

# Syllabus

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MICROECONOMETRICS  
IDEA PhD Program

## Chapter 1: A Brief Review of Maximum Likelihood, Generalized Method of Moments (GMM), and Numerical Tools

### *I. Maximum Likelihood*

- A. The Likelihood Principle
- B. The Maximum Likelihood Estimator (MLE)
- C. Asymptotic Properties of the MLE
  - Identification
  - Regularity conditions
  - Consistency
  - Asymptotic distribution

### *II. Generalized Method of Moments (GMM)*

- A. General Formulation
- B. Estimation
- C. Asymptotic Properties
  - Consistency
  - Asymptotic distribution
  - Optimal weighting matrix

### *III. Numerical Methods*

- A. Differentiation
- B. Newton-Raphson Optimization
- C. Integration

## Chapter 2: Panel Data

### *I. Introduction*

### *II. Static Models*

- A. The Fixed Effects Model. Within Groups Estimation
- B. The Random Effects Model. Error Components
- C. Testing for Correlated Individual Effects

### *III. Dynamic Models*

- A. Autoregressive Models with Individual Effects
- B. Difference GMM Estimation
- C. System GMM Estimation
- D. Specification Tests

## **Chapter 3: Discrete Choice**

### *I. Binary Outcome Models*

- A. Introduction
- B. The Linear Probability Model
- C. The General Binary Outcome Model
  - Maximum Likelihood Estimation
  - Asymptotic properties
  - Marginal effects
- D. The Logit Model
- E. The Probit Model
- F. Latent Variable Representation
  - Index function model
  - (Additive) Random utility model

### *II. Multinomial Models*

- A. Multinomial Outcomes
- B. The General Multinomial Model
  - Maximum Likelihood estimation
  - Asymptotic properties
  - Marginal effects
- C. The Logit Model
  - The Multinomial Logit (MNL)
  - The Conditional Logit (CL)
- D. Latent Variable Representation
- E. Relaxing the Independence of Irrelevant Alternatives Assumption
  - The Nested Logit (NL)
  - Random Parameters Logit (RPL)

Multinomial Probit (MNP)

F. Ordered Outcomes

*III. Endogenous Variables*

A. Probit with Continuous Endogenous Regressor

B. Probit with Binary Endogenous Regressor

C. Moment Estimation

*IV. Binary Models for Panel Data*

**Chapter 4: Censoring, Truncation, and Selection**

*I. Introduction*

*II. Censoring and Truncation. The Tobit Model*

A. Maximum Likelihood Estimation

B. Potential Inconsistency of the MLE

C. Alternative Methods for Censored Data

Heckman Two-Step Estimator

Median Regression

Symmetrically Trimmed Mean

*III. Selection*

A. The Sample Selection Model

B. Heckman Two-Step Estimator

**Chapter 5: Duration Models**

*I. Introduction*

A. Motivation

B. Duration Data

*II. The Hazard Function*

A. Hazard Function for a Discrete Variable

B. Hazard Function for a Continuous Variable

C. Some Frequently Used Hazard Functions

*III. Conditional Hazard Functions: The Proportional Hazard Model*

A. The Proportional Hazard Model

B. Discrete Durations

*IV. Likelihood Functions*

A. Complete Continuous Durations

B. Censored Continuous Durations

C. Discrete Durations

*V. Unobserved Heterogeneity*

A. Unobserved Heterogeneity vs Spurious Duration Dependence

B. Unobserved Heterogeneity in Continuous Duration Models

C. Unobserved Heterogeneity in Discrete Duration Models

*VI. Multiple-Exit Discrete Duration Models*

A. Discrete Multiple-Exit Models

B. Full Information Maximum Likelihood

C. Limited Information Maximum Likelihood: Competing Risk Models

**Chapter 6: Policy Evaluation Methods: Treatment Effects**

*I. Potential Outcomes and Causality*

A. Potential Outcomes, Selection Bias, and Treatment Effects

B. Identification of Treatment Effects under Different Assumptions

*II. Randomized Control Trials and Natural Experiments*

A. Random Assignment and Treatment Effects

B. Introduction of Additional Regressors

C. Partial or Imperfect Compliance and Intention-to-Treat Analysis

D. Longer Run Interaction of Treatment and Intermediate Outcomes

*III. Matching*

A. Selection Based on Observables and (Exact) Matching

B. The Common Support Condition

C. Propensity Score Matching

D. Estimation Methods

*IV. Instrumental Variables*

A. Identification of Causal Effects in IV Settings

B. Homogeneous Treatment Effects

C. Heterogeneous Treatment Effects

D. Imperfect Compliance and IV

E. Local Average Treatment Effects (LATE)

F. Conditional Estimation with Instrumental Variables

V. *Regression Discontinuity*

A. The fundamental RD assumption

B. Homogeneous Treatment Effects

C. Heterogeneous Treatment Effects

Sharp design

Fuzzy design

D. Estimation Strategies

E. Conditioning on Covariates

VI. *Difference in Differences*

A. The Setup

B. Difference in Differences in the Regression Context

C. Triple Differences Model

D. Synthetic Control Methods

## References

*(These are core references. References for applications will be given in class)*

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## **Grading**

50% Final Exam. 25% Problem sets. 25% Paper presentation.