New York University Polytechnic Institute Spring 2018
Instructor: Asha P. Matthei
Grader: TBA

Quantitative Trading Strategies: FRE 7801 (1.5 Credit Course)

Mondays 5:30 pm to 8:41 pm

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Course Objective

Build an automated trading system with quantitative methods and machine learning techniques.

Studying and implementing quantitative trading strategies, risk management and portfolio management tools. Selected models will be presented and studied in class. The practical aspects of the implementation of strategies will be discussed including the statistical estimation of the parameters, back-testing and performance assessment. Examples with real data will be presented.

Students are expected to read extensively, work out examples and implement algorithms using statistical software (Python is recommended). Please meet with the instructor for assistance with any of the topics or to pursue in-depth research on related topics of specific interest.

Slides, relevant course readings and solutions to past assignments will be posted in NYU Classes. Reading materials ahead of course meetings helps students participate actively in class. Additional readings may be posted in NYU Classes for better understanding of topics.

Bloomberg article on AI in trading

Research/Career Focus

Quantitative trading has been around for about seventy years but is more important than ever in the current market environment. Becoming a quant requires understanding and skills in a variety of different fields that include business, finance, statistics, mathematics, computer science and economics. The lectures will equip the students to actively pursue advanced research or seek careers in the area.

Prerequisites

Strong interest in working with mathematical finance and its business applications. Basic understanding of financial markets and related concepts. Understanding of machine learning strategies will be beneficial. Working knowledge of stochastic processes, times series models and econometric analysis. Proficiency in Python/Matlab/ R or another statistical analysis software is recommended. Data download using Bloomberg and Reuters API functions.

Schedule and Grading

Classes held every Monday. Projects and assignments discussed in class.
Assignments and mid-term will count towards 40% of the student's final grade.
Class participation and attendance contribute to 10% of the final grade.
Final project (proposal submission, teamwork, presentation in class and report) - 50% of the final grade.

Students are encouraged to work in groups of three and choose from a selected pool of project topics. The groups implement the models (based on selected project topic), submit a report and make a presentation on their project in the last class. Instructor will be available for assistance.

Course Outline

Class One

Objective of Class One is to understand the concept of "quantitative trading systems", its components (mainly alpha generating strategy) and the areas of focus for the rest of the semester. Final projects, types of assignments and grading systems will be discussed. The following topics will be covered:

- Introduction – History of the industry and Definitions in quantitative trading, a simple overview of the existing models and the challenges.
- Performance evaluation of portfolios and walk-through worked out examples.

Following topics will be discussed along with working examples: Calculating returns for a portfolio, measuring a portfolio's performance using performance ratios (Sharpe ratio, Treynor ratio, Jenson's alpha), risk metrics for large portfolios, using an index to track performance and also performance attribution analysis. Examples will be worked out in class to equip the students for the assignment which will cover all discussed topics.
Familiarization with firms that actively participate in systematic trading.

References:

1. Readings posted under Class One Resources NYU Classes.
2. PowerPoint slides
3. Seeking Alpha: risk-reward profiles of strategies
4. Tsay, R.S. Analysis of Financial Time Series. Chapter One.

Class Two

Objective of Class Two is familiarization with the necessary statistical and analytical methods for researching and start working on their final projects. Regression analyses, time series models, machine learning strategies applied in trading are discussed and implemented. Following topics will be covered:

- Working model of performance attribution for large portfolios, setup of relevant benchmark, rebalancing, drawdown, value at risk,
- Example setup of a simple strategy – prototype in Excel and working model implementation in R (moving average strategy),
- Familiarization with regression analyses and interpretation of statistical measures,
- Time series analyses and forecasting in automated trading,
- Machine learning techniques applicable for trading strategy development.

References:

1. Chatterjee Hadi (2006), Regression Analysis by Example. Chapters One through Nine are helpful for a quick recap of regression analyses and various related measures.
2. A-little-book-of-r-for-time-series.pdf. Book posted on NYU classes.
3. Students are encouraged to make use of online resources (videos, research websites) for learning more about R (free software with extensive online documentation).
4. Tsay, R.S. Analysis of Financial Time Series. Chapter Two

Class Three

- Second half of class is midterm (covers topics from classes one and two)
- Final project proposal due (deliverable)

Objective of Class Three is to study the implementation of trend following strategies – momentum and contrarian. Phases involved in devising a successful strategy – setup of trading signals, stop loss triggers, monitoring of portfolio risk. In addition to covering the trend following strategies, we will also discuss Trading and Exchanges by Larry Harris. The following topics will be covered:

- Introduction to Alpha-seeking strategies,
- Momentum strategies and contrarian strategies,
- Trading and Exchanges (book authored by Larry Harris) – book discussion.

