Capital Budgeting

Capital budgeting

- In capital budgeting, we change our perspective from an investor to consider us as a corporate financial officer, or a project manager.

- Search for investment opportunities. Make financial decisions about whether or not to take on certain projects.

- The main objective of project is creation of value for its stakeholders. The value is created financially by creating net cash flow.
- This process will obviously vary among firms and industries.

- **What projects should the firm take?**
  - Examples of projects includes
    - Marketing and advertising
    - R&D
    - Choices among different production processes
    - Expanding into new products, industries, or markets
    - Investments in new technology
    - Acquisitions

- Capital Budgeting is the process of determining which real investment projects should be accepted given an allocation of funds from the firm.

- The typical capital budgeting method (directly or indirectly) involves three steps:
  1. estimating cash flows generated by the project,
  2. finding an adequate discount rate for each cash flow, and
  3. estimating the initial cost of the investment (including opportunity costs).

- Estimate all cash flows for each project.
- Evaluate the cash flows.
- Make the accept/reject decision.
  - Independent projects: Accept/reject decision for a project is not affected by the accept/reject decisions of other projects.
  - Mutually exclusive projects: Selection of one alternative precludes another alternative.

Net Present Value (NPV) Rule

- Objective: Increase firm's current market value
- Every single asset or a particular project can be reduced, essentially, to a sequence of cash flows.
- The current market value is simply the NPV where the discount rates are adjusted the risk relevant to that particular cash flow.

  When the discount rates for the dates 1, 2,…, *T are* r_1, r_2, …, r_T, *then the* current market *value of a stream of cash flow* $\{CF_0, CF_1, \cdots, CF_T\}$, of an investment (a project) *is given by*

$$\text{NPV} = CF_0 + \frac{CF_1}{1+r_1} + \frac{CF_2}{(1+r_2)^2} + \ldots + \frac{CF_T}{(1+r_T)^T}$$

- This is the addition to the firm's market value by the project.

- Here *r* a discount by the appropriate cost of capital that is an appropriate risk adjusted cost of capital, adjusting the risk relevant to that particular cash flow.
- **Investment decision criteria:**

❑ Independent Projects:
  - NPV ≥ 0 - Accept
  - NPV < 0 - Reject

❑ Mutually Exclusive Projects:
  - Select the project with the highest NPV, assuming NPV ≥ 0.

❑ If there are project interactions (e.g., take one of many), then take that into account.

- The NPV rule dominates all other rules because it takes into account the maximum amount of information, including timing of all cash flows and risks, and makes the correct decision based on value creation.

- NPV= Present value of all the future cash flows –Initial cost

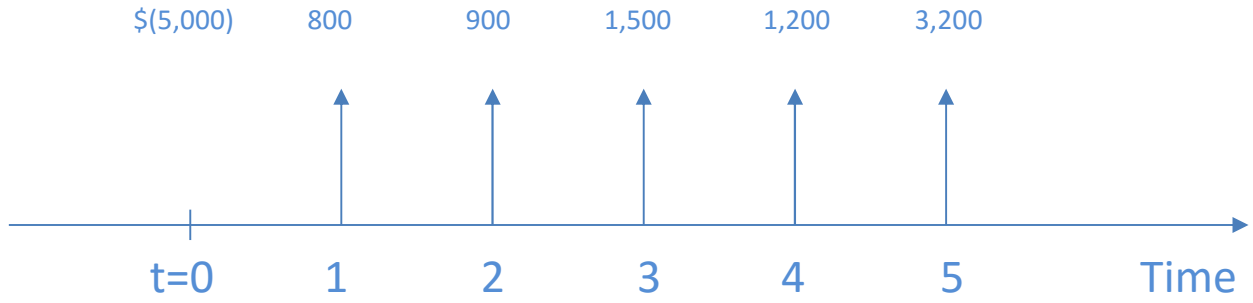
- To compute the NPV of a project, we need to consider:
  - Cash flows
  - Discount rates
  - Strategic options

