
Real Options, Corporate Performance, and Shareholder Value Creation

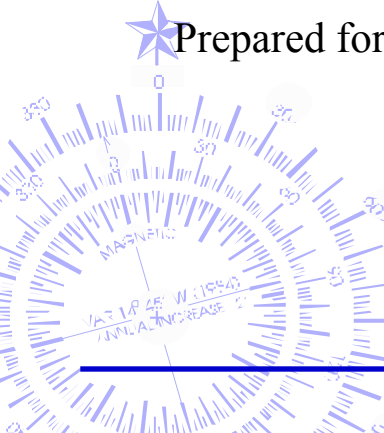
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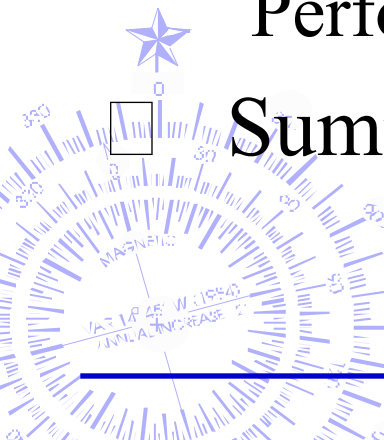
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By: Cyrus A. Ramezani, Orfalea College of Business, California Polytechnic

Overview

- Real options (RO):
 - Definition
 - Basic analytic
 - Taxonomy
 - Applications and perspectives
- Real option and financial characteristics
 - Performance metrics and real options
- Summary and conclusions



Definitions: What Is Flexibility Worth?

- Le Chatlier's principle: unconstrained optimization yields higher optimum than constrained optimization. The difference is the value of removing constraints (flexibility)
- Open loop versus feedback control: in stochastic optimization feedback control results in higher optimum value of the *objective function*. The difference is the value of flexibility
- Flexibility is valuable when there are contingencies and one has the freedom to choose
- **Key point:** Managerial or Operational flexibility is akin to valuable *options*. Managerial flexibility --real options-- can be valued by drawing analogies to financial options

The magic of Black-Merton-Scholes

- Economists had worked on valuing flexibility:

The Putty-Clay and valuation of intangibles

Difficult because it required knowledge of risk aversion

Solution of SDP problems

- Black-Merton-Scholes showed that the value of the flexibility (option) can be derived by replication and no-arbitrage arguments provided that *certain assumptions* were met.

Real and Financial Options: The Analogy

Financial	Feature	Real	Feature
Stock Price Volatility	Traded unobservable	PV of cash flows Volatility	Often Non-traded unknown process
Strike Price	Fixed and observable	Investment costs	Random and born over time
Option Maturity	Fixed and observable	Investment Horizon	Random
Dividend	Random or estimated	Cash flow Leakage	Random
Risk free rate	Short term and observable	Long Term	Term Structure

Taxonomy of Real Options:

Firms Possess the Following Options or Can Acquire Them As Well (Purchase IP, Form Strategic Alliances, Obtain Platforms).

Name	Flexibility	Industry	Comments
Defer / Delay	Ability to wait	Mining and Petroleum	American Option: Intrinsic + Time Value
Stage Investments	Build over time and learn in the process	Biotechnology, drug development	Compound Options
Scale	Expand, Contract, Shutdown, Restart	Crude oil extraction	Barrier and Compound Options
Abandon	Shutdown Permanently Optimal Exit / Entry Decisions	All	American Put Option

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The Usefulness of the Real Options Theory

- A tool for capital budgeting (improves on DCF)
- Useful framework for structuring business decisions
- How important are real options to the value of your firm?
- A method for aligning management's value creation decisions with the market
- ★ The appropriate method for valuing IP and new technology (software, IT expenditures)

Difficulties in Implementation:

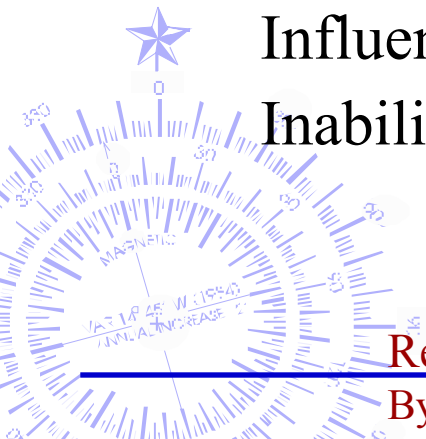
Application of option pricing theory to real investment decisions are problematic:

- Traded versus non-traded underlying: Replication
- Hedging error: rebalancing and transactions costs
- Parameter uncertainty (Does it make the RO more valuable?)
- Redundancy of real options
- Violations of assumptions underlying Black-Merton-Scholes

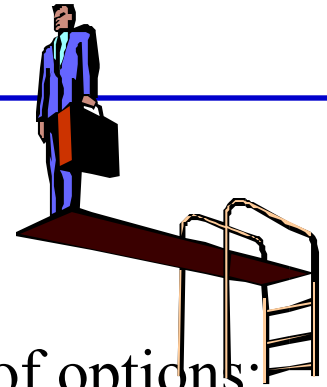
Impact of exercise on underlying process

★ Influence of exercise on firm's other real options

Inability to exercise instantaneously



Difficulties in Implementation:



Managers must optimally manage complex portfolio of options:

- Real options interactions (portfolio effects)

Sequential and strategic exercise is required

- Industry structure matters (competition versus monopoly)

Game theoretic models are needed

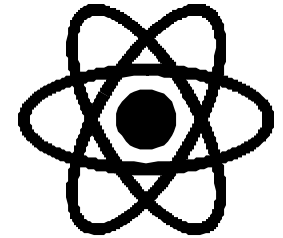
- Multiple sources of risk (input and output prices, quantity, option maturity, size of market, technology) => Ironically

★ added uncertainty enhances the value of real option!

- Path dependency arises

- Simple decision rules are hard to come by!

The Atom Analogy:



Are real options *real* or mere theoretical abstractions ?
How do RO influence corporate performance metrics ?
How do RO impact risk adjusted equity returns?

We need a tool to detect the existence of valuable real options:

- The extant Real Option theory offers logically consistent prescriptions
- The theory also offers testable hypothesis


But real options are hard to observe in practice

- This is much like the early 20th century theory describing the structure of the atom and its family of subatomic particles. Without the creation of particle detectors, the theory could not move forward.



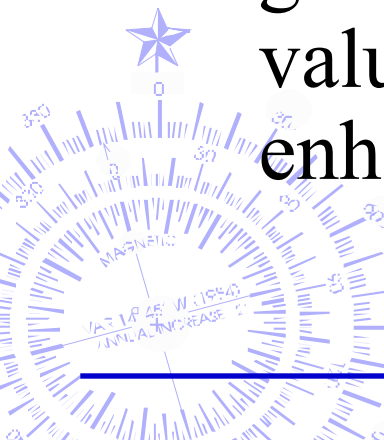
Where Is the Beef ?

Real options are:

- Easy to conceptualise: multitude of managerial flexibility has been identified and valued by risk neutral valuation techniques.
- Hard to detect: do equity prices reflect the value of firm's real options ? how is value realized?
- Performance metrics: how does real option value  affect observable performance metrics (e.g. ROI, ROE, EVA, MVA, and Tobin's Q) ?

Two Key Ingredients to Identifying Valuable Real Options:

- Share holder value creation requires active managerial control (optimal exercise of real options). Managerial flexibility should enhance the value of a firm's real options.
- Uncertainty about the cash flows (revenue) generated by investment projects enhances the value of a firm's real options. Added volatility enhances real option values!



Managerial Flexibility and Uncertainty

		Underlying Uncertainty	
		Low	High
Managerial Flexibility	Low	<i>Low value for real options:</i> Lack of volatility and managerial flexibility reduces value of real options.	<i>Moderate (ambiguous):</i> High option value but lack of discretion to optimally exercise real options.
	High	<i>Ambiguous:</i> Low option value despite managerial flexibility.	<i>High Value for real options:</i> High degree of uncertainty and managerial flexibility enhance value of real options.