In this class we also study the basic characteristics of prices. Explore the mean reversion and random walk processes and their connection with price movements/returns. Discuss ways in which assumptions affect trading strategies. In this context we will discuss some important properties displayed by sets of price data – co-integration, correlation and their differences.
Discuss the terminologies involved in trading.

References:

1. Jennifer Conrad and Gautham Kaul (Autumn 1998): "An anatomy of trading strategies", Review of Financial Studies, Vol. 11, p 489-519. The paper will provide an overview of both momentum and contrarian strategies.
2. Narasimhan Jegadeesh and Sheridan Titman (March 1993), "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency", The Journal of Finance, Vol. 48, No. 1, p 65 – 91. This is a pivotal paper used in the field of Momentum Strategies.
3. Louis K.C. Chan, Narasimhan Jegadeesh and Josef Lakonishok (December 1996), "Momentum Strategies", The Journal of Finance, Volume 51, No. 5, p 1681 – 1713. This paper is a continuum to the Jegadeesh and Titman (March 1993) paper that explores reasons for success of momentum strategies.
4. Lai, T.Z. and Xing, H. (2008): Statistical Models and Methods for Financial Markets, Springer.

Optional Reading:

5. Hogan, S, Jarrow, R., Teo, M. and Warachka, M. (2004): "Testing market efficiency using statistical arbitrage with applications to momentum and value strategies", Journal of Financial Economics, Vol. 73, pp 525-565.
6. Almgren, R and Chriss, N. (2000): "Optimal Execution of Portfolio Transactions", Journal of Risk, Vol. 3, pp. 5-39.
7. Shen, Szakmary, and Sharma (2007): An Examination of Momentum Strategies in Commodity Futures Markets

Class Four

Objective of Class Four is to study the statistical arbitrage techniques (pairs trading). This class will review the time series analysis from Class Two. Discussion on implications of CAPM in quantitative trading. The following topics will be covered:

- Mean reversion vs random walk,
- Momentum and contrarian strategies,
- Implementation of momentum strategy prototype.

Class Five

Objective of Class Five is to study statistical arbitrage strategies and their implementation. Introduction to pairs strategy and identification of potential pairs are covered in this class. Familiarization with Engle and Granger approach and Johansen's methodology. The following topics will be covered:

- Cointegration,
- Testing for cointegration in two time series,
- Different ways for implementing pairs trading strategies.

References:

1. Elliot, R.J, Van Der Hoek, J and Malcolm, W.P. (2005): "Pairs Trading"; Quantitative Finance, Vol. 5, p 271-276.
2. Gatev, E, Goetzmann, W.N and Rouwenhorst, R.G. (2006): "Pairs Trading: Performance of a Relative Value Arbitrage Rule"; The Review of Financial Studies, Vol. 19, pp. 797-827.
3. Engelberg, J., Gao, P. and Jaggannathan, R. (2009): "An anatomy of pairs trading: the role of idiosyncratic news, common information and liquidity"; unpublished.
4. Tourin, A. and Yan, R.: "Dynamic Pairs Trading using the Stochastic Control Approach".
5. Duan, J. and Pliska, S.R. (2004): "Option valuation with co-integrated asset prices"; Journal of Economic Dynamics & Control, Vol. 28, pp. 727 – 754.
6. Robert Pardo (2008), The Evaluation and Optimization of Trading Strategies. Skim the book for a few good testing models and optimal practices that are deployed in the development of a successful trading strategy.

Class Six

Objective of Class Six is to review pairs trading strategies and their implementation using VECM (including prototype setup in Excel). Recap of all strategies and implementation techniques covered in the course. Review and workshop session for final presentations. Topics covered will include:

- Implementation of pairs trading strategies,
- Chriss-Almgren Framework for Execution.

References:

1. Almgren, R. and Chriss, N. (December 2000), Optimal Execution of Portfolio Transactions.

Class Seven

Project Presentation: Each group will submit their final report and present their assigned project. Students are encouraged to read all topics and actively participate in the presentations of your peers.