

Introduction to Financial Engineering

What is Financial Engineering (FE)?

- The discipline of **financial engineering** includes applications of mathematical, statistical modeling and computational technology to problems in the financial industry and financial management of non-financial organizations.
- FE involves design and development of financial products, strategies, and systems to meet the needs of financial institutions, corporations, governments, and households.

Financial Engineering Application Areas

- Financial risk management for financial institutions, corporations, and public institutions (from hedging risks of individual transactions to enterprise-wide risk management systems)
- Derivative securities (contract design, pricing, market making, and investment, trading, and hedging applications)
- Modeling stochastic dynamics of stock prices, interest rates, foreign exchange rates, commodity and energy prices
- Asset/liability management technology for corporations, banks, pension funds
- Credit risk modeling and management and credit derivatives
- Energy industry and energy derivatives
- Real options: valuing businesses and strategic managerial decisions by applying option pricing technology

Some Factors that Drive the Growth of Financial Engineering

- **Increasing Volatility of Global Financial Markets and the Need for Risk Management**
 - Volatility of equity prices, foreign exchange rates, commodity and energy prices, and interest rates increased dramatically over the past three decades
 - Higher volatility increases risk (as well as more opportunities)
 - **Risk Management** is crucial to the survival and competitiveness of organizations
- **Global Nature of Financial Markets**
 - Multinational firms produce, market, and obtain financing globally
 - Every multinational firm has significant risk exposures to foreign currencies, domestic and foreign interest rates, energy and commodity prices, and global equity prices

- **Information Technology**

- Advances in information technology drive the growth of financial engineering. Real-time worldwide information and data collection, analysis, decision-making, and trading are made possible.
- Securities trading goes electronic and moves from exchange floors into cyberspace.
- Banks are the biggest users of information technology!

- **Goals of this Course**

- Provide an introduction to the field of financial engineering
- Develop theoretical foundations of financial engineering
- Study some of the most important products and applications of financial engineering
- Develop practical modeling skills

INTRODUCTION TO DERIVATIVES

What is a Derivative?

- A derivative is a financial contract between two parties that specifies conditions - in particular, dates and the resulting values of underlying variables - under which payments or payoffs are to be made between the parties (payments can be either in the form of cash or delivery of some specified asset).

Examples

- A **Forward contract** is a contract to buy some pre-specified underlying asset at a predetermined price (delivery price) on a specified date in the future.
- **Call and Put Options**
 - A *call option* is a contract that gives its holder *the right but not the obligation to buy* some specified quantity of an underlying asset (e.g. fixed number of shares of stock of a particular company) at a

predetermined price (*strike price*) on or before a specified date in the future (*option expiration*).

- A *put option* is a contract that gives its holder *the right but not the obligation to sell* some specified quantity of an underlying asset (e.g. fixed number of shares of stock of a particular company) at a predetermined price on or before a specified date in the future.

Underlying assets or variables in derivatives

- Stocks and stock market indexes
- Commodities (e.g., oil, gas, coal, gold, silver, aluminum, copper, corn, wheat, soybeans, paper)
- Bonds
- Interest rates
- Exchange rates
- Credit events (defaults)
- Economic variables (e.g., inflation)

There are two types of derivatives:

- **Exchange-traded:**
 - Futures
 - Options
- **Over-the-Counter (OTC):**
 - Forward contracts
 - Swaps
 - CDS

The size of the global derivatives market

The derivative market is huge: the notional outstanding value of derivatives is equal to several hundreds trillions US dollars and it is still growing!

The notional outstanding value of

- **OTC contracts** (4Q 2009): *\$615 trillions*
 - FX contracts: *\$50 trillions*
 - Interest rate contracts: *\$450 trillions*
 - CDS contracts: *\$33 trillions*
 - Equity-linked: *\$6.5 trillions*
 - Commodity-linked: *\$3 trillions*

- **Exchange-traded** (1Q 2010):
 - **Futures:** *\$346 trillions*
 - **Options:** *\$168 trillions*

(Source: www.bis.org)

Types of Derivatives Traders

- **Hedgers**

- Objective: reduce risks they already face in the course of their business.

- **Investors/Speculators**

- Objective: profit from taking directional/speculative positions on the future market direction.

- **Arbitrageurs**

- Objective: find arbitrage opportunities to realize “riskless” profits.