Advanced Econometric Methods

Instructor: Tae-Hwy Lee
Lecture: MW 11:10 – 12:30, SPR 4128
Office hours: MW 10-11, open door, or by appointment on MWF
Office: SPR 3103

Course Requirement and Grading: The course grade will be based on the many homework problems raised during the lectures and a research paper. All submission of the homeworks and paper should be typed and submitted electronically via email.

1. Homeworks (35%) on problems raised during the lectures. There will be 7 homeworks with each carrying 5% regardless of the length. You will have one week (7 days) for each homework.
2. Paper (65%) can be theoretical, applied, empirical, Monte Carlo, or a literature review on a specific topic related to the course. Please make sure the topic you choose has not been and is not being used for any other term papers for other courses.
   a. Version 1 for the paper will be due by 11:59 pm, February 28 (5%),
   b. Version 2 due by 11:59 pm, March 6 (5%),
   c. Version 3 due by 11:59 pm, March 13 (5%), and
   d. the final paper due by 11:59 pm, March 20 (50%).

Course Outline

This course has four parts. Topics A, B, C will cover the standard textbook topics. Topics A, B review the standard time series econometrics topics in the conditional mean and conditional variance, respectively. Topic C covers the standard textbook coverage on bootstrap. Topic D is on the recent development in forecasting research. It will be a review of the fast growing literature on forecasting time series, with many applications in financial econometrics.

A. Introduction to Time Series Econometrics (1 week)

There are topics in Econ 205C. We did Lectures 1-7 in Spring 2015. But we did not have time to do Lecture 8-10 during Spring 2015. Lecture 8 motivates Lecture 9, where we discuss (i) asymptotic properties of the cointegrating regression, (ii) asymptotic properties of the Engle-Granger (1987) two-step procedure, (iii) maximum likelihood analysis of cointegrated systems (Johansen 1991).

Lecture 1: Properties of Stationary ARMA Processes (Hamilton Chapters 3, 4, 6)
Lecture 2: Forecasting with Stationary ARMA Models (Hamilton Chapter 4)
Lecture 3: Estimation of Stationary ARMA Models (Hamilton Chapter 5)
Lecture 4: Multivariate Time Series Processes and VAR (Hamilton Chapters 10, 11)
Lecture 5: Models of Nonstationary Time Series (Hamilton Chapter 15)
Lecture 6: Trends (Hamilton Chapter 16)
Lecture 7: Unit Roots (Hamilton Chapter 17)
Lecture 8: Spurious Regression (Hamilton Chapter 18)
Lecture 9: Cointegration (Hamilton Chapters 19, 20)

B. ARCH Models (1 week)

Lectures 10-11 deal with the models of conditional variance while Lectures 1-9 are about the models of conditional mean. In Lecture 10, we begin with learning various issues and properties of univariate ARCH model. We consider basic models and various extensions (GARCH, IGARCH, GARCH-M, EGARCH, TGARCH, APARCH). We also discuss some alternative approaches such as stochastic volatility, moving window estimates, realized volatility, range-based volatility. Then, in Lecture 11, we learn multivariate ARCH models such as BEKK, VEC, CCC, VC, and DCC. Goal is to learn ARCH model and its various extensions, understand the properties of various volatility models, use R and Matlab to estimate various volatility models, understand the difference of dependence, correlation, martingale
difference in the context of ARCH modelling, understand the use of normal vs non-normal distributions in volatility modelling, learn alternative approaches to estimating volatility, understand issues and solutions in modeling multivariate GARCH models, forecasting volatility, High-dimensional multivariate GARCH models.

Lecture 10: Univariate ARCH models (Hamilton Chapter 21)
Lecture 11: Multivariate ARCH models

C. Bootstrap (1.5 week)

We will cover the following topics on bootstrap. A motivation of bootstrap will be given from the jackknife view of Tukey (1958). Then we discuss the limitation and extention of the jackknife for generalizing the idea to introduce bootstrap. We discuss how bootstrap works using asymptotic expansion. We review some basic theory of the central limit theorem and discuss the Edgeworth expansion to understand the bootstrap’s ability. We also consider situations where bootstrap cannot be used. Subsampling and wild bootstrap may be discussed. We consider various applications such as bias reduction, confidence intervals, testing. The goal is to understand what bootstrap is, how it works, why it fails when it does not work, how to use it, and possible advantages of using bootstrap.

