What is Capital Budgeting?

• Capital budgeting is the method using which projects or business decisions are evaluated

• Major elements of project evaluation
  – Project cash flows
  – Project risks
  – Market return

Using these elements, NPV of a project or a business decision can be calculated. If NPV is positive project is viable, if it is negative project is unviable. Similarly for business decisions, positive NPV means that the decision is good, negative NPV means that the decision is bad.
Types of Capital Budgeting Projects

- Replacement projects to maintain the business – projects which need to be undertaken to maintain the business. A full business view needs to be taken into account while evaluating these projects. These projects may be unviable standalone but should be lucrative in a full business context.
- Replacement projects for cost reduction – A detailed decision, viability of project can easily be calculated by finding the cost reduction impact.
- Expansion projects – Increased complexity in evaluating these projects because demand has to be forecasted.
- New product development projects – Highly risky but potentially highly rewarding projects. A careful examination of demand on new products should be done.
- Mandatory projects – may, for example, be a statutory compliance to a government regulation.
- Other projects – projects falling out of the purview of categories defined above. These projects can be highly complex to evaluate.
Principles of Capital Budgeting

• Cash flows and not accounting income: capital budgeting is done using incremental cash flows. Incremental cash flow is defined as changes in cash flows due to a project or a business decision.

• Identifying opportunity costs, sunk costs and externalities:
  – Opportunity costs are cash flows which will be lost if a project is undertaken. For e.g. if a project uses up land already owned by the company, the cost of land is an opportunity cost as the firm could have found alternative methods to monetize the land by renting it or selling it.
  – Sunk costs are costs which will be incurred by the firm irrespective of the project undertaken or business decision. For e.g. licensing fee already paid by a telecom operator.
  – Externalities refer to the impact of a project on firm’s other cash flows. For e.g. launching a product in the same segment as firm’s other product may have an impact on the sales of firm’s product.

• Time value of money: Cash flows which occur earlier are more valuable than cash flows which occur later.

• Tax is deducted: Tax on profits is paid to the government. Hence, it is a negative cash flow for the firm.

• Calculating rate of return: Rate of return is used to discount future cash flows to a common time so that they are comparable. This also takes care of financing costs and project’s risks.
Modified Accelerated Cost Recovery System (MACRS)

- Depreciation method chosen has a great impact on cash flows
- In US, straight line depreciation (SLM) is used for financial reporting and MACRS is used for tax filing.
- For Capital Budgeting, whatever is used for tax filing is used. Hence, in US, MACRS is used.
- MACRS uses different depreciation rates for each year as prescribed by the US government.
- Half year convention can be used to recognize the depreciation starting in the middle of the first year and hence continuing an extra calendar year in the end. For e.g. half year convention in a 3 year asset will start at middle of first year and continue till middle of 4th calendar year.
- Depreciation is calculated on actual purchase price of the asset including shipping, handling, installation costs etc. Depreciation doesn’t depend on the salvage value of the asset.
Computing Cash Flows

- **Initial investment**: Investment done in the project initially, includes upfront cost in setting up the project ($FC_{inv}$) and increase in working capital requirements ($NWC_{inv}$)

  \[
  \text{Initial Investment} = FC_{inv} + NWC_{inv}
  \]

- **After-tax operating cash flows (CF)**: Incremental cash flows from the project after tax deduction (tax is obviously a negative cash flow and is deducted).

  \[
  CF = (S - C - D)(1 - T) + D
  \]

  - $S$ = Sales
  - $C$ = Cash operating costs
  - $D$ = Depreciation expense (why is depreciation part of this when it is not a cash flow)
  - $T$ = marginal tax rate

- **Terminal year after tax non-operating cash flows (TNOCF)**: After the termination of the project one would get back salvage value of equipments and money invested in working capital. These form TNOCF

  \[
  \text{TNOCF} = \text{Salvage}_T + \text{NWC}_{inv} - T(\text{Salvage}_T - B_T)
  \]

  - $\text{Salvage}_T$ = pre-tax Salvage value
  - $B_T$ = book value
PHL, an international courier service, is planning to set up a new distribution office. PHL has an option to buy a building at a cost of $20,000. Other equipment for the office will cost $15,000 including installation. An investment of $5,000 in the net working capital is also required at the time of setting up the office.

