

# FINANCIAL ENGINEERING RESEARCH AND PRACTICE

Presented By:

**JOHN O'BRIEN**

Director, Master in Financial Engineering (MFE)  
and Adjunct Professor

University of California, Haas School of Business  
*obrien@haas.berkeley.edu*



# Financial Engineering Research

- Financial engineering is the application of financial economics, mathematics, computer technology, and the scientific method to the optimal sourcing, utilization, and protection of financial assets.
- Theoretical financial engineering research is carried on at universities around the world. The seminal research leading to the Black/Scholes/Merton option's pricing formula was completed at MIT in the early 1970s. This result marked the birth of financial engineering.



# Financial Engineering Research (2)

- At roughly the same time as the theoretical work on option's pricing was being done at MIT, Harry Markowitz at the U. of Chicago and the Rand Corporation, and Bill Sharpe at Rand and UCLA were developing a second line of financial engineering research— risk analysis, portfolio optimization, and asset pricing.
- Also at roughly the same time, Gene Fama at the U. Of Chicago formulated the efficient market hypothesis (EMH). The EMH is the proposition that an asset's current price fully reflects all publicly available information about future economic fundamentals affecting the asset's value.



# Financial Engineering Practice

- Developmental research and practice, or financial engineering, exploded on to the scene in the early 1970's driven by the prior theoretical research.
- Numerous applications of option's pricing theory were pioneered at the major U.S. investment banks, notably Goldman Sachs and Morgan Stanley, and at the private firm Leland O'Brien Rubinstein (LOR). Structured products such as equity enhanced fixed income, and portfolio "insurance" were principal among these developments.



# Financial Engineering Practice (2)

- Barr Rosenberg at UC Berkeley, later at Barr Rosenberg Associates (now BARRA), and the firm of O'Brien Associates (now Wilshire Associates) pioneered a series of portfolio optimization and risk analysis services that changed portfolio management from largely an art into a significantly quantitative activity.
- At Wells Fargo Bank (now at Barclays Global Investors, or BGI) Index Funds were born. Later LOR extended this idea to exchange traded funds (ETFs). Now Index Funds and ETFs are among the largest pools of equity assets in the world.



# Financial Engineering Practice (3)

- JP Morgan pioneered Value-at-Risk (VaR) to quantify the risk of a bank's asset portfolios.
- VaR was extended to industrial firms in the form of currency risk management and enterprise-wide risk management.
- Various forms of “asset-backed” bonds were created, most notably mortgage-backed bonds.



# Financial Engineering Practice (4)

- Catastrophe, or CAT, bonds were developed covering weather, earthquake, and other naturally occurring catastrophes.
- Credit derivatives now allow one to manage default risk.



# Valuing the Impact of Financial Engineering

- The immediate result of a financial engineering effort is often a specific recommendation or product. An example would be the use of a Put Option to protect a risky portfolio.
- The expected return of a protected portfolio is less than that of an unprotected risky portfolio – where is the value?



# Valuing the Impact of Financial Engineering (2)

- The value comes from the willingness of an investor to put money into the risky portfolio in the first place, or in his willingness to place more money into the protected portfolio than the unprotected one.
- This value is measured by the expected return of the investor's aggregate portfolio with protection, relative to the expected return of the investment-weighted sum of the investor's separate assets without protection.



# Valuing the Impact of Financial Engineering (3)

- Value Proposition: The value of a financial engineering effort is measured by its improvement to the enterprise as a whole, and not by the value of the effort in isolation.



# Profitability of a Firm

- The profitability of a firm is determined by two principal factors:
  1. Industry structure, which determines the profitability of the average firm in the industry; and
  2. Sustainable competitive advantage, which determines how a particular firm within the industry performs relative to the average firm in the industry.



# Profitability of a Firm (2)

- The key determinants of an industry's profitability are: intensity of competition, barriers to entry, threat of product substitution; bargaining power of suppliers; and the bargaining power of customers.
- The key determinants of sustainable competitive advantage are: ability to operate at a lower cost, and the ability to command a premium price through higher quality or product differentiation.