Separating the Wheat From the Chaff

- Use the uncertainty-flexibility matrix to identify firms with valuable options:

How is managerial flexibility measured?

How is underlying volatility measured?

- Compare performance measures across groups:



What performance indicators should be used ?

How to interpret the results?

Measuring Managerial Flexibility

- Expenditures on investment activities from the firm's statement of cash flows deflated by
 - Sales
 - Book value of total assets
 - Market value of total assets (net of cash)
- Monopolization creates managerial flexibility
- Research and development creates options
 - R&D deflated by sales or other measures
 - Non-reporting problem

Measuring Uncertainty

What is the underlying risk: Revenue Drivers

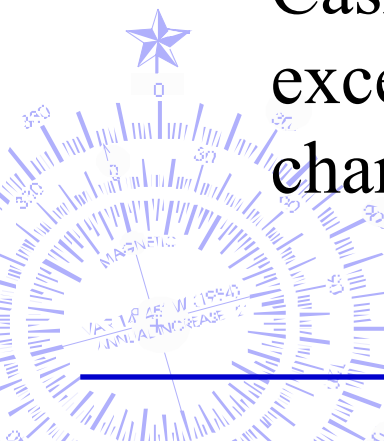
□ Volatility of quarterly sales growth

Calculated from 20 or more quarters of data

□ Volatility of the growth rate of cash flows

Calculated from 20 or more quarters of data

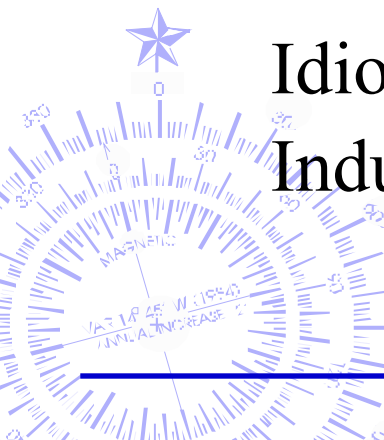
Cash flow: income (after all expenses and taxes except dividends) plus depreciation (non-cash charges for obsolescence)



Measuring Uncertainty (Cont.)

What is the underlying risk?

- Equity as an option on the assets of the firm
 - Volatility of monthly returns (total risk)
 - Calculated from 60 or more months of data
- Returns volatility is decomposed into:
 - Market volatility (CAPM and S&P 500 returns)
 - Idiosyncratic volatility (remove market risk)
 - Industry decomposition is also possible



Performance Measures:

Economic value added (EVA)

EVA = return on capital minus cost of capital

Calculated by methods described in the literature

Market value added (MVA)

MVA = market value (debt + equity) minus value of total capital



"Measure of the wealth a company has created"

Calculated by methods described in the literature

Performance Measures (Cont.):

Tobin's Q

$$Q = (\text{market value of equity} + \text{debt}) / \text{total assets}$$

Similar to market to book

Return on investment (ROI)

Income (before extraordinary items) / total capital

Return on equity (ROE)

Income (before extraordinary) / common equity

Other basic ratios:

P/E, leverage, turnover, liquidity, etc.

Data Source: COMPUSTAT and CRSP (1990 to 2002)

- Sample of consists of over 3000 firms with *clean* data
 - Available data for measures of volatility and managerial flexibility
 - Outliers (1% tail of distribution) replaced by the value of mean (includes outlier) for that SIC code
 - Missing data also replaced with means
- EVA and MVA were calculated
- Other measures (ROI, ROA, etc.) from COMPUSTAT

Searching for Real Option Value:

□ Four measures of managerial flexibility:

Investment cash flow / sales

Investment cash flow / book value

Investment cash flow / market value

R & D / sale

□ Five measures of risk (volatility):

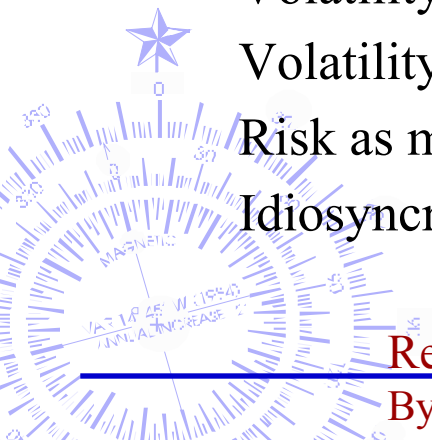
Volatility of quarterly sales growth

Volatility of quarterly cash flows

Volatility of monthly returns

Risk as measured by beta (CAPM)

