The Investment Decision: Part 1

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What do we cover in this discussion?

1. Features of capital budgeting decisions
2. Capital budgeting criteria:
    1. NPV
    2. IRR
    3. PI
    4. ARR
    5. Payback Period
    6. Discounted payback period
3. Drawbacks of IRR

Features of capital budgeting decisions

- **Long-term effects:** The consequences of capital expenditure decisions extend far into the future. The scope of current manufacturing activities of a firm is governed largely by capital expenditures made in the past. Likewise, the current capital expenditure decisions provide the framework for future activities.
- **Irreversibility:** The market for used capital equipment in general is ill-organised. Market for such used equipment may be virtually be non-existent. Once such an equipment is acquired, reversal of decision may mean scrapping the capital equipment. A wrong capital investment decision often cannot be reversed without incurring a loss.
- **Substantial outlays:** Capital expenditure usually involve substantial outlays (Several thousand crore rupees for an integrated steel plant).

Features of capital budgeting decisions

- **Measurement Problems:** Identifying and measuring the costs and benefits of a capital expenditure proposal tends to be difficult. This is more so when a capex proposal has a bearing on some other activities of the firm (like cutting into the sales of some existing product) or has some intangible consequences(like improving the morale of workers).
- **Uncertainty:** As costs and benefits extend far into the future, it is impossible to predict exactly what will happen in the future. Hence, there is usually a great deal of uncertainty characterising the costs and benefits of a capex decision.
- **Temporal Spread:** Capex are usually 10-20 years for industrial projects and 20-50 years for infrastructure projects. Such a temporal spread creates problems in estimating discount rates and establishing equivalences.

Net Present Value (NPV)

NPV = PV(Benefits) − PV(Costs)

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - \text{Initial Investment}$$

$$= \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_n}{(1+r)^n} - I$$

If the discount rates are varying,

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+r_t)^t} - \text{Initial Investment}$$

or more appropriately

$$NPV = \sum_{t=1}^{n} \frac{C_t}{\sum^{t} (1+r_i)} - \text{Initial Investment}$$

Net Present Value (NPV)...Contd.

Year	0		1		2		3		4		5
Rate		14%		15%		16%		18%		20%	
Cash flow	12000		4000		5000		7000		6000		5000

$$PV \text{ of } C_1 = \frac{4000}{1.14} = 3509$$

$$PV \text{ of } C_2 = \frac{5000}{1.15 \times 1.14} = 3814$$

$$PV \text{ of } C_3 = \frac{7000}{1.16 \times 1.15 \times 1.14} = 4603$$

$$PV \text{ of } C_4 = \frac{6000}{1.18 \times 1.16 \times 1.15 \times 1.14} = 3344$$

$$PV \text{ of } C_5 = \frac{5000}{1.20 \times 1.18 \times 1.16 \times 1.15 \times 1.14} = 2322$$

$$NPV = 3509 + 3814 + 4603 + 3344 + 2322 - 12000$$
$$= 5592$$

Net Present Value (NPV)...Contd.

Decision Criteria :-

$NPV > 0$, Accept the project

$NPV < 0$, Reject " "

$NPV = 0$, Indifferent

$$\text{Value of a firm} = \underbrace{\sum \text{Present value of Ongoing projects}}_{\text{Assets in Place}} + \underbrace{\sum \text{Net Present value of expected future projects}}_{\text{Growth opportunities}}$$

As $r_t \uparrow$, $NPV \downarrow$ for standard projects

Assumptions:- Take it or leave it projects, standalone,

NPV application: An example

- After saving \$1,500 waiting tables, you are about to buy a 42-inch plasma TV. You notice that the store is offering "one-year same as cash" deal. You can take the TV home today and pay nothing until one year from now, when you will owe the store the \$1,500 purchase price. If your savings account earns 5% per year, what is the NPV of this offer? Show that its NPV represents cash in your pocket.
- You are getting something (the TV) worth \$1,500 today and in exchange will need to pay \$1,500 in one year. Think of it as getting back the \$1,500 you thought you would have to spend today to get the TV. We treat it as a positive cash flow.

NPV application: An example.....Contd.

	Today	In one year
Cash flows:	\$ 1,500	–\$ 1,500

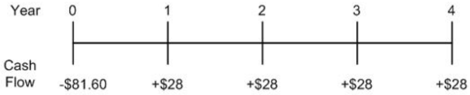
- The discount rate for calculating the present value of the payment in one year is your interest rate of 5%. You need to compare the present value of the cost (\$1,500 in one year) to the benefit today (a \$1,500 TV).

$$NPV = +1,500 - \frac{1,500}{(1.05)} = 1,500 - 1,428.57 = \$71.43$$

- You could take \$1,428.57 of the \$1,500 you had saved for the TV and put it in your savings account. With interest, in one year it would grow to \$1,428.57 X (1.05) = \$1,500, enough to pay the store. The extra \$71.43 is money in your pocket to spend as you like.

