University of Michigan — Department of Economics

Econ672: Econometric Analysis II

Prerequisites and Roadmap

Prerequisites: I assume you have a working knowledge of the following concepts.

1. Conditional and unconditional mean, variance, covariance, moments, probability densities, distribution functions and their properties, elementary set theory and its relation to probability theory
2. Properties of uniform, normal, chi-squared, and F distributions
3. Testing hypotheses, size and power of statistical tests, p-values
4. Vector spaces, subspaces, orthogonality, and inverse, rank, trace, and positive-definiteness of a matrix
5. Norms and distances, convergence of sequences in $\mathbf{R}^n$, convergence in probability, convergence in distribution, properties of supremum and infimum, triangle and Markov inequalities
6. Derivatives of vector-valued functions, mean-value and intermediate-value theorem

Good to know but not required: Some familiarity with maximum likelihood estimation, measure theory, working with σ-algebras, and the dominated convergence theorem

What you will learn: The course typically consists of 24 lectures. A tentative outline of each lecture follows. You may already be familiar with some of the material from a statistics course or because you took Econ671. This course provides a unified and self-contained discussion of the material from the perspective of econometrics.

1. Modes of convergence, continuous mapping theorem, Slutzky lemma, law of large numbers with proof via truncation, stochastic orders
2. Delta method, maximum likelihood as Kullback-Leibler divergence, identifiability, proof of identification
3. Maximum likelihood estimation (MLE), score and Fisher information identities, proof of Cramer-Rao lower bound, heuristic proof of asymptotic normality of MLE via Taylor expansions
4. L_2-projections, conditional expectation as projection, linear projections, linear model, causality and correlation, ordinary least squares (OLS) estimator
5. OLS as moment estimator, orthogonal projections onto column spaces, projection and annihilator matrices, properties of projection matrices
6. Proof of Frisch-Waugh-Lovell theorem, bias-variance tradeoff
7. Proof of Gauss-Markov theorem, finite-sample properties of OLS, F-statistics, generalized least squares (GLS) estimation

8. Proof of consistency and asymptotic normality of OLS, proof of consistency of Huber-White covariance matrix estimators
9. Structural parameters, endogeneity, identification failure, instrumental variables (IV), IV estimator consistency and asymptotic normality, Card college distance and Angrist Vietnam lottery examples, Wald estimator
10. Structural equation, first stage, reduced form, indirect least squares, two-stage least squares, classical measurement error, using second measurement as IV
11. Stationarity concepts, white noise, moving averages, heuristic discussion of autoregressive processes, random walk, proof of law of large number for dependent variables with summable auto-covariance function
12. Newey-West heteroscedasticity and autocorrelation consistent (HAC) covariance estimator, panel data, fixed effects, within-group estimation, short panels, first-differences estimation
13. Incidental parameters, random effects, clustering, difference in differences
14. M-estimation, Z-estimation, estimating equations, proof of consistency of M-estimators, examples of uniform laws of large numbers
15. Relationship between M- and Z-estimators, proof of asymptotic normality of Z-estimators under differentiability conditions
16. Standard errors for Z-estimators, asymptotic relative efficiency, mean vs. median estimation example
17. Generalized method of moments (GMM) estimation and overidentification, consistency and asymptotic normality of GMM, proof of optimality of GMM weight matrix, k-step GMM, continuously updating efficient (CUE) GMM
18. Single index models, link functions, linear probability model, probit, probit MLE, nonlinear least squares (NLS), weighted NLS (WNLS)
19. Probit marginal effects, asymptotic distribution of likelihood ratio, Rao score, and Wald tests, testing nonlinear hypotheses with Wald tests
20. Tobit, Mills ratio, tobit MLE, WNLS for tobit, Heckman two-step for tobit
21. Heckman sample selection model, discussion of marginal effects, Heckman two-step, Poisson regression
22. Potential outcomes, Rubin causal model, average treatment on the treated, average treatment effect (ATE), ignorability, conditional ignorability, estimating ATE with control functions
23. Propensity score, overlap, proof of identification of ATE and ATT under overlap and conditional ignorability, estimation of ATE and ATT, missing data, missing at random, missing completely at random, inverse probability weighting, imputation, doubly robust estimation
24. Endogeneity in Rubin causal model, monotonicity, proof of identification of local average treatment effect (LATE), estimation of LATE, intention-to-treat effects