Idiosyncratic risk (residual of CAPM)



Sorting Firms into Quadrants:

□ Twenty combinations to consider:

(Volatility of Sales Growth) *Versus* (Investment Cash Flow / Sales)

(Volatility of Monthly Returns) *Versus* (Investment Cash Flow / Sales)

Others

Nearly identical results from the 20 combinations

□ Data sorted by the median of variables:

(Volatility of Monthly Returns) *Versus* (Investment Cash Flow / Sales)

HH: Above median for both volatility of monthly returns and investment cash flow to sales

HL, LH, and HH defined in the same manner

Reported results are for Beta, Idiosyncratic, and total risk *versus*

Investment Cash Flow / Sales

Managerial Flexibility *Versus* Uncertainty

Investment Cash Flow / Sales	Flexibility: Low High	Risk: Monthly Returns, Beta, Idiosyncratic	
		Low (below Median)	High (below Median)
		<i>Low value for real options:</i>	<i>Moderate (ambiguous):</i>
		LL	HL
		<i>Ambiguous:</i>	<i>High Value for real options:</i>
		LH	HH

How to deal with the Core (the normal case) ?

Main Industries in HH:

Mining, oil and gas extraction: Alta Gold, Harken Energy, Marine Drilling

Chemicals: Pharmaceutical Preparations: Genentech, Human Genome Sciences

Semiconductor Equipment: Applied Materials, Novellus

Electronic Computers: Apple Computer, Dell Computers, 3 Com, Tellabbs

Semiconductors: JDS Uniphase, LSI Logic, National Semiconductor

 **Communications:** Metrocall, Skytel Communications, Children's Broadcasting, USA Networks

Software: AOL, BARRA, Macromedia

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Main Industries in LL:

- ❑ **Construction:** Engle Homes, US Home Corporation
- ❑ **Food:** Tyson Foods, Best Foods, Heinz, General Mills, Kellogg, Nabisco
- ❑ **Newspaper and Periodicals:** Knight Ridder, New York Times, Times
- ❑ **Plastics Materials, Synthetic Resins:** Du Pont, Dow Chemical, AHP
- ❑ **Pharmaceutical Preparations:** Eli Lilly, Merck, Pfizer, Warner-Lambert
- ❑ **Primary Metals:** USX Steel, Kaiser Aluminum, Olin Corporation
- ❑ **Electronic Computers:** Hewlett Packard, Xerox Corporation
- ❑ **Transportation Equipment:** Northrop Grumman, General Dynamics, Lockheed Martin
- ❑ **General Merchandise Stores:** Neiman Marcus Group, Nordstrom JC Penny, Sears Roebuck, K Mart, Wal-Mart Stores

Main Industries in HL and LH:

- HL: Chemicals:** Genome Therapeutics, Gilead Sciences
 - Communications Equipment:** Digital Microwave, Qualcomm
 - Semiconductor equipment:** Micron Technology
 - Apparel:** Ann Taylor Stores, Talbots
 - Miscellaneous Retail:** Office depot, Sharper Image
 - Direct Mail Advertising:** CMGI
 - Software:** 3DO Company, Adobe Systems

- LH: Oil Extraction / Refining:** Enron, Occidental, Chevron, Exxon, Texaco
 - Food:** Archer-Daniels-Midland, Coca-Cola, Anheuser-Busch
 - Paper:** Georgia-Pacific, Weyerhaeuser, Minnesota Mining & Mfg
 - Pharmaceutical:** Alza Corp, Johnson & Johnson, Schering-Plough
 - Electronic Computers:** Compaq, Sun Microsystems, Cisco Systems
 - Semiconductors:** Intel, Texas Instruments
 - Motor Vehicles:** Ford Motor, General Motors
 - Air Transportation:** American, Delta, United Airlines
 - Computer Software:** IBM, Microsoft Corporation

