Real Options: Overview and Applications

A Presentation in the “New Developments in Finance” Series

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Part One

Introduction
What’s It All About?

The Goals of Real Options Analysis are to:

- Identify Flexibility in Investments, Projects, and Firms
- Value Flexibility
- Integrate Flexibility into Strategic Decision Making
- Manage Risk Inherent in Flexibility
- Increase Returns on Capital

Bottom Line:

- Real Options Analysis Gives Strategic Intuition
  Analytical Rigor and Discipline
Background: What is an Option?

- Financial Contract
  - Right (not Obligation) to buy or sell
- Common in Financial Markets
- They Can be Priced and Evaluated
- Mathematical Models Have Been Developed (1973)
  - Variables affecting value are identified
- A Real Option is an Option on a Real Asset
  - Same methodology can be used for pricing options on real assets
Pricing and Evaluation

- Five Variables of Option Pricing
  - Exercise Price (Cost of Investment)
  - Time (How Long to Exercise?)

- Interest rate
- Asset Value (Market Value)
- Risk or Volatility or Variability
An Example

- Stock Trades at $50
- You Want Option to Buy Stock at $50
- You Can Exercise at the End of One Year
- Interest Rate is 3.5%
- Stock Price Varies by 20% Over the Year
- What’s The Option Worth?

$4.82
Options are Everywhere

The Trick is to Learn to Spot Them
Some Alternatives Are Easy to Spot…

- Option to Buy a Building
- Option to Expand or Contract Leased Space
- Option to Terminate
- Option to Renew
Others Are More Difficult

Options in Developing an Office Park

- Embedded Options Add Flexibility
  - Build office as planned
  - Add a hotel or retail space
  - Develop a park
  - Sell
  - Hold and wait

- Values May Change Over Time
- No Option Has Negative Value
Real Options: A New Way to Think

- Spotting Options
  - New perspective required
- Valuing Options
  - Methodology exists
- Enhancing Options
  - Strategic work
- Exploiting Options
  - The when and how of strategy
  - Flexibility = Opportunity
Who Uses Real Options?

- British Petroleum
- Enron
- Hewlett-Packard
- Chevron
- Airbus Industrie
- Stern Stewart & Co.
- Amazon.com
- Legg-Mason
- Asea Brown Boveri (ABB)
- Agouron Pharmaceuticals
- PowerGen
- Apple Computers
- Anadarko Petroleum
- Merck
Part Two

DCF vs. Real Options
Financial Analysis

- Based on the Concept of Net Present Value (NPV)
- Discount Cash Flows and Subtract Investment
- Resulting in a Single Value (NPV)
- Decision Rule
  - NPV > 0, Accept Project
  - NPV < 0, Reject Project
NPV is Limited

- Time is the Only Dimension
  - Cash flows are forecast and discounted
- No variability to expected cash flows
- Ignores Flexibility in Decision Making
  - External Variables
  - Internal Variables
- Go or No Go decision is Made Immediately
Real Options are Multi-Dimensional

- Time is Not the Only Variable
  - Value of flexibility can be determined
- Probabilities are Included
NPV vs. Real Options

NPV

Investment
PV
Cash Flows

Real Options

Uncertainty
Of Cash Flows

Investment
PV
Cash Flows

Risk Free
Rate

Time to
Expiration
Part Three

Using Real Options
Why Use Real Options Analysis?

- To Spot, Value, Enhance, and Exploit Flexibility
- Flexibility Has Value
- Flexibility Key to Adapting to Change
- Flexibility Key to Competitiveness
Value of Managerial Flexibility

- Right to Renew
- Option to Buy
- Phased Development
- BLT Industries

Flexibility

Uncertainty – Likelihood of New Information

Low

High

Low

High
Flexibility Value is Greatest When:

- High Uncertainty About Future
  - Likely to receive new information over time
- Management has Room to Maneuver
  - Can respond to new information
- Project is Close to Hurdle Rate
  - Decision can go either way
  - Management can preserve flexibility
How to Use Real Options Analysis

- To Strengthen and Guide Overall Strategy
  - Identify Options Embedded in Projects and Investments
- To Guide Real Estate Decision-Making
  - From Raw Land Acquisition to Final Construction
  - Build or Not to Build Decisions
  - Technological Enhancement
  - Lease Evaluation
- To Value Alternative Investments
  - Venture Capital, Direct Investments
- To Value Acquisitions
By Managing Real Options Proactively Management Can Affect Value

- Increase Value of Option
- Extend Option Duration
  - Maintain regulatory barriers
  - Signal ability to exercise
  - Innovate to hold competitive lead
- Increase PV of Cash Flow
  - Develop marketing strategies
  - Develop alliances and JVs
- Reduce Present Value of Fixed Costs

- Monitor Impact of Changes in Risk Free Rate
- Manage Risk
  - Extend opportunity
  - Product innovation
  - Product bundling
- Reduce Value Lost Waiting to Exercise
  - Create barriers to entry
  - Lock up resources
Part Four