NPV application: Another example

- **A take-it-or-leave-it decision:** A fertilizer company can create a new environmentally friendly fertilizer at a large savings over the company's existing fertilizer. The fertilizer will require a new factory that can be built at a cost of $81.6 million. Estimated return on the new fertilizer will be $28 million after the first year, and last four years.
- The following timeline shows the estimated return:



- Given a discount rate r, the NPV is:

$$NPV = -81.6 + \frac{28}{1+r} + \frac{28}{(1+r)^2} + \frac{28}{(1+r)^3} + \frac{28}{(1+r)^4}$$

NPV application: Another example....Contd.

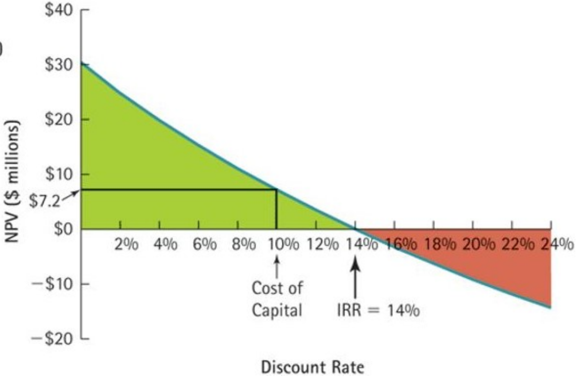
- We can also use the annuity formula.

$$\text{NPV} = -81.6 + \frac{28}{r}\left(1 - \frac{1}{(1+r)^4}\right)$$

- If the company's cost of capital is 10%, the NPV is $7.2 million and they should undertake the investment.
- **NPV Profile:** NPV profile graphs the NPV over a range of discount rates.

NPV Profile

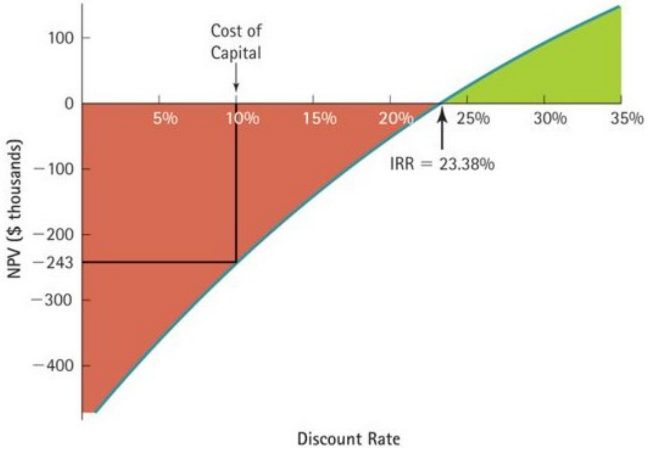
Discount Rate	NPV ($ millions)
0%	$30.4
2%	$25.0
4%	$20.0
6%	$15.4
8%	$11.1
10%	$7.2
12%	$3.4
14%	$0.0
16%	−$3.3
18%	−$6.3
20%	−$9.1
22%	−$11.8
24%	−$14.3



NPV Profile.....Contd.

- **Question:** Star basketball player Evan Cole is graduating from college with a degree in finance and preparing for the NBA draft. Several companies have already approached him with endorsement contracts. Two competing sports drink companies are pursuing him. QuenchIt offers him a single up-front payment of $1 million to exclusively endorse their sports drink for three years. PowerUp offers $500,000 per year, payable at the end of each of the next three years, to endorse their product exclusively. How will the NPV profile look like?

NPV Profile of Cole's $1 Million QuenchIt Deal



Tweaking the question a bit

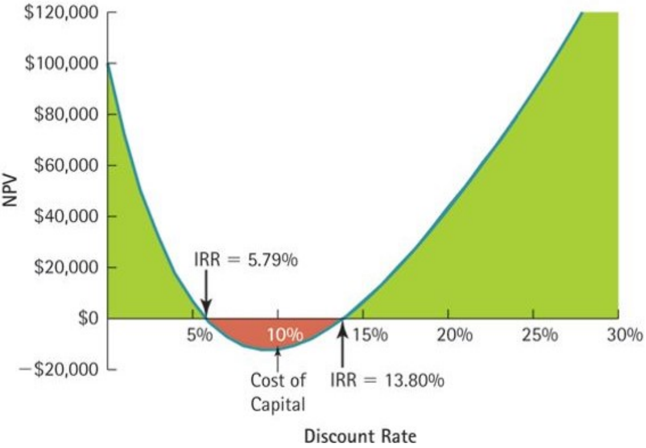
- **Question:** Evan has informed QuenchIt that it needs to sweeten the deal before he will accept it. In response, the company has agreed to make an additional payment of $600,000 in 10 years as deferred compensation for the long-term increase in sales that even a short-term endorsement by Evan would bring. Should he accept or reject the new offer? How will the new NPV profile look like?