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Selected Ratios (Table 1): Means

Means	BETA Risk		idiosyncratic Risk		Total Risk	
	HH	LL	HH	LL	HH	LL
Alpha	0.001	0.003	0.004	0.000	0.004	0.001
Beta	1.31	0.46	1.06	0.69	1.10	0.67
InvstmntCF/Sales	0.25	-0.01	0.29	0.00	0.28	0.00
R&D/Sales	0.09	0.04	0.10	0.02	0.10	0.02
Gross Profit Margin	35.05	29.16	33.95	30.13	34.05	30.01
Return on Equity	-7.06	-7.74	-18.73	7.78	-18.44	7.27
Price/Earnings	7.50	10.61	8.02	11.73	8.37	11.81
Market/Book	2.07	1.53	2.00	1.66	2.02	1.66
EVA / Total Assets (average)	-0.01	0.00	-0.03	0.00	-0.03	0.00
MVA / Total Assets (average)	0.07	-0.05	0.32	-0.40	0.30	-0.45
Tobin's Q	2.17	1.62	2.11	1.71	2.12	1.72
PP&E / Total Assets	0.33	0.34	0.38	0.34	0.36	0.34
Growth Rate Book Value	23.73	8.28	25.36	7.83	25.37	7.62
Growth Rate-Sales	25.37	10.61	30.00	8.43	29.81	8.33

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Comparison of Selected Ratios

□ Mean ratios by quadrant (Table 1):

Significant differences between HH and LL

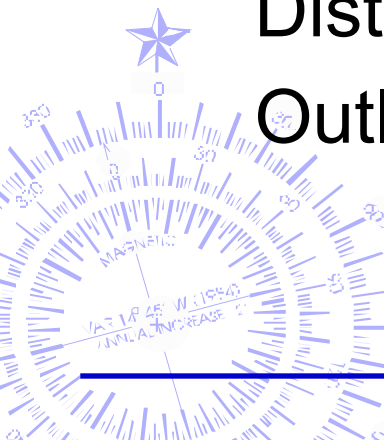
HH group: High growth rate of Book Value and Sales

HH group: High Market/Book and Low P/E

All volatility measures lead to similar sorting

Distribution of variables is highly skewed

Outliers significantly effect the means



Selected Ratios (Table 2): Medians

Median	BETA Risk		idiosyncratic Risk		Total Risk	
	HH	LL	HH	LL	HH	LL
Alpha	0.001	0.004	0.005	0.000	0.005	0.001
Beta	1.20	0.48	0.96	0.65	1.01	0.64
InvstmntCF/Sales	0.16	0.02	0.17	0.03	0.17	0.02
R&D/Sales	0.01	0.00	0.01	0.00	0.01	0.00
Gross Profit Margin	36.93	27.94	36.84	28.18	37.10	27.69
Return on Equity	8.17	7.77	2.62	11.29	2.52	11.29
Price/Earnings	13.37	11.25	7.84	13.74	7.97	13.97
Market/Book	1.55	1.24	1.40	1.31	1.40	1.30
Dividend Yield (Fiscal Yr	0.00	0.00	0.00	0.60	0.00	0.60
WACC	0.13	0.08	0.11	0.09	0.11	0.09
EVA / Total Assets (aver	-0.02	0.00	-0.03	0.00	-0.03	0.00
MVA / Total Assets (aver	0.27	-0.13	0.27	0.03	0.27	0.17
Tobin's Q	1.72	1.35	1.62	1.39	1.64	1.39
PP&E / Total Assets	0.30	0.20	0.25	0.25	0.24	0.24
Growth Rate-Book Value	18.39	5.93	19.83	5.93	19.64	5.75
Growth Rate-Sales	16.94	6.55	20.50	6.30	20.34	6.17

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Comparison of Selected Ratios

- Median ratios by quadrant (Table 2):
 - More significant differences: HH versus LL
 - High growth rate of Book Value and Sales: HH
 - HH group: High Market/Book and High P/E
 - Volatility measures lead to different sorting
 - Performance measures reflect Real Options
- Expanded comparisons are provided in the appendix (Tables 1A and 2A)

