

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**

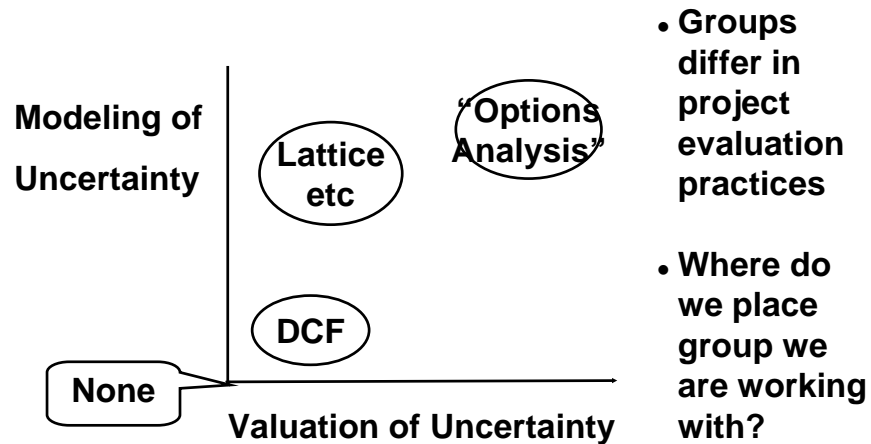
Organizations Differ

- **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 they 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



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

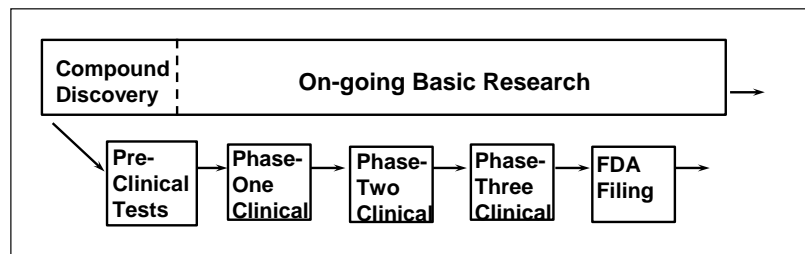
- **Compare “classic” cases at two companies**
 - Good Examples of Factors defining Choices
- **Merck: used financial approach to options**
- **See: Nichols, N.A. (1994) “Scientific Management at Merck: an interview with Judy Lewent,” Harvard Business Review, Jan-Feb, 89-99**
- **Kodak: used decision analysis**
- **See: Faulkner, T.W. (1996) “Applying Options Thinking to R&D Valuation,” Research Technology Management, May-June, 50-56**

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**



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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- **Real Options**, Lenos Trigeorgis, MIT Press 1996
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- **Real Options in Capital Investment**, Trigeorgis, ed. Praeger, 1995
- **Project Flexibility, Agency and Competition**, Brennan and Trigeorgis, eds, Oxford U. Press, 2000
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