# Advanced Econometrics I

## Peking University HSBC Business School


**Instructor:** SungBin Sohn
**Class:** Mondays and Thursdays 3:30-5:20pm in C125
**Office Hours:** Wednesdays 10-11:45am or by appointment at C324
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**Teaching Assistant:** TBA


**Course Description:**

This is a graduate level course in econometrics. Econometrics is statistical analysis of economic and financial data. It is widely applied to estimate economic relationship, test economic theory and evaluate government and business policies. It has also been applied to management, marketing, sociology, etc. This course helps students use and understand regression analysis, introduces widely used econometric models, and explores underlying economic intuition.

The course begins with brief reviews of probability distributions and limit theorems. Then, it studies the classical linear regression model (CLRM) focusing on the least squares estimator. The course further studies the cases in which main assumptions in the CLRM are violated. Some special topics (e.g., panel data, qualitative variable, instrumental variable, etc.) will be studied. If time permits, other estimation methods such as the maximum likelihood and the generalized method of moments could also be covered. The course emphasis is rather theoretical than empirical.

**Textbook and Prerequisites:**

There is no designated textbook for the course, but the following book could be useful (you are not required to read it):

William H. Greene (2003), *Econometric Analysis*, Prentice Hall

You are assumed to have already taken Mathematics (GEN500) and to be familiar with the linear algebra and calculus.

**Requirements and Grading:**

Requirements for the course include attending lectures, several problem sets, a midterm exam and a final exam. Since the course is cumulative in the sense that each lecture builds on previous ones, full attendance is required. I take roll several times randomly throughout the module. Each time you're absent, your course score will be deducted by 1 point unless you obtain my pre-approval. As for problem sets, you are encouraged to work in groups. However, you must turn in an individual solution. Plagiarism is strictly punished. Late submission is unacceptable and will not be graded. Some problem sets may contain computational exercises. Specifically, the grading of the course can be broken down to the following:

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|---|---|
| Class attendance and homework | 30% |
| Midterm exam | 30% |
| Final exam | 40% |

**Email policies:**

I strongly encourage you to ask questions during lectures and office hours. If you have special needs to reach me outside the lectures or office hours, however, you may email me. I will try to respond to your email in two business days. If you don't get my response within two business days, please send me a reminder email. When you email me, please prefix the subject header [FIN500] in order to make your email too conspicuous to miss it.

## Course Outline and References:

The schedule of topics could be updated as the course evolves.

**1. Probability distributions**

- 1.1. Normal distribution
- 1.2. Chi-squared ($\chi^2$) distribution
- 1.3. *t* distribution & *F* distribution

**2. Limit theorems**

- 2.1. Convergence
- 2.2. Law of large number (LLN)
- 2.3. Central limit theorem (CLT)
- 2.4. Slutsky's theorem
- 2.5. Delta method

**3. Classical linear regression model (Simple regression)**

- 3.1. Standard assumptions of classical linear regression model
- 3.2. Least squares estimator (LSE)
- 3.3. Properties of OLS estimator
- 3.4. Estimator of $\sigma^2$

**4. Classical linear regression model (Multiple regression)**

- 4.1. Standard assumptions of classical linear regression model
- 4.2. Least squares estimator (LSE)
- 4.3. Properties of OLS estimator
- 4.4. Gauss-Markov theorem
- 4.5. Estimator of $\sigma^2$
- 4.6. Distribution of $\beta$ & $\sigma^2$
- 4.7. Wald test
- 4.8. Goodness of fit
- 4.9. Confidence interval of $\beta$
- 4.10. Prediction and confidence interval of *y*

**5. Departure from assumptions in classical linear regression model**

- 5.1. Heteroskedasticity
  - 5.1.1. Introduction
  - 5.1.2. Generalized least squares (GLS) estimator
  - 5.1.3. Feasible generalized least squares (FGLS) estimator
- 5.2. Serial correlation
  - 5.2.1. Introduction
  - 5.2.2. Estimation
  - 5.2.3. Heteroskedasticity-Autocorrelation consistent (HAC) estimator
- 5.3. Multicollinearity
- 5.4. Non-normal error term
  - 5.3.1. Large sample properties of OLS estimators
  - 5.3.2. Large sample properties of *t*-statistic and *F*-statistic

**6 Special topics**

- 6.1. Qualitative (dummy) variable
  - 6.1.1. Dummy independent variable
  - 6.1.2. Dummy dependent variable
- 6.2. Specification error
  - 6.2.1. Inclusion of irrelevant variables
  - 6.2.2. Exclusion of relevant variables (omitted variable)
- 6.3. Measurement error
  - 6.3.1. Measurement error in a dependent variable
  - 6.3.2. Measurement error in independent variables
- 6.4. Instrumental Variable (IV)
  - 6.4.1. Endogeneity problem
  - 6.4.2. Estimation: Just-identified case
  - 6.4.3. Estimation: Over-identified case
- 6.5. Panel data
  - 6.5.1. Unobserved heterogeneity: Fixed effect (FE) model
  - 6.5.2. Difference-in-differences estimation
  - 6.5.3. Seemingly unrelated regressions (SUR)

**7. Other estimation methods (optional)**

- 7.1. Maximum likelihood estimator (MLE)
  - 7.1.1. Likelihood function and MLE
  - 7.1.2. Some statistics about likelihood function
  - 7.1.3. Properties of MLE
- 7.2. Generalized method of moments estimator (GMME)
  - 7.2.1. Method of moments
  - 7.2.2. Generalized method of moments
  - 7.2.3. Properties of GMME