Choice of Valuation Methods

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Outline for Real Options

- The Issue

- Criteria of Choice
  - Analysis Objective – choice or price?
  - Organizational Decision-Making practices
  - Analytic Capabilities of Group
  - Information available

- Two Classic Cases – Real Options at:
  - Merck – Producer of Ethical Drugs
  - Kodak – Cameras, Copiers

- Summary

- Appendix – Hybrid combination of methods
The Issue: Choice of Method

- Why is this a Question?
- Why not most theoretically correct method?

- Not obvious which method is correct
  - Elegant theory based on assumptions
  - If these are not credible, theory may not apply
Simple Idea – almost theological issue for some

- If objective is to influence design ...
  ...Then what works is what counts!
  - Need to appreciate resources and constraints that apply to process of valuation

Possible Goals of Valuation

- Psychology Offers 2 General Possibilities
  - Choice: specifies ORDER of preference
  - Judgment: measures INTENSITY of preference

- Choice is easier task
  - Requires less cognitive effort

- Judgment more difficult = ‘choice’ + measure
  - Requires more conditions if you want to get a consistent measure (see “primitive models” presentation, also ASA Chapters 18-20)

- Which applies to current situation?
What is Goal in Current Situation?

- Definition of a Strategy?
  - Ex 1: Communications Satellites – should system
    • be built all at once to a specified capacity?
    • start small with capability to expand?
  - Ex 2: Logistics – should configuration of system be
    • Centralized -- or distributed?

- Finding best Option among many?
  - Ex: Having chosen strategy to build factory extra large to permit expansion, what is best size?

- Any Organization or design team can face either issue at different times...

Which method for goal?

- Two major alternative methods:
  - Decision Analytic (Tree, Lattice, or Simulation)
  - “Options Analysis” (Risk-neutral analysis, etc)

- Decision analysis methods focus on
  - choice, on developing strategy

- “Options analysis” focuses on
  - Judgment, the pricing of any option

- Therefore:
  Analysis Objective of Valuation exercise should influence the selection of method
Organizations Differ

- Groups differ in project evaluation practices

- This matters!
  - easier to make incremental improvements
  - hard to make deep changes

- To influence the actions of groups now...
  may be best to aim for smaller changes

Organizational Practices

- Major differences in evaluation practice from perspectives of how groups
  - Value Projects – to what degree do they model and value uncertainty
  - Have Capabilities and skills – what do they know how to do? What can they be taught?
  - Have to focus their modeling and design effort – is the focus on a simple design (parking garage)? Or something vastly more complex (aircraft, copper mine)?
  - Have access to information – what is available to analysts?
2-D View of Evaluation Practices

- Groups differ in project evaluation practices
- Where do we place group we are working with?

<table>
<thead>
<tr>
<th>Modeling of Uncertainty</th>
<th>Valuation of Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lattice etc</td>
<td>DCF</td>
</tr>
<tr>
<td>Options Analysis</td>
<td>None</td>
</tr>
</tbody>
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Example: BP Projects

- Central Management defines
  - Discount rate
  - Price of Oil to be used in Evaluation
  - Evaluation Method -- DCF

- Business Unit Leaders not allowed to alter
  - Central Management does not want to be gamed

- Result:
  - Market Uncertainty in Price is Ignored
  - No Risk-Adjusted Discount Rate
  - No options analysis of projects

[Note: Developing and demonstrating way to change this is topic of current research in ESD]
What Method for BP?

