Spring 2021
Fixed Income Quantitative Trading (FRE-GY-6971, 1.5 credits)

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Course Outline:
The objective of this course is to introduce term structure modeling as an important toolkit for quantitative trading in fixed income. This course will offer a thorough presentation of how state space models are used in quantitative trading applications in liquid fixed income markets.
We will derive and implement dynamic models with corresponding valuation analytics, estimate model parameters with actual historical and intra-day data, formulate and test alpha signals and apply appropriate risk measures. Students will learn to translate theoretical knowledge into a tangible output via programming assignments and a final project.

Prerequisites:
FRE-GY-6411
Working knowledge of no-arbitrage pricing theory, statistics, data analysis, Python & Jupyter Notebooks

Grading:
- Homework Assignments & Quizzes: 35%
- Class Participation 15%
- Final in 2 parts (1h-long written exam & a project): 50%

Class Policies:
- Students are responsible for taking notes during class
- Programing homework should be done using Python with Jupyter Notebooks
- All classwork should be done independently, and cheating will not be tolerated
- Cheaters will be punished, up to failing the class

Lecture 1: Introduction & Definitions, 4/2
- Liquid interest rate markets: bonds, Eurodollars, bond futures, interest rate swaps, swap futures
- Trading platforms: exchanges, inter-dealer platforms, RFQ venues, SEFs
- Market specifics: central clearing, economic data releases, initial and variation margin, sparse trading activity, order matching engines (FIFO & Pro-rata)
- Introduction to Fixed Income Quant Trading
    - Modeling relationships in the market

Lecture 2: Historical Factor Models (HFM), 4/9
- Introduction to state space modeling & HFM
- Canonical correlation analysis (CCA) in quantitative trading

- Estimating cointegrated relationships
- Constructing small mean-reverting portfolios

Lecture 3: Term Structure Models (TSM), 4/16

- Risk neutral and physical probability measures
- Equilibrium & arbitrage-free specifications
- General Affine Model (GAM)
    - Pricing capabilities for liquid interest rate products
- Link between HFM & TSM
- Link between Nelson-Siegel & TSM

Lecture 4: Estimation of state space models with historical and intra-day data, 4/23

- Dynamic properties of the model necessary for quantitative trading
    - What makes a good model?
    - State vector specifications
- Estimation approaches
    - Quasi maximum likelihood
    - Non-linear iterative LSQ
    - Kalman filter setup
- Collinearity & high-frequency noise

Lecture 5: HFM, TSM & yield curve trading. Signal analysis when you don't have 'Big Data', 4/30

- Factor-based approach to forecasting & risk-management
- Detecting structural breaks & model parameters changes
- EMA, regime-switching models & instability testing
- Signal research framework
    - Definitions & implementations
    - Commonly used metrics of signal quality
    - Testing & validation
- Building a back-test

Lecture 6: Quant Trading in the Eurodollar futures market, 5/7

- Market overview
- Order matching: Pro-rata with 'Top'
    - Optimal order sizing & risk-management
- Implied & hidden liquidity
    - Solving for additional liquidity to improve execution
- Historical & cross-sectional dynamics
    - Empirical studies
- State space modeling
    - TSM in a Kalman filter framework

Lecture 7 (+ Final, Part_1): Advance topics & research projects, 5/14

Inclusion Statement

The NYU Tandon School values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. It is my intent that all students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. If this standard is not being upheld, please feel free to speak with me.