Economic life of the office is estimated to be three years. After three years, market value of the building will be $10,000 and its book value $9,500 and market value and book value of the equipment will be zero.

Additional revenue from this office will be $75,000 per annum. Variable cost is estimated to be 75% of the revenue and fixed cost (excluding depreciation) is estimated as $5,000 per annum.

Find the NPV of the project.
(Assume Tax rate = 40%, Cost of capital = 12%, and other standard assumptions)

Depreciation for building and equipments
Yr 1 = $8,000 , Yr 2 = $10,500 , Yr 3 = $7,000
Since the NPV is negative, PHL should not invest in the new office.
Spreadsheet Modeling

• Capital budgeting is usually done using computers. Often spreadsheets like Microsoft Excel® are commonly used for this purpose.

• Spreadsheets are very convenient and there are a number of reasons for their use
  – They are an effective means of building a complex model
  – Built-in functions are easy to use
  – Model’s assumptions can be changed and solved easily
  – They can be easily shared
  – Ease of presentation
Effects of Inflation

- Nominal cash flows vs. real cash flows: Real cash flows are inflation adjusted while nominal cash flows are not. Caution must be borne in mind while using discount rate for these cash flows. Real discount rate is used for real cash flows and nominal discount rate is used for nominal cash flows

\[ (1 + \text{nominal rate}) = (1 + \text{real rate}) \times (1 + \text{inflation rate}) \]

- Effect on Project profitability: profitability of a project is inversely proportional to inflation rate.
- Effect on tax savings from depreciation: If inflation is higher, it will reduce the benefit of tax savings due to depreciation. This is because depreciation itself will reduce as the asset price on which it is charged will be lower than the current asset price, which will be higher because of high inflation.
- Effect on value of payments to debt-holders: Value of money transferred to debt holders will reduce in a high inflation period.
- May effect revenues and costs differently: Prices of inputs and outputs may change differently. This may create either a positive or a negative effect on cash flows of the firm.
Mutually exclusive projects with unequal lives: When the decision is to compare between two or more mutually exclusive projects (that is only one of those can be chosen at a given point of time) with unequal life spans, two methods are used

- Least common multiple of lives approach: Least common multiple of both projects’ lives is found and projects are repeated back to back in that LCM life span (since it is the LCM life span each project will repeat integral number of times). Then the resulting NPVs are compared.
- Equivalent annual equity (EAA) approach: An equivalent series of annual payments are calculated to represent NPVs of each project. These annual payments are then compared.

Capital rationing: If the capital to be invested in the projects is limited then the capital has to be invested in such a way that the overall NPV of the portfolio of projects it is invested in is maximum.

- Hard capital rationing is one where capital to be invested in projects is limited and it can’t be increased,
- Soft capital rationing happens when a proper justification has to be done to and approval sought from top management for capital investment beyond a limit.
Example: Mutually exclusive projects with unequal lives

Q. American Bus is considering improving its fleet. It has two options – a) buy Volvo buses with a useful life of 2 years, with NPV@12% = $2 million and IRR of 15% or b) buy Benz buses with a useful life of 4 years, with NPV@12% = $3.5 million and IRR of 18%.

Which option should American Bus consider?
These options represent two mutually exclusive projects with different life spans. LCM of the life spans these options is four years.

So, option a) will repeat twice in these four years. So, its cash flows can be modeled as below

\[
\begin{align*}
\text{0} & \quad \text{2} & \quad \text{4} \\
$2 \text{ million} & \quad $2 \text{ million} & \\
\end{align*}
\]

\[
\text{NPV} = $2 \text{ million} + \frac{$2 \text{ million}}{1.12^2} = $3.59 \text{ million}
\]

So, option b) will repeat once in these four years. So, its NPV is same as $3.5 million

Comparing NPVs standardized over four years, American Bus should choose option a)

Note than option a) was chosen over b) despite b) having a higher IRR
Solution: EAA approach

Find annuity (EAA) for both the options, representing their NPVs

\[ EAA_{volvo} : PV = -\$2\ million, FV = 0, N = 2, I = 12 \]
\[ PMT = ????? \]

\[ EAA_{benz} : PV = -$3.5\ million, FV = 0, N = 4, I = 12 \]
\[ PMT = ????? \]

\[ EAA_{volvo} > EAA_{benz} \]

Hence, American Bus should choose option a) of buying from Volvo over option b) Benz
Example: Capital rationing

Q. Indico has opportunity to invest in four capital projects but the available capital budget is only $5000. Out of the given projects, which one should Indico invest in?