New NPV Profile

Panel (a)

0%	100,000
1%	72,680
2%	50,267
3%	32,151
4%	17,793
5%	6724
6%	−1469
7%	−7148
8%	−10,632
9%	−12,201
10%	−12,100
11%	−10,547
12%	−7732
13%	−3823
14%	1030
15%	6698
16%	13,065
17%	20,030
18%	27,502
19%	35,403
20%	43,663
21%	52,219
22%	61,019
23%	70,014
24%	79,161

Panel (b)



Benefit-Cost Ratio

Benefit-Cost Ratio (BCR)

$$BCR = \frac{PVB}{I}$$, where PVB = present value of benefits, I = " " " costs or Investment

$$\text{Net } BCR = \frac{PVB}{I} - 1 = BCR - 1$$

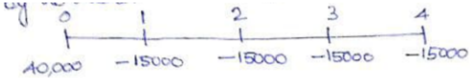
So if

BCR	Net BCR	
>1	>0	Accept the Project
<1	<0	Reject " "
$=1$	$=0$	Indifferent

Internal Rate of Return (IRR)

- The discount rate for which NPV of the cashflows is equal to zero is the IRR.
- In the example we discussed above, IRR=14% because at that rate, NPV=0.
- If $IRR > COC$, accept the project.
- If $IRR < COC$, reject the project.
- If $IRR = COC$, Indifferent.

Trial and error Calculation of IRR



$$\frac{15000}{r}\left[1-\frac{1}{(1+r)^4}\right]=40000$$

How to calculate r without spread sheet? [r = IRR]

Trial & Error:

Assume r = 10%.

$$LHS = 15000\times\frac{1}{0\cdot10}\left[1-\frac{1}{(1\cdot1)^4}\right]=47548 > 40000$$

So, increase r, to lessen the difference between LHS & RHS.

Let r = 20%.

$$LHS = 15000\times\frac{1}{0\cdot20}\left[1-\frac{1}{(1\cdot2)^4}\right]=38831 < 40000$$

So, our 'r' (the IRR) is somewhere between 10% & 20%

Trial and error Calculation of IRR

10%	47,548	40,000
r%		
20%	38831	

$$r = 10\% + (20\% - 10\%) \times \frac{(47548 - 40000)}{(47548 - 38831)}$$

$$= 0.10 + (0.10) \times \left(\frac{7548}{8717}\right)$$

$$= 0.10 + 0.086589$$

$$= 0.186589 \text{ or } 18.65\%$$

Weakness of the IRR

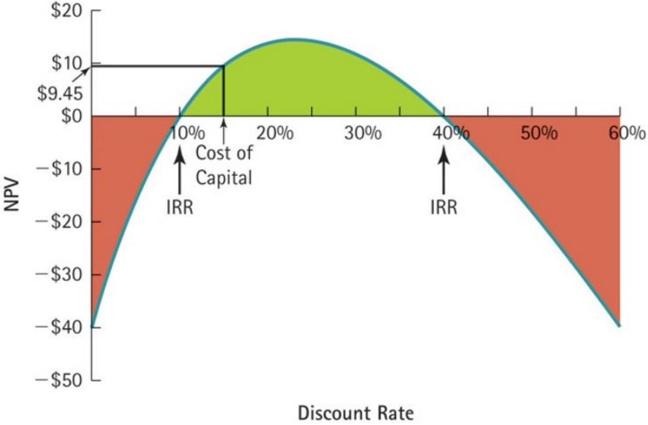
- In most cases IRR rule agrees with NPV for stand- alone projects if all negative cash flows precede positive cash flows.
- In other cases the IRR may disagree with NPV.
- There may be cases where multiple IRRs. Then the normal rules of IRR may not be usable.
- Pitfall 1: Lending or Borrowing
- Pitfall 2: Multiple rates of return
- Pitfall 3: Mutually exclusive projects
- Pitfall 4: What happens when there is more than one opportunity cost of capital?

Modified Internal Rate of Return

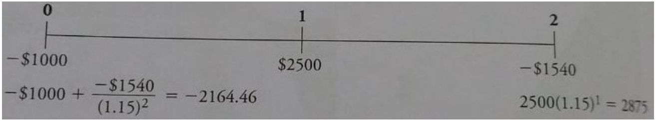
- Used to overcome problem of multiple IRRs.
- Computes the discount rate that sets the NPV of modified cash flows to zero.
- Possible modifications:
  - Bring all negative cash flows to the present and incorporate into the initial cash outflow.
  - Leave the initial cash flow alone and compound all of the remaining cash flows to the final period of the project.

