Investment Opportunities and Real Options

NPV Analysis

• Let capital cost of a project be $50M
• Next month value of project revealed
  – $55M with probability 0.5
  – $47M with probability 0.5
  – NPV = $1M > 0
  – Traditional rule: invest if NPV > 0.

What’s Missing?

• Value of Delay
  – Suppose no revenues lost by waiting one month
    and learning demand state.
  – NPV = (0.5)(55-50) + (0.5)(0) = $2.5M
  – Value of waiting = $1.5M
  – All NPVs calculated at time 0
What is wrong with NPV?

- Ignores opportunity cost of waiting
  - A cost of investing irreversibly today is giving up possibility of gaining valuable information on demand or costs of project.
- Ignores the value of creating options
  - Investment may be valuable because it opens up opportunities for further investments in the future
  - R&D; keeping a loss making factory open
- NPV=0 → Don’t exit, enter

Investment Opportunity Creates a Call Option

- Investment opportunities: a right, but not an obligation to make an investment
- Exercising an option by making an irreversible investment “kills” the option.
- Need to consider the cost of waiting for new information that may affect the decision.

Effect of Uncertainty

- NPV analysis underestimates effect of uncertainty: only consider effect on discount rate (higher risk premium)
- Need to consider effect of uncertainty on options
  - More uncertainty decreases value of investments that use up options (waiting more valuable)
  - More uncertainty increases value of investments that create new options
Preemption and Real Options

- Value of preemption: commitment may affect rivals’ actions.
- Cost of preemption: commitment destroys flexibility
  - Obsolete technology
  - Too large, small

Example
Size of the market is 0 with probability 0.9 and 400 with probability 0.1
Expected size of the market = 40
Each customer will be identical and have a willingness to pay for the good of $100.
Timing:

<table>
<thead>
<tr>
<th>market size revealed</th>
<th>competition</th>
</tr>
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<tbody>
<tr>
<td>you can build</td>
<td>others can build</td>
</tr>
<tr>
<td>others can't</td>
<td>or not</td>
</tr>
</tbody>
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Preempt with Capacity of 40?

- If market size turns out to be 0, massive excess capacity.
- If market size turns out to be 400, rivals build anyway.
- Can’t pre-empt with capacity < 400
- Capacity of 400 pays only if costs < $10 and rivalry fierce enough to deter entry
Example 2
Size of the market is 200 or 400, each with probability ½.
Expected size of the market = 300
Customer willingness to pay random draw from 0 to 100, monopoly price = $50, monopoly sales 100 or 200.
Timing:
\[ \text{you can build} \quad \text{market size revealed} \quad \text{competition} \quad \text{others can build} \quad \text{others can't} \]

Preempt with Capacity of 300?
- If market size turns out to be 200, massive excess capacity.
- With pre-emption, don’t have to use it all.
- If market size turns out to be 400, enjoy profits
- Right capacity could be as high as 400.
- Lower cost rivals may not be pre-empted.
- Depends on cost of capacity
- Higher cost of capacity increases profits

Capital budgeting under uncertainty
- Return to good cash flow estimates high
  - strategic analysis essential
  - cannot extrapolate from current performance
- Capital budgeting strategy
  - consider competitor’s capital budgeting problem
  - incorporate forecast that strategy will change with new information.
  - incorporate competitive uncertainty.
Summary

• NPV ignores option value of investments
• Option value considerations
  – Favor investments that preserve options like keeping a plant open
  – Disfavor investments that exercise options like building a plant
• Option value considerations increase as variability increases
• Commitment affects rival behavior, but exercises options