Topics in Econometrics

Program: MSc Data Science
Course Type: Elective
Credit : 4

Course Objective

This is an advanced econometrics course designed for students with a solid foundation in classical linear regression. The proposed course will build upon linear regression and introduce students to several advanced regression models and Bayesian econometrics. The advanced models will include multiple forms of discrete data (when the dependent variable is not continuous) modeling and panel data (when a cross-section is observed over a short period) models. Then the course will cover Bayesian econometrics which utilizes Bayes theorem to merge prior beliefs about parameters with data (or likelihood) to produce updated beliefs, known as posterior distributions. Since these posterior distributions are typically intractable, estimation and inference will typically employ Markov chain Monte Carlo techniques. Within the Bayesian framework, the course will cover modeling and estimation of linear regression, discrete data models, panel data models, and quantile regression. Students will apply these econometric models to real-world applications.

The course is designed for Masters' students and will be particularly beneficial for students aiming to pursue higher studies or work in research settings.

Software: Given that econometrics, especially Bayesian econometrics, is computationally intensive, a strong foundation in coding is necessary. We will use R for Classical Econometrics and switch to MATLAB for Bayesian Econometrics.

Prerequisites

Probability and Statistics, Algorithms.

Intermediate knowledge of statistics, calculus, linear algebra, different kinds of distributions, linear regression, and its variants is necessary for a proper understanding of the course material.

All class assignments will be in R or MATLAB.

Course topics will be chosen from this list:

Discrete Choice Models

1. Modeling, estimation, and inference in various discrete choice settings: binary probit, binary logit, truncated and censored data models, ordinal data models, and multinomial models.
2. Applications in economics or finance of the above models.

Panel Data Models

1. Pooled model, fixed effects model, random effects model
2. Pooled model: estimation via ordinary least squares, within transformation, between transformation. Pooled OLS with first differences
3. Fixed effects model: estimation via least squares dummy variable (LSDV) approach, within estimation, and first-difference method.
4. Random effects model: estimation via GLS and FGLS.
5. Testing of fixed effects vs random effects.
6. Application of pooled OLS, fixed effects, and random effects models to Grunfeld investment data.

Bayesian Econometrics

1. Basic concepts of probability and inference – Frequentist probabilities, subjective probabilities, prior, likelihood, and posterior.
2. Posterior Distribution and Inference – Properties of posterior distributions (the likelihood function, vector of parameters, Bayesian updating, large samples, and identification) and Inference (point estimates, interval estimates, prediction, and model comparison).
3. Prior Distributions – Normal linear regression model, proper and improper priors, conjugate priors, exchangeability, and conditionally conjugate priors.
4. Markov chain Monte Carlo Methods – Basics of Markov chain theory, Gibbs Sampling, Metropolis algorithm, Metropolis-Hastings algorithm, calculation of marginal likelihood, numerical standard error, and convergence.
5. Linear Regression and Extensions – Linear regression, linear regression with heteroscedasticity, limited dependent variable models (Tobit for Censored Data, Binary Probit Model, Binary Logit Model, Ordinal Probit Model).
6. Bayesian estimation of panel data models.
7. Bayesian quantile regression in linear, binary, ordinal, and panel data models.
8. Estimation of econometrics models to real-life applications by coding the MCMC algorithms.

Text and References

(1) William Greene (2017), *Econometric Analysis*, 8th Edition, Prentice Hall, New York.

(2) William H. Greene and David Hensher (2010), *Modeling Ordered Choices: A Primer*, Cambridge University Press, Cambridge.

(3) Edward Greenberg (2012), *Introduction to Bayesian Econometrics*, 2nd Edition, Cambridge University Press, New York.

(4) Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin (2013), *Bayesian Data Analysis*, 3rd Edition, Chapman & Hall, New York.

(5) Christoph Hanck, Martin Arnold, Alexander Gerber, and Martin Schmelzer (2024), *Introduction to Econometrics with R*, Link: https://www.econometrics-with-r.org