Closing the Business Case

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The top 5 investor questions

• How much will I need to invest?
• How much will I get back?
• When will I get my money back?
• How much is this going to cost me?
• How are you handling risk & uncertainty?
Investment criteria

- Net present value
- Payback
- Discounted payback
- Average return on book value
- Internal rate of return
Net present value (NPV)

• Measure of present value of various cash flows in different periods in the future
• Cash flow in any given period discounted by the value of a dollar today at that point in the future
  – “Time is money”
  – A dollar tomorrow is worth less today since if properly invested, a dollar today would be worth more tomorrow
• Rate at which future cash flows are discounted is determined by the “discount rate” or “hurdle rate”
  – Discount rate is equal to the amount of interest the investor could earn in a single time period (usually a year) if he/she were to invest in a “safer” investment
Calculating NPV

- Forecast the cash flows of the project over its economic life
  - Treat investments as negative cash flow
- Determine the appropriate opportunity cost of capital
- Use opportunity cost of capital to discount the future cash flow of the project
- Sum the discounted cash flows to get the net present value (NPV)

\[ NPV = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_T}{(1+r)^T} \]
### NPV example

<table>
<thead>
<tr>
<th>Period</th>
<th>Discount Factor</th>
<th>Cash Flow</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>-150,000</td>
<td>-150,000</td>
</tr>
<tr>
<td>1</td>
<td>0.935</td>
<td>-100,000</td>
<td>-93,500</td>
</tr>
<tr>
<td>2</td>
<td>0.873</td>
<td>+300,000</td>
<td>+261,000</td>
</tr>
</tbody>
</table>

Discount rate = 7%  
NPV = $18,400
Points to keep in mind about NPV

• Assumes only one course of action:
  – Reasonable assumption if conditions are stable
  – No room for managerial flexibility

• Choice of the discount rate is difficult:
  – Typically, use a combination of equilibrium models (like CAPM) and “expert judgment”
  – Should always perform sensitivity analysis on discount rate!
Payback

• Investment decision based on “time it takes to recover investment”
• No discounting of cash flows
• Gives equal weight to cash flows before cut-off date & no weight to cash flows after cut-off date
• Cannot distinguish between projects with different NPV
• Difficult to decide on appropriate cut-off date
## Payback example

<table>
<thead>
<tr>
<th>Project</th>
<th>$C_0$</th>
<th>$C_1$</th>
<th>$C_2$</th>
<th>$C_3$</th>
<th>NPV @ 10%</th>
<th>Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-2,000</td>
<td>+1,000</td>
<td>+1,000</td>
<td>+5,000</td>
<td>3,492</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>-2,000</td>
<td>0</td>
<td>+2,000</td>
<td>+5,000</td>
<td>3,409</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>-2,000</td>
<td>+1,000</td>
<td>+1,000</td>
<td>+100,000</td>
<td>74,867</td>
<td>2</td>
</tr>
</tbody>
</table>
Discounted payback

• Payback criterion modified to account for the time value of money
  – Cash flows before cut-off date are discounted
• Surmounts objection that equal weight is given to all flows before cut-off date
• Cash flows after cut-off date still not given any weight
Average return on book value

• Investment decision based on book rate of return of project relative to book rate of return of entire firm (or some external yardstick)
• Book rate of return given by dividing the average forecasted profits (after depreciation & taxes) by the average book value of the investment
• Average return on book value depends on accounting income (different from cash flow)
• Decision of yardstick is arbitrary
Internal rate of return (IRR)

• Investment criterion is “rate of return must be greater than the opportunity cost of capital”
• Internal rate of return is equal to the discount rate for which the NPV is equal to zero

\[ NPV = C_0 + \frac{C_1}{1 + IRR} + \frac{C_2}{(1 + IRR)^2} + \ldots + \frac{C_T}{(1 + IRR)^T} = 0 \]

• IRR solution is not unique
  – Multiple rates of return for same project
• IRR doesn’t always correlate with NPV
  – NPV does not always decrease as discount rate increases
IRR example

Net present value ($)

