	-30.0

Table 3–Incremental IRR of Project A & B, NPV of Project A and B-Example 3

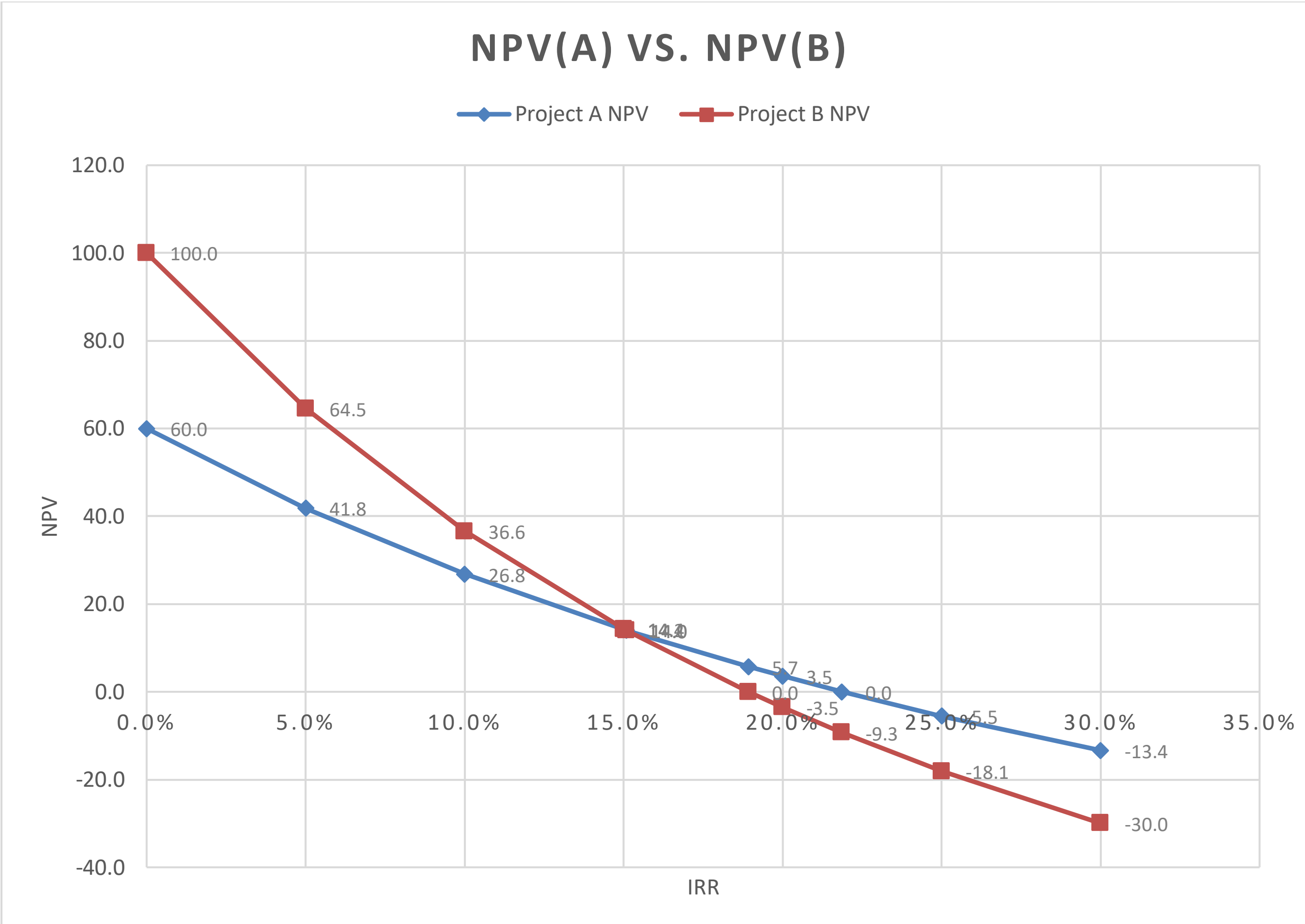

Figure 3–IRR of Project A & B, NPV of Project A and B-Example 3

Conclusion

This is a fairly straightforward rule -- select the project with the highest positive net present value. Whenever NPV and IRR disagree, always take the one with the highest NPV, because that choice has a greater return on investment. Project investment results are also logical and believable to assume that a corporation can reinvest at that required rate of return and have a financially viable project.

Whenever NPV and IRR rank mutually exclusive projects differently, choose the project with the higher net present value. The Cost Engineer will do that specifically because of the reinvestment assumption of the NPV. When the reinvestment assumption states that all cash flows can be reinvested at the required rate of return the investment is sound.

If corporations are utilizing the IRR as being a required rate of return reinvestment, these rates are not likely, which is why the cost engineer would never base IRR decision on rates. The corporation should never reinvest based on the net present value, because the net present value assumptions are, that the weighted average cost of capital is the rate at which the corporation can reinvest at will.

Cost engineers continually use NPV and IRR equations to obtain the data to form the foundation for their analysis and evaluations which confirms their business model. With these results, management is then able to make an informed capital budget decision. [3]

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