# Financial Engineering and a Firm's Profitability

- Analyzing industry structure is an exercise in financial economics. Global industries are not engineered, but result from the independent decisions of many entities to enter into, or not, a particular activity. As yet, financial engineering has not made a distinct contribution in this area.



# Financial Engineering and a Firm's Profitability (2)

- Financial engineering has made distinct contributions to analyzing and affecting sustainable competitive advantage. Financial engineering's contributions have been in the areas of sourcing of capital, allocation of capital, and risk management. Identifying opportunities for sustainable competitive advantage can affect the decision of a firm to enter an industry.



# Financial Engineering and the Sourcing of Capital

- Capital Structure
  - The well known and pioneering work of Miller and Modigliani outline the basic tenants of capital structuring in the absence of taxes and default risk.
  - Financial engineering has shown how derivatives can be used to minimize taxes, and manage default risk; thus reducing the cost of capital. Shifting income among taxing authorities using options, and credit derivatives are two examples.



# Financial Engineering and the Sourcing of Capital (2)

- Raising Capital
  - Common stock and bonds are the basic securities for raising capital. They access the two basic types of investor preference.
  - Financial engineering has vastly broadened the span of investor preferences that can be met, thus reducing the cost of capital. Examples are convertible bonds, catastrophe bonds, asset-backed bonds, a bond with various types of warrants attached, stock with Put or Collar options attached, etc.



# Financial Engineering and the Allocation of Capital

- Investment decisions involve evaluation under uncertainty. The flexibility to decide on a course of action, as the uncertainty is resolved, has measurable, and often major, value. Options pricing theory provides the means for assessing that value. This discipline is known as Real Option analysis.



# Financial Engineering and the Allocation of Capital (2)

- The benefits of Real Option analysis derive from:
  - Structuring the analysis as a sequence of decisions, and not a single current decision
  - Clarifying the role of uncertainty at each stage of the analysis
  - Quantifying the present value of future decisions



# Financial Engineering and the Allocation of Capital (3)

- Principal sources of value in a Real Option are:
  - To initiate, or expand, now or to wait
  - To abandon, or contract, now or to wait
  - To build or to contract out
  - To slow down or speed up development
  - To build large capacity or sequence smaller capacity units
  - To hold back, produce, or license



# Financial Engineering and the Allocation of Capital (4)

- Real Option analysis is a new discipline, but already it has proven particularly valuable in the oil, drug, and movie industries. The role of Real Option analysis is likely to grow substantially as it becomes more widely understood.



# Managing Risk

- A firm's cost of capital is proportional its non-diversifiable risk.
- Investors can diversify some risks of owning a firm, but not other risks.
- The firm must decide which risks to diversify, insure, hedge, or to simply bear.



# Managing Risk (2)

- Financial engineering provides a broad set of tools for evaluating and implementing risk management. Examples include asset portfolio diversification (optimization), hedging the price-risk of factors of production (power, raw materials), hedging the income stream (currency translation), hedging the sources of capital (interest rates, market levels), hedging supplier or customer default (credit derivatives), and many others.



# Concluding Comment

- Financial engineering will grow in global importance due to:
  - The globalization of production and distribution.
  - The drive for increased economic efficiency.
  - The universality of money.



# Interested in a Deeper Understanding of Finance?

- **Master's in Financial Engineering Program (MFE)**
  - 12 Month program leading to a Master of Financial Engineering degree from U.C. Berkeley.
  - [www.haas.berkeley.edu/MFE](http://www.haas.berkeley.edu/MFE)
- **Financial Investment Technology (F.I.T.)**
  - 7 January – 1 February, 2002
  - One-month intensive course in quantitative financial economics leading to an F.I.T. Certificate.
  - [www.haas.berkeley.edu/finance/FIT](http://www.haas.berkeley.edu/finance/FIT)
- **Berkeley Program in Finance (BPF)**
  - Twice yearly, two-day seminar in contemporary issues in finance.
  - [www.haas.berkeley.edu/BPF](http://www.haas.berkeley.edu/BPF)

