Financial Engineering and Risk Management

Course Overview

Martin Haugh   **Garud Iyengar**

Columbia University
Industrial Engineering and Operations Research

Why financial markets?

Financial markets enable efficient allocation of resources

- across time
- across states of nature

Young worker with a high salary. What should she do?

- Financial markets: invest in stocks and bonds to finance retirement, home ownership, education, etc.
- No financial markets: consumption? what else?

Farmer producing oranges.

- Financial markets: Hedge using futures markets, weather related derivatives.
- No financial markets: only the spot market available.

More on markets and products

Role of Markets

- Gather information
- Aggregate liquidity i.e. supply and demand
- Promote efficiency and fairness

Products: satisfy "needs"

- Hedge risk
- Allow speculation
- Raise funds
- Fund liabilities

Modeling financial markets

Two kinds of market models

- Discrete time models
  - Single period models
  - Multi-period models
- Continuous time models

Pros/Cons of discrete time models

- Pros: All important concepts with less sophisticated mathematics
- Cons: No closed form solutions ... have to resort to numerical calculations.

Focus of this course: Discrete time multi-period models

Caveat: Very, very few continuous time concepts covered, e.g. the Black-Scholes formula.

Financial Economics vs Financial Engineering

Financial Economics: Use equilibrium arguments to

- Price equities, bonds and other assets
- Set interest rates

Financial Engineering: Assume prices of equities and interest rates given

- Price derivatives on equities, bonds, interest rates, etc., using the no-arbitrage condition

Not even close to being a complete separation

- For example, Capital Asset Pricing Model of interest to both

Central problems of FE

Security pricing

- Primary securities: stocks and bonds ... financial economics
- Derivative securities: forwards, swaps, futures, options, on the underlying securities.

Portfolio selection: choose a trading strategy to maximize the utility of consumption and final wealth.

- Intimately related to security pricing
- Single-period models: Markowitz portfolio selection
- Real options, e.g. options on gas pipelines, oil leases, mines.

Risk management: understand the risks inherent in a portfolio

- Tail risk: probability of large losses
- Value-at-risk and conditional value-at-risk
- Starting to become important for portfolio selection as well.

Led to interesting applied math / operations research problems.