- Example: A firm is considering investing in a project that has the following cash flows:

Year (t)	Expected After-Tax Net Cash Flows (CF_t)
0	$(5,000)
1	800
2	900
3	1,500
4	1,200
5	3,200

- Where, CF_0= $(5,000) represents the net cost, or initial investment

- If the firm's required rate of return is 12%, the cash flow timeline for the asset is:



- The NPV for the project is:

$$NPV = -5{,}000 + \frac{800}{1.12} + \frac{900}{1.12^2} + \frac{1{,}500}{1.12^3} + \frac{1{,}200}{1.12^4} + \frac{3{,}200}{1.12^5}$$
$$= \$77.82$$

Accept the project as: NPV > 0

NPV Meaning

- The net present value is simply the difference between the present value of all cash flows inflows and the present value of all cash outflows. In other words, NPV is simply value minus cost.

  NPV=present value –present cost

- There are 3 possible categories NPV will fall into:
  - Positive NPV: If NPV is positive, then it means the asset is worth more than what you are paying.
  - Negative NPV: If NPV is negative, then it means the asset is worth less than what you are paying.
  - Zero NPV: If NPV is zero, then it means you're paying exactly what the asset is worth.

Discount Rates

- A project's discount rate (i.e., required rate of return) is the expected rate of return demanded by investors for the project.
- The discount rate in general depend on the timing and risk of the cashflow.
- The discount rate is usually different for different projects. Therefore, it is incorrect to use a company-wide “cost of capital” to discount cash flows of all projects.

- What is the required rate of return on a project?
  - Simple case: single discount rate can be used for all cashflows of a project.
  - General case: the term structure of discount rates is different for different cash flows.

What is the cost of capital?

- The cost of capital is simply the return expected by those who provide capital for the business.
- Any investment a company makes has to earn enough money that investors get the return they expect and debt holders can be repaid.
- There are two ways that cost of capital is typically used.
  1. Mangers use it to evaluate individual investments. This implies invests in projects such that the expected returns exceed the cost of capital.
  2. Investors use it to assess the risk of a company's equity. Investors will look at an aspect of the cost of capital — the beta or volatility which will help them understand if a stock is a risky investment or not.

- **Use CAPM to estimate cost of capital.**
  - Project's required rate of return is determined by the project beta:

$$\bar{r}_{project} = r_f + \beta_{project}(\bar{r}_m - r_f)$$

$$\text{where, } r_f = \text{risk free rate; } r_m = \text{market return;}$$

$$\beta = \text{riskiness of the project cash flows}$$

- What matters is the project beta, not the company beta!
- What if project beta is unknown?
  - Find comparable company and use its beta.
  - Find comparable historical project and use its cashflows to estimate beta.
  - Use intuition and empirical judgment to guesstimate beta.

- **Example:** Bloomberg, a provider of financial data and analytics, is considering entering the publishing business (Bloomberg Press), and must evaluate the NPV of the estimated cashflows from this business. What cost of capital should it use for these NPV calculations?
  - Bloomberg should not use its own beta to discount Bloomberg Press cashflows.
  - Bloomberg should use the beta of a publishing company (e.g., John Wiley & Sons).
- Beta of John Wiley & Sons : 1.29; Risk free rate: 5%;
- Market risk premium= (r_m-r_f)= 6%

$$\bar{r}_{project} = r_f + \beta_{project}(\bar{r}_m - r_f)$$
$$= 0.05 + 1.29 \times 0.06 = 12.7\%$$

- Use judgment in interpreting and adjusting this estimate.
- How good is the approximation?

Project Interaction

- Often we have to decide on more than one project among a set of projects.
- For mutually independent projects, if there's no project interactions, take them all as long as they have positive NPV.
- For projects dependent of each other, if there are project interactions(e.g., mutually exclusive—accepting one, rules out the others), we have to compare their NPVs, pick the one that's got the highest NPV.