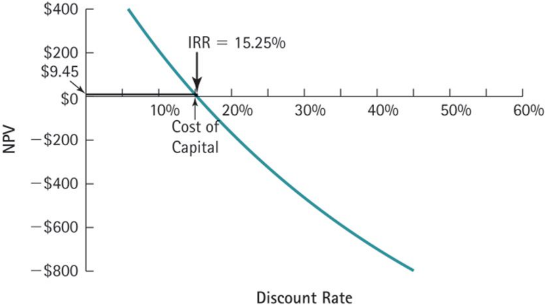
Modified Internal Rate of Return...Contd.

- The graph shows the NPV profile for a multiple-IRR project with cash flows of -\$1000, \$2500 and -\$1540 in years 0,1 and 2, respectively. As the NPV profile shows, the project has two IRRs: 10% and 40%.



Modified Internal Rate of Return...Contd.





MIRR: A final word

- Is it advisable to modify the cash flows?
- It is not really an internal rate of return?
- It does not solve some of the problems of IRR.

The Payback Rule

- Based on the notion that an opportunity that pays back the initial investment quickly is the best idea.
- In this method, we calculate the amount of time it takes to pay back the initial investment, called the payback period.
- Accept the project if the payback period is less than required cut off decided by the management.
- Reject the project if the payback period is greater than required cut off.

Payback Period: An example

- Assume a company requires all projects to have a payback period of three years or less. For the project below, would the firm undertake the project under this rule?

Year	Expected Net Cash Flow
0	-$10,000
1	$1,000
2	$1,000
3	$12,000

- The sum of the cash flows from years 1 through 3 is $14,000. This will cover the initial investment of $10,000. Because the payback is less than 3 years the project will be accepted.

Weakness of payback period

- Though easy to understand and calculate, it ignores the time value of money.
- Ignores cash-flows after the payback period.
- Lacks a decision criterion grounded in economics.

Discounted Payback period

- The discounted payback period is a measure of how long it takes until the cumulated discounted net cash flows offset the initial investment in an asset or a project. In other words, DPP is used to calculate the period in which the initial investment is paid back.
- The difference between generic payback period and discounted payback period is that the discounted payback period takes the time value of money into account. This means that an earlier cash flow has a higher value than a later cash flow of the same amount (assuming a positive discount rate). The calculation therefore requires the discounting of the cash flows using an interest or discount rate. The generic payback period, on the other hand, does not involve discounting.

How Is the Discounted Payback Period Calculated?

- The formula to calculate the discounted payback period is:

$$DPP = y + abs(n) / p$$

- where:
  - y = the period preceding the period in which the cumulative cash flow turns positive,
  - p = discounted value of the cash flow of the period in which the cumulative cash flow is greater than or equal to 0,
  - abs(n) = absolute value of the cumulative discounted cash flow in period y.
- The following tables contain the cash flow forecasts of each of these options. The discount rate was set at 12% and remains constant for all periods.

Demonstration

Year	–	1	2	3	4	5	6
Investment and Cost (outflows)	– 5,000	-5,000	-1,000	– 500	– 500	-1,000	-1,000
Benefits and Earnings (inflows)	–	–	3,000	5,000	5,000	4,000	4,000
Net Cash Flow	– 5,000	-5,000	2,000	4,500	4,500	3,000	3,000
Discounting cash flow formula	*-5000 / (1 + 12%) ^ 0*	*-5000 / (1 + 12%) ^ 1*	*2000 / (1 + 12%) ^ 2*	*4500 / (1 + 12%) ^ 3*	*4500 / (1 + 12%) ^ 4*	*3000 / (1 + 12%) ^ 5*	*3000 / (1 + 12%) ^ 6*
Discounted net cash flow	**– 5,000**	**-4,464**	**1,594**	**3,203**	**2,860**	**1,702**	**1,520**
Cumulative discounted cash flows	**– 5,000**	**-9,464**	**-7,870**	**-4,667**	**-1,807**	**– 105**	**1,415**

Demonstration.....Contd.

- y (the period preceding the period in which the cumulative cash flow turns positive) which is year 5 in this example.
- p (discounted value of the cash flow of the period in which the cumulative cash flow is greater than 0) is 1520, the periodic discounted net cash flow of year 6.
- abs(n), the absolute value of the cumulative discounted cash flow in period y, which amounts to -105.
- Discounted Payback Period = 5 + abs(-105) / 1520 = 5.07.

Accounting Rate of Return (ARR)

- A=Average Income after tax/Initial Investment
- B=Average Income after Tax/Average Investment
- C=Average Income after tax plus Interest/Initial Investment
- D=Average Income after tax plus Interest/Average Investment
- E=Average Income before Interest and Tax/Initial Investment
- F=Average Income before Interest and Tax/Average Investment
- G=(Total Income after tax plus depreciation-Initial Investment)/[(Initial Investment/2)*Year]