(Initial investment costs and NPV of each project are given in the table)

<table>
<thead>
<tr>
<th>Project</th>
<th>Investment outlay</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project A</td>
<td>- $2500</td>
<td>$450</td>
</tr>
<tr>
<td>Project B</td>
<td>- $1500</td>
<td>$300</td>
</tr>
<tr>
<td>Project C</td>
<td>- $1000</td>
<td>$200</td>
</tr>
<tr>
<td>Project D</td>
<td>- $2000</td>
<td>$400</td>
</tr>
</tbody>
</table>
Since Indico wants to maximize NPV, it obviously should choose in the order of highest positive NPV projects.

Project A and Project D are the highest two NPV projects, with a total cost of $4500 and NPV $850. But if we choose project B, C and D our cost comes to be $4500 and NPV $900.

Indico should hence choose project B, C and D in order to maximize its NPV in the given budget. Note that it couldn’t choose project A which is the highest NPV project.
Evaluating Risks of a Capital Project

- **Sensitivity Analysis**: Sensitivity analysis is observing the change in any key dependent parameter (for e.g. NPV) by changing independent parameters it depends on, one at a time. For e.g. change in NPV can be seen by changing sales.

- **Scenario Analysis**: Scenario analysis is like sensitivity analysis but allows for changes in multiple independent parameters to show effect on dependent parameter. A likely probability distribution of independent parameters is considered.

- **Monte Carlo Simulation**: Using this simulation model, a range of probability distribution of dependent variable can be calculated by simulating changes in independent parameters.
Example – Sensitivity analysis

• PHL (refer to previous example) is analyzing its expansion projects by testing sensitivity of NPV and IRR to the following parameters. The cases are 10% decrease in parameters and 10% increase in parameters.
  Do a sensitivity analysis of NPV and IRR with respect to these parameters – revenue, variable costs, fixed costs, salvage value.
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Economic life of the office is estimated to be three years. After three years, market value of the building will be $10,000 and its book value $9,500 and market value of the equipment will be zero and its book value $7,500.

Additional revenue from this office will be $75,000 per annum. Variable cost is estimated to be 75% of the revenue and fixed cost (excluding depreciation) is estimated as $5,000 per annum.

Find the NPV of the project.
(Assume Tax rate = 40%, Cost of capital = 12%, and other standard assumptions)

Depreciation for building and equipments
Yr 1 = $8,000 , Yr 2 = $10,500 , Yr 3 = $7,000
### Solution

<table>
<thead>
<tr>
<th></th>
<th>Down 10%</th>
<th>Base Case</th>
<th>Up 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV</td>
<td>-3582</td>
<td>-1170</td>
<td>1243</td>
</tr>
<tr>
<td>IRR</td>
<td>7%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Variable Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV</td>
<td>6068</td>
<td>-1170</td>
<td>-8407</td>
</tr>
<tr>
<td>IRR</td>
<td>21%</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Fixed Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV</td>
<td>-526</td>
<td>-1170</td>
<td>-1813</td>
</tr>
<tr>
<td>IRR</td>
<td>11%</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td><strong>Salvage Value</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV</td>
<td>-1805</td>
<td>-1170</td>
<td>-534</td>
</tr>
<tr>
<td>IRR</td>
<td>9%</td>
<td>10%</td>
<td>11%</td>
</tr>
</tbody>
</table>
Example – Scenario analysis

• Do a scenario analysis on the PHL’s project’s NPV and IRR assuming a bad case when revenue and salvage value are down 20% while fixed and variable costs are up 20%, and a good case when revenue and salvage value are up 20% while fixed and variable costs are down 20%.