Comparison Based on Regression:

- Conditional versus Unconditional means
- Cross-Sectional Regression Model:

$$\text{Performance Measure} = a + \sum B_i X_i + \epsilon_i$$

Where:

PM: Tobin's Q, EVA, MVA, ROE, ROI

Conditional Mean: a

Control Variables:

X_i

B_i

Coefficient:

ϵ_i

Residual (heteroskedastic):

Regression Analysis: EVA/Assets and Tobin's Q

Variable	EVA	EVA	TQ	TQ
	HH	LL	HH	LL
CONSTANT	-1.179 *	0.004	0.706 *	0.443 *
Beta	-0.547 *	-0.490 *	0.169 *	0.072
Invstm ntCF/Sales	0.789 *	0.235	0.181	-0.117
R&D/Sales	0.204	-0.229	2.021 *	2.549 *
Cap Expend/Net Assets	3.003 *	-1.007	0.298	3.490 *
Acquisitions/Net Assets	1.184	-0.775	-1.569 *	-0.125
Volatility of Cash Flows	0.005 *	0.001 *	0.000	0.003 *
Total Asset Turnover	0.367 *	0.084 *	0.444 *	0.140 *
Total Debt/Total Equity	0.001 *	0.000	-0.001 *	0.000
Dividend Yield (Fiscal Yr)	0.031	0.025	0.030	-0.017
Gross Profit Margin	0.009 *	0.001	0.006 *	0.018 *
Growth Rate-Sales	0.000	0.006 *	0.007 *	0.012 *
Price/Earnings	0.000	0.000	0.003 *	-0.001 *
Quick Ratio	-0.077 *	-0.075 *	0.112 *	0.001
Return on Equity	0.003	-0.006 *	-0.003 *	-0.002
Return on Investment	0.027 *	0.035 *	0.004	0.023 *
PP&E / Total Assets	0.025	-0.012	-0.016	-0.143
Adjusted R-Squared	0.3	0.27	0.25	0.34

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Regression Summary:

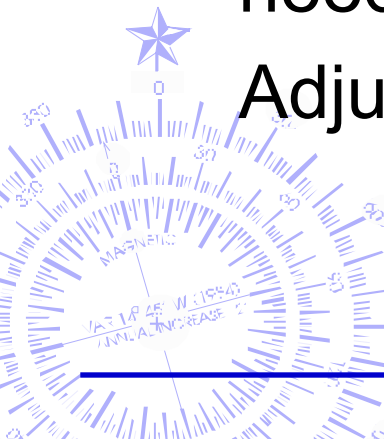
□ Regression Results Show that:

The Conditional mean of the Performance Measures are significantly different for each quadrant

The coefficient of control variables are also very different

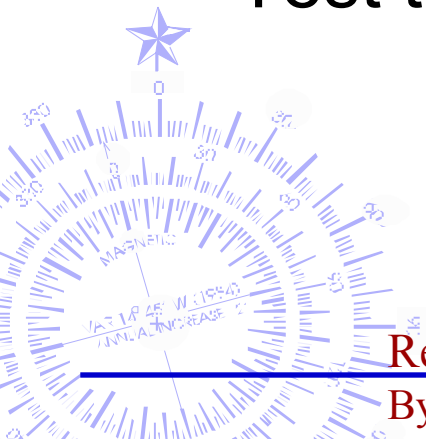
Statistical tests indicate that a different model is needed for each quadrant

Adjusted R-squared range: 0.20 to 0.67



Further Enhancements:

- The regression model will be improved:
 - Pool time series-cross section data
 - Make correction for heteroskedasticity
 - Expand the list of explanatory variables
 - Remove the normal *core*
 - Assess the influence of outliers
 - Test the robustness of results



Summary and Conclusions

- We considered how the existence of Real Options affect financial measures of firms' performance
- We find that performance measures for firms with valuable real options are significantly higher
- Financial Ratios seem to reflect the value of firms' real options