Carnegie Mellon University
Tepper School of Business

47-811 Econometrics I Fall 2023
(6 units)

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Class Meetings:

Section A1	Monday & Wednesday	Noon - 1:50 pm	rm TEP 5210
	mini 1: August 28 to October 11		

COURSE DESCRIPTION

This course is an introduction to the basic questions, tools and techniques used in empirical social science research. Students will learn to calculate and perform correct inference on parameter estimates.

The course focuses on the multivariate linear model. Topics include: consistency and asymptotic normality of the parameter estimates, sampling distributions, hypothesis testing parameter restrictions and specification tests. Students will learn the impact of departures from traditional assumptions in the linear model (e.g. correlated errors, heteroscedastic errors, correlation between the regressors and the errors) and how to address these situations. Students are expected to be familiar with multivariate calculus, linear algebra, and basic probability and statistics.

Students will write R Markdown programs on problem sets.

GRADING

The students will be graded on three problem sets and a final exam. The course grade will be determine by: 60% problem sets and 40% a final exam.

TEXTBOOKS

Some useful econometric books are

- Hansen, Bruce, **Econometrics**, Princeton University Press, 2022. *This is the current standard for graduate Econometrics. It has empirical examples and theoretical presentations. Less rigorous than Hayashi.*
- Wooldridge, Jeffrey M., **Introductory Econometrics: A Modern Approach** 7$^{\text{th}}$, South-Western College Publishing, 2018, *An advanced undergraduate text, very nicely written.*
- Greene, William, **Econometric Analysis** 8$^{\text{th}}$ edition, Prentice Hall, 2018. *First year graduate school book in econometrics. A nice bridge from an undergraduate econometrics course. Asymptotic theory in the appendix.*
- Hayashi, Fumio, **Econometrics**, Princeton University Press, 2000. *A fairly advanced first year graduate school book in Econometrics. Chapter 2 concerns asymptotic theory.*

THE GENERAL OUTLINE

- Weeks 1 and 2. Where Econometrics fits into Statistics and Machine Learning. The three basic parts of Statistics. How to model different functions. Introduce the linear model. Alternative ways to interpret linear regression: Least squares, moment estimation, projection and maximum likelihood. Statistics for linear regression for iid normal errors. Sampling distributions and inference.
- Week 3. Problems with regression. Introduction to the LLN and the CLT. Introduction to asymptotic theory. The delta method.
- Week 4 and 5. Linear regression when the errors are not iid. Generalized least squares. Heteroscedasticity and autocorrelation. White standard errors.
- Week 6. Linear regression when the errors and the regressors are correlated. Instrumental variables (IV). Connection with causal inference.
- Week 7. Introduction to maximum likelihood. Discrete dependent variables (classification versus regression).

THE GENERAL OUTLINE

- Introduce the linear model. Assumptions. Fixed versus random regressors. (Lecture 1)
- Alternative ways to interpret linear regression: Least squares, moment estimation, projection and maximum likelihood. (Lecture 2)
- Derived the sampling distributions under iid assumptions. R^2 as a measure of goodness of fit. Adjusted R^2. Kernel density to estimate a density. (Lecture 3 and 4)
- Properties of the least squares estimators. Unbiased. Consistent. Normality. Efficient.
- Perform inference under iid assumptions. Hypothesis Testing: Size and Power. (Lecture 5)
- Problems with regression. Influential observations and making averages robust. (Lecture 5)
- Introduce the LLN and the CLT. The Delta method. (Lecture 6)
- Derive the sampling distributions under weaker assumptions on the error. (Lecture 6)
- Problems with regression when the regression errors are not iid. (Lecture 7)
- Adjustments to linear regression when the errors are not iid. Generalized Least squares. Weighted Least squares. (Lecture 8)
    1. Heteroscedasticity. (Lecture 8)
    2. Autocorrelation. The Durbin-Watson test. (Lecture 9))
    3. Heteroscedasticity and autocorrelation. White standard errors. (Lecture 10)
- Perform inference under weaker assumptions on the error. (Lecture 10)
- Adjustments to linear regression when the errors and the regressors are correlated. (Lecture 11)
- Instrumental variables.
- Testing Overidentifying Restrictions in IV models.
- Perform inference under when the errors and the regressors are correlated. (Lecture 12)
- A simple introduction to nonlinear least squares.
- Maximum likelihood estimation. (Lecture 13)
- Discrete dependent variables. (Lecture 14)