+2000

+1000

0

IRR = 28

-1000

-2000

Discount rate, percent
Dealing with risk & uncertainty

• Artificially high hurdle rate
• Bracketing (upper & lower bounds)
• Probabilistic analysis
• Decision tree analysis
Artificially high hurdle rate

- Simplistic
- Doesn’t fully capture range of possibilities
- Not well suited for products with relatively small margins such as aircraft
- Better suited for products with relatively large margins or projects that require small capital outlays
Bracketing

- Better that using a high hurdle rate
- Gives indication of variability in financial performance
- Highly unlikely that all the factors or issues will be all good or all bad at the same time
- Can over estimate “best” and “worst” case outcomes
- Best used for analysis with few factors
Probabilistic analysis

• Essentially a Monte-Carlo simulation of NPV
• Repetitive NPV analyses using input values selected from probability distributions
• Can become very complex for products with many components & factors
• Requires many assumptions & good understanding of development & manufacturing/production processes
Decision tree analysis

• NPV calculation that incorporates different future scenarios based on the likely hood of that scenario occurring
• Cash flow for any given year is the weighted sum of the cash flows for each scenario that could occur in that year
• Weightings are equal to the probability that a specific scenario will occur
## Decision tree example

<table>
<thead>
<tr>
<th>Period</th>
<th>Option</th>
<th>Prob.</th>
<th>Cash Flow</th>
<th>PV</th>
<th>Prob. * PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Both</td>
<td>100%</td>
<td>-150,000</td>
<td>-150,000</td>
<td>-150,000</td>
</tr>
<tr>
<td>1</td>
<td>A</td>
<td>50%</td>
<td>+50,000</td>
<td>+46,750</td>
<td>+23,375</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>50%</td>
<td>+100,000</td>
<td>+93,500</td>
<td>+46,750</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>50%</td>
<td>+50,000</td>
<td>+43,650</td>
<td>+22,825</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>50%</td>
<td>+200,000</td>
<td>+174,600</td>
<td>+87,300</td>
</tr>
</tbody>
</table>

Discount rate = 7%  
NPV = $30,250
Decision tree analysis

• Widely used technique to determine value of investments under uncertainty

• Main steps:
  – Determine possible states of nature
  – Determine probability of reaching each state (use conditional probabilities)
  – Determine NPV for each end state (use constant discount rate)
Solving the tree

- Move along the tree from end to the front
- NPV for any state (except for end states) is the weighted sum of the NPV of following state
- Weightings are the probabilities of reaching such states
Points about decision analysis

• Difficult to apply when multiple sources of uncertainty are present
• Does not resolve problem of choice of discount rate
Possible analysis approaches

• Bottom-up analysis
• Top-down analysis
Bottom-up analysis

• Determine costs and timing (profile of expenditure versus time) for each phase of cargo system development and production based on heuristics or first principles analysis
• Determine market penetration (profile of cargo system revenue versus time) based on heuristics or first principles analysis
• Determine uncertainty in all values
• Determine NPV and variability in NPV
Top-down analysis

- Determine market penetration (profile of cargo system revenue versus time) based on heuristics or first principles analysis
- Scale existing profile of expenditure versus time for development and production of a closely related system
- Determine costs for which NPV equals zero
- Determine uncertainty in market penetration
- Determine uncertainty in costs
Managing risk

• Hedge investment
  – Buy portfolio that is not correlated with the market for the product you are developing

• Limit impact of factors outside your control
  – Insure against detrimental actions or inaction of partners, or catastrophic events

• Change the playing field
  – Influence market to either make it more stable overall or more favorable to your product
Managing risk

• Build in flexibility
  – Create ability to respond to changes in product requirements space and market

• Plan staged development and introduction
  – Develop strategy to evaluate product utility and market situation before full investment is made
Summary

• Investment criteria
  – NPV

• Risk & uncertainty
  – Bracketing (if there are only a few key factors)
  – Probabilistic analysis (if details of processes available)
  – Decision tree analysis (is there are clear investment options)

• Analysis approaches
  – Bottom-up analysis (if details of processes available)
  – Top-down analysis (if details of processes not available)

• Manage your risks