ECONOMIC STATISTICS

NEW SZÉCHENYI PLAN

ELTE ECON

ECONOMIC STATISTICS

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ECONOMIC STATISTICS

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ECONOMIC STATISTICS

Week 12

Time series regression

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ADL(p,q) model

Autoregressive distributed lag model – ADL(p,q):

$$Y_t = \alpha + \delta t + \phi_1 Y_{t-1} + \ldots + \phi_p Y_{t-p} +$$
$$+ \beta_0 X_t + \beta_1 X_{t-1} + \ldots + \beta_q X_{t-q} + e_t$$

X, Y: same stationarity assumption

- Both stationary or
- Both of them have unit root

Case 1: X and Y stationary

- OLS applicable
- Modified form:

$$\Delta Y_t = \alpha + \delta t + \rho Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \ldots + \gamma_{p-1} \Delta Y_{t-p+1} +$$

$$+ \theta X_t + \omega_1 \Delta X_t + \ldots + \omega_q \Delta X_{t-q+1} + e_t$$

$$\text{Equilibrium}: 0 = \alpha + \rho Y^* + \theta X^*$$

$$\text{Long-run multiplicator}: -\frac{\theta}{\rho}$$

Interpretation of the coefficients

- ”Usual” interpretation: effects of temporary changes (ceteris paribus)

- Long-run multiplicator: effect of a permanent one unit change

Case 2: X and Y have unit root

- Spurious regression if X and Y have unit root!

- OLS estimation is not correct!!! Except for cointegration.

- E.g. Estimated coefficient of X is significant if its true value is 0

Cointegration

- Both Y and X have unit root, but a linear combination of them is stationary
- Trends of Y and X move together
- There is an equilibrium relationship between Y and X

- Spurious regression problem is not present
- Estimated coefficient: long-run multiplicator

Testing cointegration

Engle-Granger-test:

- Unit root tests for X and Y

If unit root processes:

- Regress Y on X, residual: u
- Unit root test for u (without deterministic trend)
- If u is stationary: Y and X cointegrated

Null hypothesis: lack of cointegration

Example: agricultural and fuel price indices

- MNB: monthly indices, base: same month of previous year
- Economic relationship?

- Unit root processes – test
- OLS : generate residual
- Unit root test without deterministic trend – result: no unit root
- Cointegrated? If yes – interpret the OLS results

Estimation results

Cointegrated variables:

Dependent Variable: MEZOG

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9,502	0,867	10,961	0,000
UZEM	0,284	0,056	5,103	0,000

R-squared 0,118

Case 3: X and Y not cointegrated

- Dickey–Fuller-test: unit root processes
- Engle–Granger-test: not cointegrated

OLS not applicable!

- Solution: regression on first differences
- Interpretation: effect of difference on difference

Cointegration – error correction model

- Y and X cointegrated
- OLS – long-run relationship
- Sort-run relationship? – error correction model (ECM):

$$\Delta Y_t = \varphi + \lambda e_{t-1} + \omega \, \Delta X_t + \varepsilon_t$$

$$e_{t-1} = Y_{t-1} - \alpha - \beta X_{t-1}$$

$$\lambda < 0$$

Error correction model

- $\lambda<0$: corrects deviation from equilibrium
- Stationary variables in the regression – OLS applicable
- Instead of e: estimated residual
- Interpretation of coefficients:
  - λ: effect of deviation from equilibrium
  - w: short-run effect

ECM - estimation

0: Test unit root, cointegration

1: Regress Y on X, residual: u

2: Regress ΔY on ΔX and lagged u

Similar to ADL(p,q) model: more lags + trend can be included

ECM example

Agricultural and fuel price indices (MNB)

Regress ΔAgr on ΔFuel and lagged u

- Interpretation of coefficients?
- Is the stability condition satisfied?

