Economics 308: Econometrics

Professor Moody

Text
Moody, Basic Econometrics with Stata (BES)

References on reserve:
Pindyck and Rubinfeld, Econometric Models and Economic Forecasts (PR)
Wooldridge, Jeffrey M., Introductory Econometrics (W)
Kennedy, Peter, A Guide to Econometrics (K) HB139 K45 2003
Belsley, Kuh, and Welsch, Regression diagnostics (BK) QA278.2 .B44
Stock and Watson, Introduction to Econometrics (SW)

Some journal articles are available electronically in the Course Documents section of Blackboard.

Grading:

Midterm  20%
Final Exam  40%
Project  40%

You must complete all homework assignments. Questions based on the assignments may be on the midterm and the final exam.

Some important dates:
Add/Drop deadline: September 6.
Withdrawal deadline: October 28.
Final Exam: 308-02 (MWF 10), 12/18, 2-5
            308-03 (MWF 11), 12/16, 9-12

Attendance policy: I do not take attendance.

Review: Correlation and Regression.

Describing the relationship between two variables
Scatter diagrams
Correlation
Simple regression
Why is it called regression?
Reference: BES Ch. 7

Assignment 1: reproduce the regression on page 11 of BES.

Theory of Least Squares

Properties of estimators

Small sample properties
  - bias
  - efficiency
  - mean square error
  - relative efficiency
  - robustness

Large sample (asymptotic) properties
  - consistency
  - mean square error consistency
  - asymptotic efficiency
  - asymptotic unbiased

Note: consistency "carries over" transformations while unbiasedness does not

References: W 699-713, M Ch. 2.6, PR 27-30, SW 56-60, BES Ch. 8, 58-60, W Ch. 19.

Assignment 2

**Gauss-Markov Theorem**

Gauss-Markov assumptions
\[ Y_i = \alpha + \beta X_i + U_i \]
\[ U_i \sim iid(0, \sigma^2) \]

Which implies that
  - \( \hat{\beta} \) is a linear function of \( Y \)
  - \( \hat{\beta} \) is random variable with a distribution (the sampling distribution of \( \beta \))
  - \( \hat{\beta} \) is an unbiased estimator of \( \beta \)

Deriving the variance of beta: \( Var(\hat{\beta}) = \hat{\sigma}^2 / \Sigma x^2 \)

Gauss-Markov theorem: OLS is BLUE
OLS is also a maximum likelihood estimator
Inference and Hypothesis Testing

Assume the error term is distributed normally, then the sampling distribution of betahat is also normal with

\[ E(\hat{\beta}) = \beta \] (the truth)

\[ Var(\hat{\beta}) = \frac{\hat{\sigma}_u^2}{\Sigma x^2} \]

however, we must estimate the variance of u:

\[ \hat{\sigma}_u^2 = \Sigma e^2 / (n - 2) \]

A note on the Normal, Chi-square, t, and F distributions

Testing hypotheses concerning \( \beta \)
References: PR Ch. 2; W 724-736, SW 108-117, BES Ch. 8, 65-75.

Maximum likelihood and the likelihood ratio test
References: M 118-129, K Ch. 4.4, BES Ch. 8, 76-78.

Multiple Regression

Why? Because life is complicated: omitted variable bias
Three variable regression model
Interpretation of formulas
Goodness of fit: \( R^2 \)
References: W Ch 3-6, M Ch 4, PR Ch 4-5, SW Ch 5, BES Ch 8, 79-83

Assignment 3

Omitted variable bias and modelling

Review: multiple regression formula determining the direction of bias.
There is only one way to be right and there are many ways to be wrong.
   It is wrong to include an irrelevant variable (inefficiency)
   and it is wrong to leave out a relevant variable (bias).
   However, omitting a relevant variable whose value is less than its standard error will decrease mean square errors.
Proxy variables
References: M Ch 11.6, W Ch 9.2, PR Ch 7.3, 7.5.1; W Ch 3, SW Ch 5, BES Ch 8, 83-90.
Digression: torturing the data until it tells you what you want to hear.

**Dummy Variables**

References: W Ch 7, PR 104-108, 121-123, M Ch 8.1-8.3, K Ch 13, SW 119-122, BES Ch 8 90-94.


**Useful Tests**

- F-test
- Chow test
- Granger causality test
- J-test for non-nested hypotheses
- LM test

References: W Ch 4.5, 237-240; PR 110-112, 115-117, 216-219; M 393-394, 443-446; SW 165-70, 448-9, 468-9; BES Ch 8, 94-102.

**Regression Diagnostics**

- Influential Observations
- Multicollinearity

References: BKW, M Ch 7; BES Ch 9.

Digression: torturing the data until it tells you what you want to hear: Leamer, "Let's Take the Con out of Econometrics" *American Economic Review*, March, 1983, 31-43. (Blackboard)

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**Econometrics: What if the Gauss-Markov Assumptions are Violated?**

**Heteroskedasticity**

Definition: nonconstant error variance, a common problem in cross sections.