• Solution

<table>
<thead>
<tr>
<th></th>
<th>Good Case</th>
<th>Base Case</th>
<th>Bad Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>Up 20%</td>
<td>75000</td>
<td>Down 20%</td>
</tr>
<tr>
<td>Variable Costs</td>
<td>Down 20%</td>
<td>56250</td>
<td>Up 20%</td>
</tr>
<tr>
<td>Fixed Costs</td>
<td>Down 20%</td>
<td>5000</td>
<td>Up 20%</td>
</tr>
<tr>
<td>Salvage Value</td>
<td>Up 20%</td>
<td>9000</td>
<td>Down 20%</td>
</tr>
<tr>
<td>NPV</td>
<td>20474</td>
<td>-1170</td>
<td>-19599</td>
</tr>
<tr>
<td>IRR</td>
<td>40%</td>
<td>10%</td>
<td>-18%</td>
</tr>
</tbody>
</table>
Determining the Discount Rate

- Discount rate for a project is calculated using CAPM, taking project risks into account vis-à-vis market’s risks

\[
R_{\text{project}} = R_F + \beta_{\text{project}} \left[ E(R_{\text{market}}) - R_F \right]
\]

- \( R_F \) = risk free rate
- \( R_{\text{project}} \) = project’s discount rate
- \( \beta_{\text{project}} \) = beta of the project
- \( E(R_{\text{market}}) - R_F \) = market risk premium
Determining the Discount Rate - Example

• A 3 year project has beta of 1.4. Initial cost of setting up the project is $1 million and it will generate annual cash flows of $450,000. Find the NPV of the project.

Assume risk free interest rate as 8% and the expected market return is 18%

– Solution

\[ R_{\text{project}} = \text{RF} + \beta_{\text{project}} \left[ \text{E}(R_{\text{market}}) - R_f \right] \]

\[ = 8\% + 1.4 \left[ 18\% - 8\% \right] \]

\[ = 22\% \]

\[ \text{NPV} = -$1 \text{ million} + $ 450,000/1.22 + $ 450,000/1.22^2 + $ 450,000/1.22^3 \]

\[ = -$80,991 \]
Real options are options with underlying assets being real assets *(and not financial assets)*. These are based on real choices that a business may have in the future, for e.g. option to increase capacity, close down a plant etc.

- Types of options
  - Timing options (deferred decision with the hope of better information in the future)
  - Abandonment options (option to abandon a project, same as put option)
  - Expansion options (option to expand in future, same as call option)
  - Flexibility options
    - Price setting (option to change the price)
    - Production flexibility (option to change the production)
  - Fundamental options (option inherent in the project itself)

- There is an inherent value in any option, and hence in real options
  - Net value of an option = value of the option – cost of the option
- So, if there is a real option present in a project, its net value should be added to the NPV of the project

### Overall NPV

\[
\text{Overall NPV} = \text{project NPV} - \text{option cost} + \text{value of the option}
\]
Real Options - Example

• P&J is planning to set up new shampoo production facility with an estimated NPV of the cash flows as negative $2.5 million. P&J at this stage is also toying with the idea to install another $2 million worth of equipments which will give it the flexibility of producing 3 more variants of shampoo in the future based on demand. This option of producing variants of shampoo has a value of $5 million. Evaluate the profitability of the project including the real option.

• Solution

Overall NPV = project NPV –option cost + option value
  = - $2.5 million - $2 million + $5 million
  = $0.5 million

NPV of the project including the real option is positive
Hence the real option has made P&J’s project viable
A 3 year project requires an investment of $20,000 and annual expected cash flows are $8,000. What is the NPV of this project.

We also know that there is a 50% probability that the project will be a failure and the cash flows then will be $4,000 and 50% probability that the project is a success, resulting in cash flows of $12,000 annually. Whether the project is a failure or success will be known after the end of the first year. There is an option to abandon the project at the end of first year, the salvage value received will be $13,000.

How to decide whether to abandon the project or not. What is the NPV of the project now? What is value of the abandonment option?

Cost of capital is 12%
Solution

NPV of the project without the option = - $785

The project should be abandoned if the present value of the cash flows from the project at the end of year 1 is less than the salvage value.

If the project is a success
PV of cash flows at the end of year 1 = $ 28,822 > $ 13,000
hence the project should not be abandoned

If the project is a failure
PV of cash flows at the end of year 1 = $ 9,607 < $ 13,000
hence the project should be abandoned
NPV when the project is a success = $8,822
NPV when the project is a failure = -$4,821

(Note that the project will be abandoned, so the cash flow at the end of year 1 = $4,000 + $13,000 = $17,000, cash flows at the end of year 2 and 3 will be zero)

NPV of the project = NPV when success* probability of success + NPV when failure* probability of failure

= $8,822* 0.5 + (-$4,821)*0.5

= $2,000

Value of the option = NPV of the project with the option – NPV of the project without the option

= $2,000 – (-$785)

= $2,785