Alternatives to NPV

- In practice, investment rules other than NPV are also used:
  - Payback Period
  - Profitability Index (PI)
  - Internal Rate of Return (IRR)

- Firms use these rules because they were used historically and they may have worked (in combination with common sense) in the particular cases encountered by these firms.
- These rules sometimes give the same answer as NPV, but in general they do not. We should be aware of their shortcomings and use NPV whenever possible.
- The bottom line is: **The NPV rule dominates these alternatives.**

Payback Period

- **Payback Period is the minimum period *k* such that**

$$CF_1 + CF_2 + \cdots + CF_k \geq -CF_0 (or\ I_0)$$

  In words, *k* is the minimum number of period required to "recover" the initial investment I_0.
- What's the minimum number of periods that the sum of the future cash flows exceeds the initial investment?

- **Decision criterion using payback period**

❑ Independent Projects:
  - Payback period (*k*) $\leq$ some fixed threshold *t** - Accept
  - Payback period (*k*) > some fixed threshold *t** - Reject

❑ Mutually Exclusive Projects:
  - Among all the projects having $k \leq t^*$, accept the one that has the minimum payback period.

- Example. Let $t* = 3$. Consider the two independent projects with the following cash flows (in thousands):

	CF0	CF1	CF2	CF3	CF4	CF5	CF6	k
Project 1	-100	20	40	30	10	40	60	4
Project 2	-100	10	10	80	5	10	10	3

Decision: Accept Project 2 as $k \leq t^*$.

- **Problems with payback period**
  - It ignores time-value of money
  - It doesn't take into account scale
  - It ignores cash flows after the payback period k

- Example. (Continued.) Suppose that the appropriate discount rate is a constant 10% per period.

  Then we calculate the NPV for project 1 =$39,315

  and NPV for project 2 = $(−7,270)

  So , NPV for project 1 is positive.

  But we accepted project 2 and not project 1!

Discounted Payback Period

- **Discounted Payback Period**
  - Taking into account appropriate discounting, we have the discounted payback period.
  - Discounted payback period is the minimum $t*$, *so that*

$$\frac{CF_1}{1+r_1} + \cdots + \frac{CF_k}{(1+r_k)^k} \geq -CF_0 (or, I_0)$$

    where *r is the discount rate.*

- Problem: It still ignores the cash flows after the discounted payback period *k*.

- ⇒**Use NPV!**

Profitability Index

- Profitability Index (PI) is the ratio of the present value of *future cash flows and the initial cost of a project:*

$$PI \equiv \frac{PV}{-CF_0} = \frac{PV}{I_0}$$

$$\mathrm{PV} = \frac{CF_1}{1+r_1} + \frac{CF_2}{(1+r_2)^2} + \cdots + \frac{CF_T}{(1+r_T)^T}$$

where I_0 is the amount of initial investment made for this project.

- PI is the gross present value, divided by the initial investment.

- **Decision criterion using PI**

❑ For independent projects:

  – Accept all projects with PI greater than one (this is identical to the NPV rule)

❑ For mutually exclusive projects:

  – Among the projects with PI greater than one, accept the one with the highest PI.

- **Problems with PI**
  - PI ignores scale. The scaling can lead to wrong answers in comparing mutually exclusive projects.
  - PI gives the same answer as NPV when
    - There is only one cash outflow, which is at time 0.
    - Only one project is under consideration.
  - The profitability index simply tells whether something is a positive or negative NPV. It does not tell how much NPV is generated from a particular project.

⇒**Use NPV!**

Internal Rate of Return (IRR)

- IRR is the implied rate of return of the project. IRR is that yield, or that rate of return, such that it makes the project break-even.
- IRR is the solution that satisfies

$$\frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \cdots + \frac{CF_t}{(1+IRR)^t} = I_0 \text{ (or } CF_0)$$

  where I_0 is the amount of initial investment made for this project.
- IRR is the rate of return at which the present value of the future cash flows is actually equal to the amount of investment (NPV=0).
- Finding out the IRR from the above equation is not a simple equation-solving exercise. We need to use either trial and error method or interpolation method to determine the required IRR, making the equation equal to zero.