Estimation results

Dependent Variable: D(AGR)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0,155	0,128	-1,208	0,228
D(FUEL)	0,039	0,036	1,085	0,279
RESID(-1)	-0,046	0,0145	-3,183	0,002

R-squared 0,056

Summary

- 3 cases:

1. X and Y stationary – long-run and short-run effects
2. Cointegration (Engle-Granger test)
3. X and Y not stationary, no cointegration – differencing

- Error correction model: applicable for cointegrated variables

Time series regression

Seminar 12

ADL(p,q) model

Autoregressive distributed lag model – ADL(p,q):

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$$+ \beta_0 X_t + \beta_1 X_{t-1} + ... + \beta_q X_{t-q} + e_t$$

X, Y: same stationarity assumption

X and Y stationary

- OLS applicable
- Modified form:

$$\Delta Y_t = \alpha + \delta t + \rho Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \ldots + \gamma_{p-1} \Delta Y_{t-p+1} +$$
$$+ \theta X_t + \omega_1 \Delta X_t + \ldots + \omega_q \Delta X_{t-q+1} + e_t$$

$$\text{Long-run multiplicator: } -\frac{\theta}{\rho}$$

Example – sales and computers

Computer.wf1 (one firm, 98 months)

Y: % change of sales

X: % change of amount spent on computers

- Unit root test (without trend)
- ADL(2,3) model: long-run multiplicator = 0,09/0,115 – interpretation?

X and Y have unit root

- Spurious regression if X and Y have unit root!

- OLS estimation is not correct! Except for cointegration

Testing cointegration

Cointegration: both Y and X have unit root, but a linear combination of them is stationary

Engle–Granger-test:

- Unit root tests for X and Y

If unit root processes:

- Regress Y on X, residual: u
- Unit root test for u (without deterministic trend)
- If u is stationary: Y and X cointegrated

Null hypothesis: lack of cointegration

Example: agricultural and fuel price indices

- MNB: monthly indices, base: same month of previous year

- Unit root processes – test
- OLS – EViews: resid variable: residual (genr …=resid)
- Unit root test without deterministic trend!
- Cointegrated? If yes – interpret the OLS results.

X and Y not cointegrated

- Dickey–Fuller-test: unit root processes
- Engle–Granger-test: not cointegrated

OLS not applicable!

- Solution: regression on first differences
- Interpretation: effect of difference on difference

Example: inflation and wage growth

- Data: wp.wf1 – log wage and price level 1855-1987, UK
- Unit root processes
- Differenced variables: stationary
- Engle-Granger test – regress lnP on lnW, analyze the residual
  - Not cointegrated
- ADL(1,1) model for differences, modified form – long run effect?

Cointegration – error correction model

- Y and X cointegrated
- OLS – long-run relationship
- Sort-run relationship? – error correction model (ECM):

$$\Delta Y_t = \varphi + \lambda e_{t-1} + \omega \Delta X_t + \varepsilon_t$$

$$e_{t-1} = Y_{t-1} - \alpha - \beta X_{t-1}$$

$$\lambda < 0$$

- Interpretation of coefficients:
  - λ: effect of deviation from equilibrium
  - w: short-run effect

ECM – estimation

0: Test unit root, cointegration

1: Regress Y on X, residual: u

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ECM example

Agricultural and fuel price indices (MNB)

Regress ΔAgr on ΔFuel and lagged u

- Interpretation of coefficients?
- Is the stability condition satisfied? (negative coefficient of u?)

Practicing

MNB data: 1996–2009 monthly EUR (ECU) central exchange rate and monthly export (seasonally adjusted)

- Effect of exchange rate on export?
  - Estimate a model taking into account the stationarity properties and cointegration

Homework 7 (groups)

Use MNB data. Analyze the time series of deposits and credits in relationship with the interest rates.

- Chose1 deposit and 1 credit time series, and respective interest rates
- Characterize the time series (4 time series)
- Stationary variables? Are deposits and interest rate, and credit and interest rate cointegrated?