Effects:

1. ols estimates remain unbiased, but
2. inefficient,
3. standard errors and t-scores are incorrect

Tests: Breusch-Pagan, White
Cure: weighted least squares
  1. known variances: weighted least squares
  2. unknown variances: assume that the error variance is a function of one or more observable variables
Why not just correct the standard errors? Heteroskedastic consistent (robust) standard errors

Modeling the variance: feasible generalized least squares (FGLS)

References: W Ch. 8-4, M Ch 5, PR Ch 6.1, K Ch 7, SW 124-129, 139-140, 591-596; BES Ch 10

Assignment 4

**Specification Bias**

Rule: if one or more of the explanatory variables in a regression are correlated with the error term, the resulting OLS estimates are biased and inconsistent

Causes of correlation between X and u
  - incorrect functional form
  - omitted variables
  - errors of measurement in the independent variables
  - simultaneous equations

**Errors in variables**

Definition
Effects: ols is biased and inconsistent
Cure: instrumental variables (two stage least squares)
Problems:
  1. Choice between a biased but efficient estimator (ols) and an unbiased but inefficient estimator (IV)
  2. Where are the instruments?
References: M Ch 11.1-11.3, 11.5-11.7, PR Ch 7; SW 248-250; BES Ch 11.

**Simultaneous equations**

When an equation is part of a simultaneous equation system, such that causation runs from Y to X as well as X to Y, then X is correlated with the error term and OLS is biased and inconsistent.

Example: the consumption function
Example: supply and demand
Endogenous and exogenous variables, structural versus reduced form
Consistent parameter estimation: instrumental variables (2sls)
Indirect Least Squares
The identification problem
   The order condition for identification
Types of equation systems: general, recursive, block recursive
Strategies: ols, ols with lags, reduced form, 2sls, VAR
Standard tests
   Hausman test for mis-specification
   Basmann test for over-identification restrictions
   Bound-Jaeger-Baker test for weak instruments
System estimation methods: ZELS, 3SLS
References: M Ch 9, M Ch 12.10, PR Ch 11; KO Ch 7, K Ch 9; SW Ch 10; BES Ch 12.

Assignment 5

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**Time Series Analysis**

Time series data have advantage and disadvantages. The primary advantage is that we know time does not go backwards, so we can use lags to identify causal relationships (not possible in cross sections). The disadvantages are that we have to worry about certain problems that are unique to time series data, namely autocorrelation, unit roots, and cointegration.

**Linear Dynamic Models**

Autoregressive Distributed Lag (ADL) model.
The L (lag) operator.
The following models are special cases of the ADL.
   Static model
   AR model
   Leading Indicator model
   First Difference model
   Distributed Lag model
   Partial Adjustment model
   VAR model
   Common Factor model
   Error Correction model

Note: the Error Correction model is not really a special case, since we did not restrict any coefficients. It is just a re-statement of the ADL after some algebra.
References: SW 443-336, 485-486; BES Ch 13.
Autocorrelation

Definition: $u(t)$ correlated with $u(t-1)$ (and/or $u(t-2)$, etc.)

Effects:
- OLS remains unbiased
- Variance of $\hat{\beta}$ will not be minimum (loss of efficiency)
- Standard errors will be underestimated and t-scores overestimated
  (second order bias)
- If regressors include a lagged dependent variable, then ols estimators will be
  biased and inconsistent as well as inefficient.


There are two reasons for autocorrelation (1) serial correlation in the error term and (2)
omitted variables with time components. If the autocorrelation is due to omitted lagged
variables, then we can't fix it with Cochrane-Orcutt. We need to test to see if we have serial
correlation or mis-specified dynamics.

Likelihood ratio test for mis-specified dynamics

Heteroskedasticity and autocorrelation consistent (HAC) standard errors (Newey-West)

References: M Ch 6, PR Ch 6.2, K Ch 7.4; SW 504-517, 530-531; BES Ch 14.

Analysis of non-stationary data

Random walks and unit roots
Spurious regressions
Unit root tests: ADF, DF-GLS
References: SW 457-467, 545-552; BES Ch 15.

Assignment 6

Cointegration and long run equilibrium

Short-run relationships: first differences
Cointegration and the long-run relationship
  Testing for cointegration
  Estimating the cointegrating regression
  Error correction model
  Dynamic Ordinary Least Squares
Panel Data

Motivation: cures one kind of omitted variable bias, efficient use of data, increases the number of observations

Fixed effects model
  Least squared dummy variables (LSDV)
  Absorb regression
  Xtreg

Time series issues
  Linear trends
  Individual state trends
  Unit roots and nonstationarity
  First difference model
  Autocorrelation
  Clustering
    A problem with clustering panel data models
  Cointegration in panel data models
  Nickell bias in panel data models
  Other panel data models
    Hausman-Wu again

References: PR Ch 9.4; W Ch 13, 14; SW Ch 8; BES Ch 17.