MA668: Algorithmic and High Frequency Trading
Lecture 01

Prof. Siddhartha Pratim Chakrabarty
Department of Mathematics
Indian Institute of Technology Guwahati

About the Course

1. Ties together:
   - A. Basic economics.
   - B. Empirical foundations of high-frequency data.
   - C. Mathematical tools and models to create a balanced perspective of algorithmic and high-frequency trading.
2. Prerequisites:
   - A. Expected: Basic knowledge of continuous time finance.
   - B. Not expected: Knowledge of stochastic optimal control stopping.
3. The textbook is organized into three parts:
   - A. Basic elements of electronic markets to the economics behind them.
   - B. Relevant mathematics.
   - C. Models and problems of algorithmic trading.

A Prelude

To understand how electronic markets work, we must first understand the context in which trading in financial markets occurs. Accordingly, we will consider the following:

1. Short discussion on: Stocks/preferred stocks/mutual funds/hedge funds.
2. Market participants: Noise traders, informed traders/arbitrageurs, market makers.
3. Structure of electronic exchanges, Limit Order (LO), Market Order (MO) and Limit Order Book (LOB), fees.
4. Construction of LOB.

Shares and Bonds

1. Shares:
   - A. "Shares" are claims of ownership on corporations, claims which are used by corporations to raise money.
   - B. For shares to be traded in an electronic exchange, they have to be "listed" in an exchange, a process to the first issuance of the public shares (Initial Public Offerings (IPO)).
   - C. Shares are a claim of ownership of the company that gives the owner the rightful shares of the company's profit and to be a part of the corporation's decision process through voting at the Annual General Meeting (AGM).
   - D. Such shares are called "ordinary shares" or "common stock".
2. Bonds:
   - A. The other primary instrument used by corporations to raise capital are "bonds" by which the corporation commits to paying the holder a regular income (interest) but gives them no decision rights.

Shares and Bonds (Contd ...)

Shareholders	Bondholders
No guarantee about dividends	Guaranteed pre-determined payments
Have voting rights	No voting rights

Table: Shareholders versus Bondholders

1. Preferred stocks derive characteristics from both these types of contracts *i.e.,* it is a hybrid of stocks and bonds.
   - A. Receive a pre-arranged income, but has fewer guarantees.
   - B. Legal treatment like equity.
   - C. No voting rights.

The Asset Classes

Financial contracts are separated into different asset classes:

A. Equities: Shares, preferred stocks.
B. Debts: Bonds, money market accounts, savings account, Treasury bills.
C. Exotics: Foreign exchange, commodities, real estate.
D. An investor will find these different asset classes in electronic exchanges, usually in the form of specialized securities such as mutual funds (actively managed) and exchange traded funds (ETFs) (passively managed).

Mutual Funds

1. Mutual fund is an investment product that acts as a delegated investment manager.
   - A. The investor, by buying units of a mutual fund gives money to a financial management company, whose primary objectives are funds' asset management and investment strategy, and of course, management fees.
   - B. Investment strategy: Actively managed or passively tracks an index.
2. An investor of a mutual fund participates in both appreciation and depreciation. For redemption, the investors' choice depends on the type of fund:
   - A. Close-end funds: The fund sells shares initially through an IPO, which are then listed on exchange for purchase/sale, and are not redeemable on a continuous basis.
   - B. Open-end funds: Shares can be created or bought back for investors wishing to redeem (process takes place once a day). Accordingly, the Net Asset Value (NAV) is determined after the market closes.

Exchange Traded Funds (ETFs)

1. Like mutual funds, ETFs act as delegated investment managers, but they differ in certain aspects:
   - A. They tend to have very specific investment strategies, usually geared towards generating the same returns as a particular market index.
   - B. Not obligated to purchase the shares back. Instead the fund can transfer to the investor a basket of securities that mirrors that of an ETF.
   - C. Investors looking for diversified investments, but reduced trading costs prefer ETFs.
   - D. Note that: Investors looking for skilled managers such as for stock picking prefer mutual funds.

Hedge Funds and Other Securities

1. Hedge funds are funds that pursue more aggressive trading strategies and have fewer regulatory and transparency requirements.
2. Because of lesser regulatory oversight, access to hedge funds is largely limited to accredited investors.
3. There are other securities traded in electronic exchanges, especially derivatives such as futures, options and swaps.

Classifying Market Participants

Let us consider specific objectives, in addition to making money:

1. Shares: One type of participant is corporate managers, who will create some of the assets that are traded in the exchange, and who will at times, actively participate in the market by increasing or reducing the supply of their corporate shares.
2. Funds: Manage large number of financial contracts, are very active in electronic exchanges and originate a substantial fraction of the trading observed in exchanges.
3. Proprietary traders: They trade their competitive advantage, be it identifying fundamentally mispriced assets, identifying price momentum or sentiment based price changes, have special technical abilities etc.

Primary Classes of Traders

We differentiate between three primary classes of traders:

1. Fundamental (or noise or liquidity) traders: Those who are driven by economic fundamentals outside the exchange.
2. Informed traders: Traders who profit from leveraging information not reflected in market prices, by trading assets, in anticipation of their appreciation or depreciation (May include arbitrageurs, which sometimes is considered as a separate class).
3. Market makers: Professional traders who profit from facilitating exchange in a particular asset and exploit their skills in executing trades.

A Few Observations

1. Noise trading: Trading that is orthogonal to any events driving market prices.
2. Liquidity trading: Trading driven by the need to liquidate or accumulate a position for liquidity resources orthogonal to market events.
3. Fundamental trading: Usually reserved for traders having medium-term and long-term investment strategies.
4. Market makers: Profits from detailed knowledge of the trading process and adapts to the market, as circumstances change.
5.
   - A. Fundamental: Active/Aggressive trading.
   - B. Informed: Active/Aggressive trading.
   - C. Market makers: Passive/Reactive trading.

Trading in Electronic Markets

A way for people to signal their willingness to trade, and a matching engine to match those wanting to buy and those wanting to sell.

Orders and the Exchange

An electronic market has two types of orders:

1. Market Order (MO):
   - A. These are usually considered aggresive orders that seek to execute a trade immediately.
   - B. Sending an MO, means a trader wants to buy/sell a certain quantity of shares at the best available price and will (usually) result in an immediate trade (execution).
2. Limit Order (LO):
   - A. These are considered as passive order.
   - B. A trader sending in an LO indicates the desire to buy/sell at a given price up to a certain maximum quantity of shares.
   - C. Since the price offered in an LO is usually worse than the current market price, it will not result in an immediate trade.
   - D. Consequently, it will have to wait until it is either matched with a new order (and executed) or it is withdrawn (cancelled).