- Likelihood of getting Central Management to let project managers use “options analysis” is remote (but we’re trying) – DCF is standard

- If object is to add value to projects using options, seems best to evaluate them in a way compatible with DCF

- In short, Organizational Evaluation Practices should influence the selection of method

Analytic Capabilities of Group

- To implement evaluation of options for a project, it is necessary to work with project proponents – they control process and data

- Are they
  - Engineers? – trained in decision analysis
  - Financial Managers? – grounded in options analysis

- As a practical matter, Analytic Capabilities of Group will influence the selection of method
Analytic Focus of Group

- What is the central analytic focus of the group? What must be done ensure satisfactory product? The evaluation must tie in with this – else it does not have a place in design process. For example:
  - Aircraft Design: Aerodynamic analysis
  - Bridge Design: the Structural Analysis
  - Copper Mine: “mine plan” or excavation sequence

- If you want the people who really design the system to look at options, you need to tie procedure into what they use already
  - With BP, research project based upon using their Oil and Gas Model (OGM), to gain acceptance for method

Information Available

- “Options Analysis” requires extensive data:
  - Price of Asset
  - Standard deviation of asset value
These may not be available

- “Options Analysis” also assumes:
  - Existence of Efficient Market for Asset
This may not exist

Thus,

Availability of Information will constrain the selection of method
Also Keep in Mind...

- Level of required effort, ease of use – for both
  - Analysts – who have to do work
  - Clients – who have to understand, if they are to act

- Financial models work well with
  - 1 or 2 variables with market price history

- Decision analysis works well when
  - Likelihood, timing of uncertainties understood
  - Information sources focused on project
  - Important Variables do not have price history

Choosing Valuation Method in Practice

- Compare “classic” cases at two companies
  - Good Examples of Factors defining Choices

- Merck: used financial approach to options

- Kodak: used decision analysis
Merck – the company

- Developer, producer of ethical drugs

- Spends billions on Research and Development
  - Thousands of candidate compounds
  - Hundreds of possible drugs
  - Tested in a controlled sequence of trials

- Understands that R&D creates options
  - Successful Research gives “right, but not obligation” to proceed to next phase of development

- Has extensive group for “options analysis”

Merck -- Business Details

- Development process highly regulated by FDA
- 1000’s of candidate drugs go through 10 year path to market provide statistical database
- Reasonable to speak in terms of an average project and estimate volatility

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Pre-Clinical Tests → Phase-One Clinical → Phase-Two Clinical → Phase-Three Clinical → FDA Filing
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Compound Discovery → On-going Basic Research
Merck – the Real Options Case

- **Project Gamma**
  - Opportunity to work with Start-up Biotech Company
  - Merck would fund continuation of R&D
  - Merck would get right to buy Start-up in 2 years
  - Start-up gets opportunity to continue, and cash out

- Investment in R&D buys option for production in 2 years -- a “European” call

- “Options analysis” used to value development contract with biotech company

- Let’s see how and why…

Merck – Analytic Context

- **Goal of Analysis:** To determine Price of Option

- **Location of Analysis:** Finance Department
  - Acquisitions one of their responsibilities
  - Had extensive experience with financial options

- **Information plentiful**
  - Deep statistics on success rates for new drugs
  - Much data on performance biotech start-ups

- **Choice of Method:** Financial “options analysis”
Merck -- Information Details

- Average drug takes $359 million (1990s data) and 10 years to market
- 1/10,000 compounds tested becomes a drug
- Fraction of population with disease X known
- Successes and failures at each testing step documented and averaged
- Database of pharmaceutical and biotech stock performance created

Analysis for Merck Case

- Project Gamma as a European call option

Valuation procedure

- Asset = Stock in Start-up Company
- Value of Asset = value of projected cash flows
- Strike Price = Cost of manufacturing scale-up
- Risk-free rate = rate on U.S. Treasuries
- Volatility based on stock market performance of comparable biotech companies in database

Sensitivity Analysis

- Volatility: varied between 40 to 60 percent
- Time to Expiration: varied between 2 to 4 years
Merck -- Real Options Summary

- Merck needed to determine price

- Valued real options using financial “options analysis”
  - Black-Scholes formula
  - Other models for support (Monte-Carlo simulation)
  - Applied to variety of areas: R&D, acquisitions, etc...