- The trial and error process is as follows:
  - Start with a guess of the discount rate ‘r’
  - Calculate NPV using the ‘r’
  - If the NPV is close to zero, then ‘r’ is the IRR
  - If the NPV is positive, increase ‘r’
  - If the NPV is negative, decrease ‘r’
  - Continue the process until NPV reaches zero

IRR calculation

- Find IRR

	CF0	CF1	CF2	CF3
Project	-10,000	5,000	5,000	5,000

$$\frac{5000}{(1+IRR)}+\frac{5000}{(1+IRR)^2}+\frac{5000}{(1+IRR)^3}=10000$$

Or, $\frac{5000}{(1+IR\ \ )}+\frac{5000}{(1+IRR)^2}+\frac{5000}{(1+IR\ \ )^3}-10000=0$

- By trial and error method we find two extreme values that give the equation values greater than zero and less than zero.
- At 18% calculation is more than 0.
- At 25% calculation is nearer to 0.
- The answer is 23.49%, where NPV=0.

Year	**Cash Flows**	**At 18%**	**At 25%**
0	-10000	-10000	-10000
1	5000	4237.29	4000
2	5000	3590.92	3200
3	5000	3043.15	2560
Total		871.36	-240

- **Decision criterion using IRR**

- Independent Projects:
  - Accept a project if its IRR is greater than some fixed hurdle rate IRR* (cost of capital).
- Mutually Exclusive Projects:
  - Among the projects having IRR's greater than IRR*, accept one with the highest IRR.

- **Assumptions in IRR calculation**
  - There is only one cash outflow, which occurs at time 0.
  - All the cash flows are non-negative.

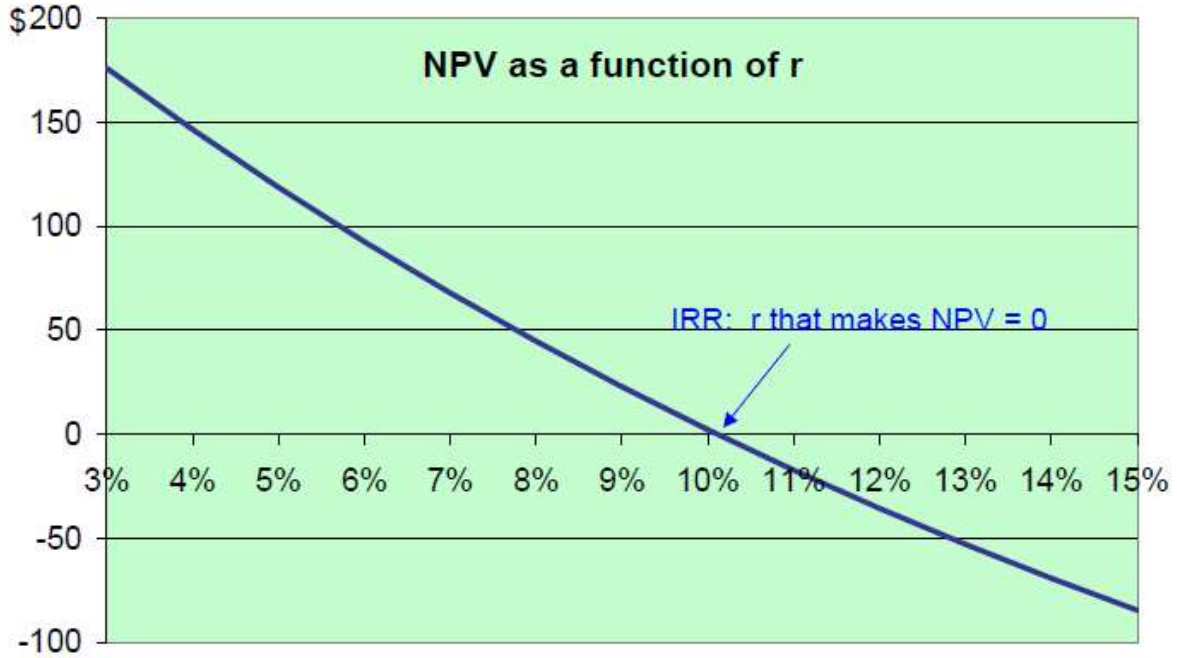
- IRR rule leads to the same decisions as NPV if
  1. There is only one cash outflow, which occurs at time 0
  2. Only one project is under consideration
  3. The opportunity cost of capital is the same for all periods
  4. The threshold rate is set equal to opportunity cost of capital

