ECON 876
Introduction to Empirical Finance

Summary of Course

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Part I: Generalized Method of Moments

1. Why GMM?
2. GMM and its antecedents
   - Method of Moments
   - Minimum chi-square
   - Instrumental Variables
   - GMM
3. Instrumental Variables
   - Population moment condition and identification
   - A decomposition
   - Asymptotics
   - Model specification test
4. General GMM
   - Identification - global
   - Identificaiton - local
   - The estimator
   - A decomposition

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Identifying restrictions
Overidentifying restrictions
Consistency
Asymptotic normality
Covariance matrix estimation
HAC estimator
Two - step and iterated GMM estimation
Continuous updating GMM estimator
Hypothesis testing
The overidentifying restrictions test
Testing subset of moment conditions
Testing restrictions on the parameters
Structural stability testing
Moment selection
Weak Identification
Many Moment Conditions

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Part II: Hansen-Jagannathan Bounds and Distances

1. Bounds
2. Distances

Part III: Machine Learning with Regularized Regressions

1. Introduction
2. Regularization and shrinkage
3. LASSO: Survival of the Bigger
4. Oracle Inequalities
   Oracle Inequality for Least Squares
   Oracle Inequality for LASSO
5. Regularized Regression for Heavy-tailed Time Series

Part IV: High-dimensional Linear and Regularized GMM

1. Linear GMM: Introduction
   Notation
   Linear Model

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Assumptions and oracle inequalities
The debiased two-step GMM estimator
Constructing $\hat{\Gamma}$

2. High-dimensional GMM: Introduction
Regularized Minimum Distance Estimation Problem
Bounds on Estimation Error of RMD Estimator
3. High-dimensional Fama-MacBeth Regressions

Part V: Simulation-based Estimation

1. Auxiliary Model and Model of Interest
2. The Principle
3. Asymptotics
Estimating MA using AR models
Asymptotics Indirect Inference
Indirect Inference versus EMM
4. Comparison of MLE and Indirect Inference
Geometric Brownian Motion

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Ornstein-Uhlenbeck

Part V: Deep Learning

1. Feedforward Neural Networks
2. Layers
3. Learning XOR
4. Activation functions
5. Learning XOR - solution
6. Output Units
   - Linear
   - Sigmoid Units
   - Softmax Units
7. Hidden Units
   - Rectified Linear Units and Their Generalizations
   - Logistic Sigmoid and Hyperbolic Tangent
8. Architecture Design
   - Universal Approximation Properties and Depth

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9. Back-Propagation and Other Differentiation Algorithms
10. Regularization for Deep Learning

Part VII: An Adversarial Approach to Structural Estimation
1. Introduction
2 Adversarial Estimation Framework
3. Statistical Properties
   Assumptions
   Theorems
   What if D is not Rich Enough?
4. Practical Aspects

Part VIII: Univariate ARCH Models
1. Introduction
2. Financial series and GARCH models
   Stylized facts
   Models for conditional heteroskedasticity

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GARCH processes
3. Stationarity conditions
Weak ARMA representation
Stationarity of the GARCH(1,1)
Stationarity of the GARCH(p;q)
Forecasts
4. Examples of asymmetric GARCH
EGARCH model
TGARCH model
5. Identification
Weak white noise test
Test for conditional homoskedasticity
6. GARCH estimation
OLS estimator
QMLE
7. Risk-Return Trade-off
8. GARCH-MIDAS model

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Part IX: Multivariate ARCH Models

1. Portfolios and VaR
2. MGARCH models
   - Definition
   - Typology of MGARCH models
3. VEC, BEKK and factor-GARCH models
   - Bivariate VEC(1,1)
   - Vech and vec operators
   - General VEC(1,1)
   - Diagonal and Scalar VEC
   - Bivariate BEKK
   - One-factor MGARCH model
4. Conditional correlations
   - Forecasting correlations with DCC models
   - DCC-MIDAS model
5. ML estimation of MGARCH models

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Part X: State Space Models and Kalman Filter
Markov Chain Monte Carlo Estimation and Filtering
1. Introduction to the Kalman Filter
Kalman Filter Iterations
Kalman filter Initialization and Iterations
Steady State Kalman gain
MLE of State Space Models
2. Bayes' Theorem
Bayesian versus Frequentist
Bayesian Inference
Decision Theory
Estimation
Lindley's Paradox
3. Markov Chains
Computational issues
Basic Markov chain theory
State visitation and chain classification

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Stationarity and stationary measures
Time reversibility
Markov chain convergence theorem
Laws of Large Numbers
Central Limit Theorem
Simulating Markov Chains

4. Markov Chain Monte Carlo Methods
Metropolis-Hastings Algorithm
Random walk Metropolis
Clifford-Hammersley Theorem
Gibbs sampler
Examples
Stochastic Volatility

Part XI: Principal Components Analysis and Covariance Matrix Estimation

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2. Eigendecomposition
3. Singular Value Decomposition
4. Moore-Penrose Pseudoinverse
5. Principal Components Analysis
6. Factor Models
   - Asymptotic behavior of eigenvalues
   - Large dimensional approximate factor models
   - Method of asymptotic principal components
   - Asymptotic properties - stationary data
   - Determining the number of factors
   - Linear Factor Augmented Regressions
7. Testing factor spaces
   - Group factor models
   - General Factor Structure
   - Identification of Factor Spaces
   - Estimation - Factors and Loadings
   - Inference on the Number of Common Factors

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High Dimensional Covariance Matrix Estimation

Regularizing the Eigenstructure

Sparse Gaussian Graphical Models

Other Research Areas

Practical issues

- Grade is based on four homework assignments - each counting for 25 %. Each homework has a theory and practical implementation
- Please send email to `eghysels@unc.edu` with following info: (a) name, (b) program/year (e.g. second year KFBS PhD), (c) whether you take class for credit or not
- TA for class is Junsu Pan `junsupan@live.unc.edu`
- Schedule: Teach twice 2 hours a week, Mon-Wed. Can we do 4-6 PM instead of 5-7 PM?
- This is an accelerated schedule, 1.5 hours extra each week which allows us to finish by end of March. We take a 5 min break in middle of lecture?