**Spring 2019**

**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 (hour-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
* Cheating will not be tolerated. Cheaters will be punished, up to failing the class

**Lecture 1: Introduction & Definitions, 4/5**

* 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), TBA**

* 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), 4/19**

* 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, 4/26**

* 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’, 5/3**

* 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, 5/10**

* 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, 5/17**