Example

Saturn cashflows

Year	0	1	2	3	4
Cashflow	-800	154	154	154	614

What is the IRR? 10.11%



- Example. Consider the following mutually exclusive projects:

CF	0	1	2	3	4	5	6
Project 1	-100	20	40	30	10	40	60
Project 2	-100	10	10	80	5	10	10

Then, $IRR_1 = 21\%$ and $IRR_2 = 7\%$

- **Problems with IRR**
  - Non-existent or multiple IRRs in certain cases.
  - Incorrect rankings for loans and other projects with negative cashflows in future periods.
  - Ignore scale because it's a rate of return.

- **Example:** Non-existence of IRR

	CF0	CF1	CF2
Project 1 Project 2	-105 105	250 -250	-150 150

- No IRR exists for these two projects as the solutions can involve complex numbers.

Example: Incorrect ranking for loan-type cashflow sequences

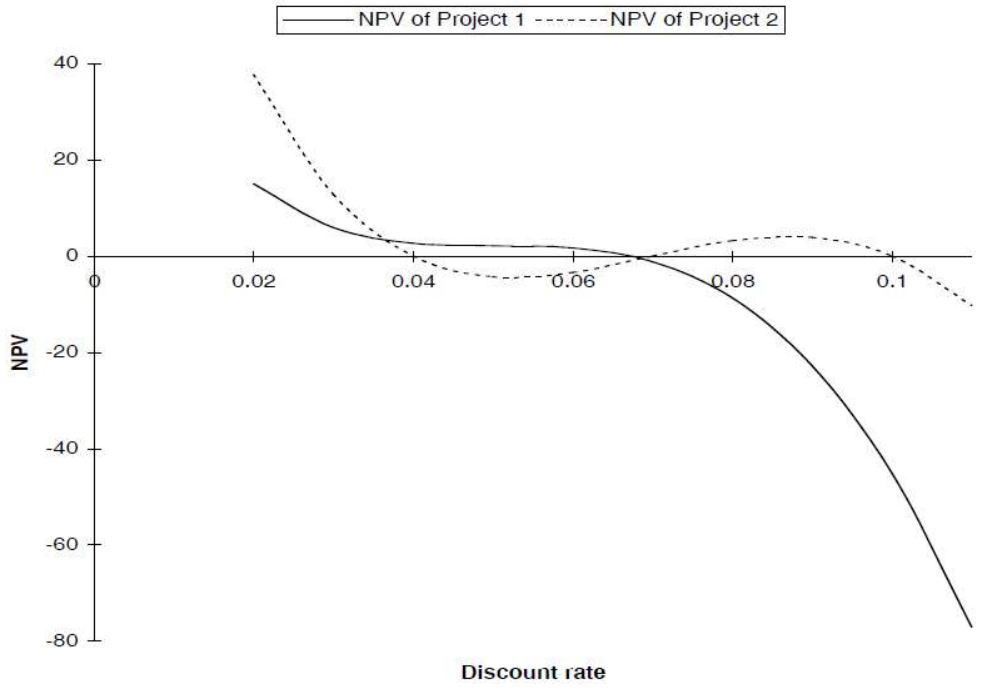
	CF0	CF1
Project 1 Project 2	-100 100	120 -120

- The IRR of both projects is 20%
- If actual opportunity cost is 10%, IRR says to accept both projects
- However,
  - Project 1 has a positive NPV only if *discount rate< 20%*
  - Project 2 has a positive NPV only if *discount rate > 20%*
- Should take project 1 and reject project 2
- Ranking problems can occur when (1) initial investments differ, or (2) the timing of future cash flows differ.