- Recognized imprecision due to assumptions
  - Sensitivity analysis on volatility, time to exercise
  - This helps to address remaining uncertainties

Kodak – the Company

- Involved in multiple businesses: film, printing, etc., besides production of copiers

- “average project” hard to define
  - Product development processes might be similar, but do vary
  - No comparable data available publicly, from either FDA or start-ups in copier industry (none exist)

- Data needed for a financial analysis not available
Kodak – the Real Options Case

- Color Printer Project
  - R&D project run by engineers
  - Faces technical and market uncertainties
  - Decisions on R&D and production are separate
  - Production can be started ‘any time’ after R&D

- Investment in R&D creates “right, but not obligation” to move into production
  - An “American” call

- Decision analysis used to “green light” R&D

- Let’s see how and why…

Kodak – Analytic Context

- Goal of Analysis: to choose R&D strategy

- Location of Analysis: Systems Engineering group
  - Not up on financial “options analysis”
  - R&D department used to decision analysis

- Information available:
  - Estimates of Probability of Technical Success,
    Market Size for Project
  - No comparable statistical data on volatility, etc.
    - Projects vary widely between business units
    - Difficult to assemble relevant databases

- Choice of Method: Decision Analysis
Analysis for Kodak Case

- Color printer project as American option

Valuation Procedure
- Asset value = based on Project cash-flows
- Strike price = Production scale-up costs
- Discount rate = 12%
- Timeframe was two years (1993 – 1995)
- Volatility of payoffs implied by range of outcomes

Sensitivity Analysis
- To check robustness of decision to do project

Kodak – Real Options Summary

- Kodak needed to choose a strategy
  - Proceed with R&D or not

- Valued Real Options using Decision Analysis

- Emphasis on value of “options thinking”
  - Recognition of flexibility (Kodak can decide not to produce copier, even if R&D is successful)
  - Exact value of option not important so long as it is greater than cost of R&D
  - Big advance over DCF with no flexibility
Lessons from Cases

- Both financial “options analysis” and decision analysis can be used to value real options
- Which can be used depends on context
- Which should be used depends on goals, etc
- Beware of false sense of precision
  - any method uses assumptions
  - Sensitivity Analysis always needed
- Significant value in the mind-set -- Approximations can enable vast improvement

Let’s think about a case…

- Current project with a major oil co (not BP)
- They produce “bunker oil”, heavy fuel for ships
- Restrictions % Sulfur in fuel for ships transiting EU waters, California shore (from 5 to 0.5%)
- Such regs could drastically affect value of their existing products, change their markets
- Uncertainty is great
- Yet design process has not dealt with this risk

HOW TO PROCEED?
- New capacity now? Or later?
- R & D? Alliances with Diesel Manufacturers?
Discussion of this case

- Business leader persuaded top management that uncertainty had to be taken into account
- This is a crucial step!

- Now which method?
- Purpose-built tool (like Excel) to fit all projects?
- Process that adds simulation or decision analysis to design of fuel producing plants?

YOUR THOUGHTS?

New analytic possibility

- Is it possible to combine lattice and decision analyses?

- This would offer several advantages:
  - Lattice for gradually evolving processes
  - Decision A. for sudden, "step" changes such as new Environmental Regulations, Government policies

- Examples:
  - What to do in face of uncertainty in oil production, in face of new low sulfur regulations?
  - How to develop supply chain, when competitors might decide to move in?
Thesis by Nestor Quispez-Asin

- He has created procedure to do Decision Analysis against a background evolution of uncertainties represented by lattice
- This is a “brute force” method; becomes computationally difficult over more than two periods
- However, appears attractive as a tool for exploring major strategies

- He will present his results to class before end of term, once he has wrapped them up.

Summary

- Choice of Valuation Method depends on
  - Analysis Objective – choice or price?
  - Organizational Decision-Making practices
  - Analytic Capabilities and Focus of Group
  - Information available

- Most useful, productive method represents a balance between “theory” and “practicality”

- Great accuracy generally illusory, due to many assumptions that must be made

- Much Value in “Options Thinking”
Some References

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