SYLLABUS

IEOR E4733 – Algorithmic Trading

Term: Spring 2016
Department: Industrial Engineering and Operations Research (IEOR)

Instructor: Iraj Kani (ik2133@columbia.edu)
TA: TBA

References:


Market Microstructure Theory, Maureen O’Hara, Blackwell Publishing 1995


Requirements: Basic understanding of financial markets and trading strategies, concepts and environment is recommended. Knowledge of stochastic processes, time series models and econometric analysis is also recommended. Knowledge of Matlab, S / S Plus / R or other statistical analysis software is also recommended.

Assignments and Grading: There will be 6-8 homework assignments and a group project that together determine the grade for this course. Homework assignments may involve implementation in MATLAB or other environments (e.g. Excel/VBA). All assignments and the project will involve groups of 3-5 students based on the class size. Grades are individually assigned, based on performance on assignments (65%), the group project write-up and presentation (25%), and class participation (10%).

Office Hours: There will be weekly office hours by each TA, with location and other details to be announced during the first session of the course.

Course Website: Courseworks (E4733)
Course Description

During the past few decades financial markets have undergone a rapid expansion due to increases in computer power and proliferation of trading algorithms. At the same time there has been a significant increase in the number of trading venues, and alternative trading mechanisms and protocols. All this has led to the development of a number of new and novel quantitatively-driven investment styles, mostly based on automated computer-driven trading strategies executed on electronic platforms.

Microstructure is the study of trading mechanisms used for exchanging financial assets, and examination of processes and outcomes of such exchanges under specific trading rules. Microstructure studies examine the nature and consequences of different trading mechanisms, and explore how different trading protocols affect price formation, and why asset prices exhibit particular time series properties they do. In this course we will review the foundations of securities trading and market microstructure. We will review important models in the microstructure and present mathematical tools in their structural and statistical representations. We will discuss applications of univariate and multivariate autoregressive time series analysis to trades prices and order flows, and examine their economic underpinning arising from asymmetric information, inventory control and strategies of participants.

We will also discuss the costs associated with trading, how these costs are measured and strategies that minimize them, including the study of models for optimal splitting of the orders across time, to reduce transaction costs and control the temporary and permanent price adjustments that result from trades.

Course Outline

Foundations of Securities Trading and Market Microstructure

Nature of Markets and Prices

1. Sources for Value and Reasons for Trading
2. Mechanisms for trading
3. Liquidity and Transparency
4. Econometric Issues

Trading Mechanisms, Markets and Market Making
1. Limit Order Markets, Floor Markets, Dealer Markets
2. Auctions, Crossing Networks and Other Trading Mechanisms
3. Examples: NYSE and NASDAQ Markets

**Univariate Time Series Analysis**

1. Stationarity and Ergodicity
2. Moving Average Models
3. Autoregressive Models
4. Forecasting, Filtering, and Model Estimation
5. Wold Theorem

**Information- and Inventory-Based Microstructure Models**

**Information-Based Model**

1. Informed Traders and Uninformed Traders
2. Roll Model of Trade Prices
3. Random Walk Model of Security Price
4. Roll Model of Bid, Ask and Transaction Prices

**Sequential Trade Model**

1. Trade Quantities and Price Behavior
2. Simple Sequential Trade Model
3. Market Dynamics: Bid and Ask Quotes Over Time
4. Order Flow and Probability of Informed Trading
5. Distributions of Buys and Sells
6. Event Uncertainty and Poisson Arrivals

**Strategic Trade Models**

1. Strategic Behavior of Informed Traders
2. Strategic Behavior of Uninformed Traders
3. Link between Strategic and Sequential Trade Models

**Generalized Roll Model**

1. Structural Model and Its Statistical Representation
2. Forecasting and Filtering
3. General Univariate Random Walk Decompositions
4. Identification in Random Walk Decompositions

**Multivariate Linear Microstructure Models**
1. Modeling Vector Time Series
2. Structural Model of Prices and Trades
3. Forecasts and Impulse Response Functions
4. Random Walk Decomposition in Multivariate Models
5. Other Structural Models

**Multiple Securities and Multiple Prices**

1. Stacked Model of Multiple Prices
2. The Structural Model
3. VMA Representation
4. VAR Representation
5. Cointegrated Prices and VECM Specification

**Inventory Models**

1. Order Arrival and Market Making
2. Market Maker’s Ruin Problem
3. Risk Aversion and Dealer’s Problem
4. Empirical Analysis of Dealer Inventories
5. Dynamics of Prices, Trades, and Inventories

**Market Depth**

1. Market Structures and Liquidity Providers
2. Limit Order Book Price Schedules
3. Competitive Dealer Market, Limit Order Market and Monopolistic Dealer

**Trading Costs and Optimal Trading Strategies**

**Transaction Costs**

1. Component Transaction Costs
2. Implementation Shortfall
4. Optimal Trading Strategies

**Trading Benchmarks**

1. Benchmark Prices, BAM and VWAP
2. VWAP Trading Strategies
3. Models of Order Slicing and Timing

**High Frequency Trading Strategies**
Evolution of High Frequency Trading

1. Comparison with Traditional Approaches to Trading
2. Evaluating Performance of High Frequency Strategies
3. Market Efficiency and Trading Opportunities at Different Frequencies

High Frequency Strategies

1. Trading on Microstructure: Inventory Based and Information Based
2. Event Arbitrage Strategies
3. Statistical Arbitrage Strategies
4. Managing Portfolios of High Frequency Strategies