

Course Outline

ECO606: Econometric Methods

(A four credit compulsory course)

Overall Course Objective

This course is designed to build applied econometric competence across five interconnected areas of empirical research methodology. Each module combines econometric theory with an emphasis on identification, estimator choice, and correct interpretation, so that participants are able to select the right technique for a given data structure and research question, whether the challenge is dynamic dependence, endogeneity, panel heterogeneity, a limited or discrete dependent variable, nonstationary time series, or the measurement of production efficiency and productivity growth. Throughout the course, Stata and EViews will be used for hands-on training and applied estimation.

Module 1: Dynamic Regression, Instrumental Variables, and Regularized Estimation

Learning Objective

By the end of this module, students will be able to model dynamic relationships between economic variables over time, address endogeneity using instrumental variables, and apply regularization techniques to improve prediction and variable selection when OLS assumptions break down, including multicollinearity, high dimensionality, and overfitting.

Topics Covered

- Distributed lag models: finite and infinite lag structures
- The Koyck transformation and geometric lag models
- Almon polynomial distributed lag models
- Sources of endogeneity: omitted variables, simultaneity, measurement error
- Instrumental variables (IV) estimation and Two-Stage Least Squares (2SLS)
- Instrument relevance and exogeneity; tests for weak and invalid instruments
- Overidentification tests (Sargan/Hansen J-test)
- The bias-variance trade-off and the limits of OLS in high-dimensional settings
- Ridge regression: L2 penalty, shrinkage, and multicollinearity control
- Lasso regression: L1 penalty and automatic variable selection
- Elastic-net regression: combining L1 and L2 penalties

- Cross-validation for tuning-parameter selection
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Module 2: Static and Dynamic Panel Data Analysis

Learning Objective

By the end of this module, students will be able to exploit the cross-section and time-series structure of panel data to control for unobserved heterogeneity, choose correctly between fixed-effects and random-effects specifications, and estimate dynamic panel models that remain consistent in the presence of a lagged dependent variable.

Topics Covered

- Structure and advantages of panel (longitudinal) data
 - Pooled OLS and its limitations with panel data
 - The Fixed Effects (within/LSDV) estimator
 - The Random Effects (GLS) estimator
 - The Hausman specification test: choosing between fixed and random effects
 - Testing for time-fixed effects and cross-sectional dependence
 - Nickell bias and the inconsistency of dynamic panel OLS and FE with a lagged dependent variable
 - Difference GMM (Arellano-Bond estimator)
 - System GMM (Arellano-Bover / Blundell-Bond estimator)
 - Instrument proliferation and specification diagnostics: AR(1)/AR(2) tests and the Hansen/Sargan test
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Module 3: Discrete Choice, Limited Dependent Variable, and Count Data Models

Learning Objective

By the end of this module, students will be able to identify when a dependent variable violates the assumptions of linear regression because it is binary, categorical, ordinal, censored, truncated, or a count, and to select and estimate the appropriate non-linear model, interpreting results using marginal effects and odds or incidence-rate ratios.

Topics Covered

- Binary outcome models: the linear probability model and its shortcomings

- Logit and probit models: latent-variable formulation and estimation by maximum likelihood
 - Interpreting coefficients: odds ratios and marginal effects
 - Multinomial logit and multinomial probit models for unordered categorical outcomes
 - The Independence of Irrelevant Alternatives (IIA) assumption and its tests
 - Limited dependent variable models: censoring and truncation
 - The Tobit model and censored/truncated regression
 - Sample selection bias and the Heckman two-step correction
 - Ordinal regression: ordered logit and ordered probit models
 - Modelling count data: the Poisson regression model and the equidispersion assumption
 - Overdispersion and the negative binomial regression model
 - Zero-inflated and hurdle count models
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Module 4: Time Series Econometrics: Nonstationarity, Cointegration, and Multivariate Dynamics

Learning Objective

By the end of this module, students will be able to test time series for stationarity, distinguish spurious relationships from genuine long-run equilibria using cointegration analysis, correct short-run dynamics with error correction models, and use multivariate time series methods, VAR and VECM, to trace how shocks propagate through an economic system.

Topics Covered

- Stochastic processes, stationarity, and the consequences of nonstationary data
- Unit root testing: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS tests
- Spurious regression and the order of integration
- Cointegration: the Engle-Granger two-step approach
- The Johansen procedure for multivariate cointegration and rank testing
- Error Correction Models (ECM): short-run dynamics and long-run equilibrium adjustment
- Vector Autoregression (VAR): specification, lag-order selection, and estimation
- The Vector Error Correction Model (VECM) for cointegrated systems
- Granger causality testing
- Impulse Response Function (IRF) analysis: tracing the dynamic effect of shocks
- Forecast Error Variance Decomposition (FEVD)

Module 5: Production econometric methods

Learning Objective

By the end of this module, participants will be able to estimate production technologies while addressing input endogeneity, measure firm-level or sector-level technical efficiency using stochastic frontier methods, and decompose total factor productivity growth into its underlying sources.

Topics Covered

- Production function estimation: Cobb-Douglas and translog forms
- Endogeneity of input choices and simultaneity bias in production function estimation
- Parametric Semi-parametric estimation approaches
- Olley-Pakes, Levinsohn-Petrin, Akerberg-Caves-Frazer
- Cost frontier estimation
- Estimation of Technical progress, Total factor productivity, Returns to scale, Market power, and Elasticity of substitution

Recommended Readings

- Baltagi, B.H. (2021). *Econometric Analysis of Panel Data*, 6th ed. Springer.
- Cameron, A.C., and Trivedi, P.K. (2005). *Microeconometrics: Methods and Applications*. Cambridge University Press.
- Cameron, A.C., and Trivedi, P.K. (2013). *Regression Analysis of Count Data*, 2nd ed. Cambridge University Press.
- Coelli, T.J., Rao, D.S.P., O'Donnell, C.J., and Battese, G.E. (2005). *An Introduction to Efficiency and Productivity Analysis*, 2nd ed. Springer.
- Enders, W. (2014). *Applied Econometric Time Series*, 4th ed. Wiley.
- Greene, W.H. (2018). *Econometric Analysis*, 8th ed. Pearson.
- Hamilton, J.D. (1994). *Time Series Analysis*. Princeton University Press.
- Hastie, T., Tibshirani, R., and Friedman, J. (2009). *The Elements of Statistical Learning*, 2nd ed. Springer.
- Long, J.S., and Freese, J. (2014). *Regression Models for Categorical Dependent Variables Using Stata*, 3rd ed. Stata Press.

- Lutkepohl, H. (2005). New Introduction to Multiple Time Series Analysis. Springer.
- Stock, J.H., and Watson, M.W. (2019). Introduction to Econometrics, 4th ed. Pearson.
- Wooldridge, J.M. (2010). Econometric Analysis of Cross Section and Panel Data, 2nd ed. MIT Press.
- Wooldridge, J.M. (2015). Introductory Econometrics: A Modern Approach, 6th ed. Cengage Learning.