Real Options as Strategy
A Real Estate Development Project

<table>
<thead>
<tr>
<th>Real Estate Development Project</th>
<th>in millions</th>
</tr>
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<tbody>
<tr>
<td>Pro-Forma Projections</td>
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<tr>
<td></td>
<td>0</td>
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<tr>
<td>Rent</td>
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<tr>
<td>- Operating Expenses</td>
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<td>- G&amp;A</td>
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<td>Net Operating Income</td>
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<td>Cash Flows</td>
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<tr>
<td>- CapEx</td>
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<tr>
<td>Free Cash Flow</td>
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<tr>
<td>Terminal Value</td>
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<td>Discount Rates</td>
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<tr>
<td>PV</td>
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<tr>
<td>NPV of Project</td>
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## Rearrange the Proformas

### Real Estate Development Project (Rearranged)

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<tr>
<th>Phase One</th>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
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<tr>
<td>10% Discount</td>
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<td>0.909</td>
<td>0.826</td>
<td>0.751</td>
<td>0.683</td>
<td>0.621</td>
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<td>PV</td>
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<td>3.8</td>
<td>3.6</td>
<td>3.4</td>
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<td><strong>Phase One NPV =</strong></td>
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### Phase Two (Expansion Option)

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<td>+ Terminal Value</td>
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<td>51.5</td>
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### In Sum

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<td>4.4</td>
<td>4.2</td>
<td>9.6</td>
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<td>+ Terminal Value</td>
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Focus on the Embedded Option

<table>
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<tr>
<th>Phase Two (Expansion Option)</th>
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<th>2</th>
<th>3</th>
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<th>5</th>
<th>6</th>
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<tbody>
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<td>+ Terminal Value</td>
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<tr>
<td>6% Discount</td>
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<tr>
<td>PV at 10%</td>
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<td>32.0</td>
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<tr>
<td>PV at 6%</td>
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<td>-44.8</td>
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</table>

Phase Two NPV = **-6.4**

New Summary NPV = **-4.4**

PV Years 4 through 6 = **38.4**
Valuation of the Option

<table>
<thead>
<tr>
<th>Investment</th>
<th>B-S Variable</th>
<th>B-S Component</th>
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</thead>
<tbody>
<tr>
<td>PV of Free Cash Flow</td>
<td>$S$</td>
<td>Underlying Price</td>
</tr>
<tr>
<td>Costs of Capital Project</td>
<td>$X$</td>
<td>Exercise Price</td>
</tr>
<tr>
<td>Time to Decision</td>
<td>$t$</td>
<td>Time to Expiration</td>
</tr>
<tr>
<td>Time Value of Money</td>
<td>$R_f$</td>
<td>Risk-free rate of return</td>
</tr>
<tr>
<td>Riskiness of Project</td>
<td>$\sigma$</td>
<td>Standard Deviation</td>
</tr>
</tbody>
</table>
Identifying $S$, $X$, $t$, $R_f$, $\sigma$

$S = \text{Value of the Underlying} = 38.4$
$X = \text{Exercise Price} = 53$
$t = \text{Time to Expiration} = 3$
$R_f = \text{Risk-free Rate of Return} = 6\%$
$\sigma = \text{Riskiness of Project} = 30\% \text{ (assumed)}$

<table>
<thead>
<tr>
<th>Black-Scholes Calculation</th>
<th>BS Value of Option</th>
<th>Phase One</th>
<th>Total Value</th>
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<tbody>
<tr>
<td>$S$ 38.40 $</td>
<td>$ 5.8</td>
<td>$ 2.0</td>
<td>$ 7.8</td>
</tr>
<tr>
<td>$X$ 53.00 $</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>log R 5.83%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t$ 3.00</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$\sigma$ 30.0%</td>
<td></td>
<td></td>
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<tr>
<td>delta 0.00%</td>
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<tr>
<td>$d_1$ -0.0237</td>
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<td></td>
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</tr>
<tr>
<td>$d_2$ -0.5434</td>
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<tr>
<td>$N(d_1)$ 0.490531</td>
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<tr>
<td>$N(d_2)$ 0.293443</td>
<td>= probability that underlying will finish in the money</td>
<td></td>
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</table>
A Portfolio of Real Options…

- Any Number of Projects Can be Analyzed
  - In terms of value
  - In terms of risk
  - In terms of timing
- They Can Then be Assembled into a Strategy
...Can be Arranged to Form a Strategy Based on Value, Risk, and Timing

<table>
<thead>
<tr>
<th>Risk</th>
<th>NPV</th>
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<tbody>
<tr>
<td>Low</td>
<td>Less Than 0</td>
</tr>
<tr>
<td></td>
<td>Never</td>
</tr>
<tr>
<td>High</td>
<td>More Than 0</td>
</tr>
<tr>
<td></td>
<td>Now</td>
</tr>
</tbody>
</table>

Values:
- NPV: Less Than 0, 0, More Than 0
- Risk: Low, High
- Value: Never, Now, Maybe, Soon, Probably, Later