Example: Multiple IRR's

	CF0	CF1	CF2	CF3
Project 1	-500,000	1,575,000	-1,653,750	578,815
Project 2	-500,000	1,605,000	-1,716,900	612,040

$IRR_1 = 7\%$ and $IRR_2 = \begin{cases} 4\% \\ 7\% \\ 10\% \end{cases}$



Example: Incorrect project ranking using IRR for mutually exclusive projects:

a)Projects of different scales:

	CF0	CF1	IRR	NPV at 10%
Project 1 Project 2	-10,000 -20,000	20,000 36,000	100% 80%	8,181.82 12,727.27

- One solution to this problem is to use **incremental cashflows:**
  - See if lower investment (project 1) is a good idea
  - See if incremental investment (project 2) is a good idea (positive value)

	CF0	CF1	IRR	NPV at 10%
Project 1 Project 2	-10,000 -20,000	20,000 36,000	100% 80%	8,181.82 12,727.27
Project 2-1	-10,000	16,000	60%	4,545.45

b) Projects with different time patterns of cash flows:

CF	0	1	2	3	4	5	etc.	IRR	NPV at 10%
Project 1 Project 2	-90 -90	60 18	50 18	40 18	0 18	0 18	... ...	33% 20%	35.92 90.00
Project 2-1	0	-42	-32	-22	18	18	...	15.6%	54.08

⇒**Use NPV!**

- Ranking Conflicts: Due to reinvestment rate assumptions, the NPV method is generally more conservative, and is considered to be the preferred method.
- NPV - Assumes reinvestment of future cash flows at the cost of capital.
- IRR - Assumes reinvestment of future cash flows at the project's IRR.
- In addition, the NPV method maximizes the value of the firm.

- The bottom line is that NPV is the better approach, but IRR is often easier to interpret.

Capital rationing

- It is limiting the size of the capital budget. There's a limit to how much money we can invest.
  - instead of choosing every project that has an NPV greater than zero, select the group of projects with the highest combined NPV possible within the capital constraint.

- In cases where capital must be rationed, a firm should rank projects according to their Profitability indexes.

  Profitability Index = PV / Investment
- Projects with highest present value (PV) per dollar of investment are considered more attractive and the investment dollars are first allocated to them so that the returns of the firm are maximized.

- Capital Rationing Example : (Firm's Cost of Capital = 12%)

- Independent projects ranked according to their IRRs:

Project	Project Size	IRR
E	$20,000	21.0%
B	25,000	19.0
G	25,000	18.0
H	10,000	17.5
D	25,000	16.5
A	15,000	14.0
F	15,000	11.0
C	30,000	10.0

- No Capital Rationing - Only projects F and C would be rejected. The firm's capital budget would be $120,000.

- Capital Rationing - Suppose the capital budget is constrained to be $80,000. Using the IRR criterion, only projects E, B, G, and H, would be accepted, even though projects D and A would also add value to the firm. Also note, however, that a theoretical optimum could be reached only be evaluating all possible combinations of projects in order to determine the portfolio of projects with the highest NPV.

Other issues in capital budgeting

- Competitive response
  - Cashflow forecasts should take into account responses of competitors (e.g., investment in a new technology).
- Other considerations like political, social, cultural, implementation, all sorts of practical aspects.
- Sources of positive-NPV projects
  - Short-run competitive advantage (right place at right time)
  - Long-run competitive advantage (patent, technology, economies of scale, product-differentiations etc.)