Lecture 12: Jackknife and bootstrap, central limit theorem and Edgeworth expansions, asymptotic refinement in hypothesis testing and confidence intervals, bootstrap bias reduction, consistency of bootstrap, subsampling References: Hall (1992 Chapters 1-3), Horowitz (2001), Hansen (2014 Ch10).

D. Forecasting (5 weeks)

We reviews the recent development in time series forecasting research. We begin with a review of basic forecasting theory, loss functions and econometric models, properties of optimal forecasts, concept of forecast rationality under flexible loss functions. We then review the methods of comparing predictive ability of non-nested and nested models. We discuss forecasting with many predictors, using factor models based on the principal components, Nelson-Siegle factor models, and Stein-type shrinkage. Also considered are forecasting with constraints and bagging, using bootstrap bias correction, using nonlinear models, about estimating the forecaster’s loss function using observed forecasts, and etc. Each topic will be demonstrated with examples and applications in financial econometrics.

Lecture 13: Loss functions and econometric models

Lecture 14: Introduction to forecasting univariate, multivariate, stationary, nonstationary time series
References: Granger and Newbold (1986)

Lecture 15: Forecast combination
mean forecast, quantile forecasts, expectile forecasts, expected shortfall forecasts, binary forecasts and classifiers, averaging, majority vote, power of democracy, bagging, boosting, random forests, support vector machine, Bayesian model averaging, Mallow model averaging, applications References: Bates and Granger (1969), Timmermann (2006), Lee and Yang (2006), Hastie, Tibshirani, and Friedman (2009)

Lecture 16: Forecast evaluation and comparison in predictive regression
Lecture 17: Forecasting using factor models.

Lecture 18: Forecasting using constraints, nonparametric and semiparametric models, bagging.

Lecture 19: Estimation of asymmetric loss and forecasting under asymmetric loss function
GMM estimation of loss/preference given the revealed forecasts, Overidentifying testing of forecast optimality under estimated loss function, Encompassing test for counter-factual evaluation of forecasts

Lecture 20: Forecasting using decompositions and maximum entropy
Entropy, Kullback-Leibler divergence, Logarithmic probability score, Maximum entropy, Applications of information theory for theory-coherent estimation and forecasting, Applications of information theory for model averaging, forecast combination, and portfolio theory, multiplicative decomposition, additive decomposition, copula, aggregation

Lecture 21: Forecasting by model averaging

Lecture 22: Forecasting with lasso, adaptive lasso, ridge, and bias correction

Lecture 23: Forecasting with ANN, ELM, kernel ridge regression, boosting
Artificial neural network (ANN) models, Testing for neglected nonlinearity with randomly activated neural networks, Consistent specification testing with nuisance parameters present only under the alternative, Extreme learning machines (ELM), Quck Nets and least angular regression, Boosting ANN and ELM, Kernel ridge regression (KRR)

Lecture 24: Model Selection
Derivation of AIC and TIC (generalized AIC), Derivation of BIC, Properties of AIC and BIC: AIC vs BIC, Can the Strengths of AIC and BIC Be Shared? Cross-validation: properties, cross-validation vs AIC, Mallow criterion

Lecture 25. Simulation Methods in Econometrics
Simulating specific distribution: Direct methods (probability integral transform, Box-Muller algorithm)
Simulating specific distribution: Indirect methods (Motivating example for Accept-Reject algorithm)
Classical simulation: Accept-Reject algorithm , Important sampling, Multivariate simulation
Markov Chain Monte Carlo: Theory of Markov Chains, Gibbs sampling, Metropolis-Hastings algorithm
Applications in regression models in econometrics
Simulated method of moments

Lecture 26. More Topics in Bootstrap Methods
Consistency of the bootstrap
Bootstrap when a parameter is on the boundary of the parameter space
Bootstrap with heavy-tailed distribution
Selected References


100. Lee, T-H. and Yiyao Wang (2015), "Finding SPF Percentiles Closest to Greenbook".


