ECONOMIC STATISTICS

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ECONOMIC STATISTICS

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ECONOMIC STATISTICS

Week 10

Univariate time series analysis: autocorrelation, stationarity, AR(1) model

Anikó Bíró

Distributed lag model – pitfalls

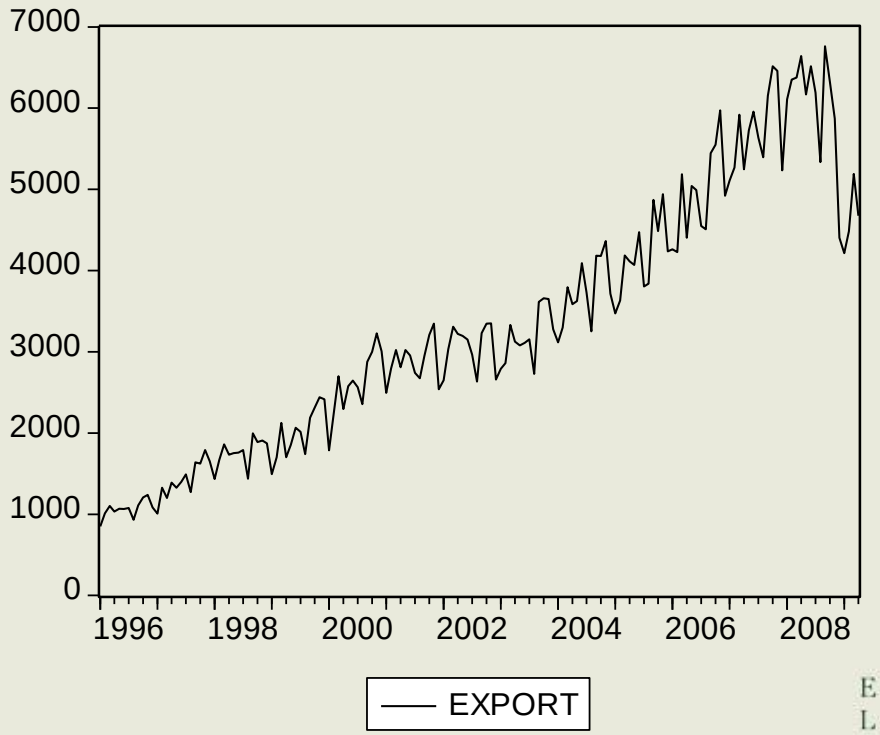
- Distributed lag model: regression of Y on X and on the lags of X

- OLS does not work if:
  - Y depends on lagged Y (e.g. investment/GDP, household expenditure on durable goods)
  - The variables are nonstationary

Univariate time series analysis

- Model for a single time series
- Graphical analysis

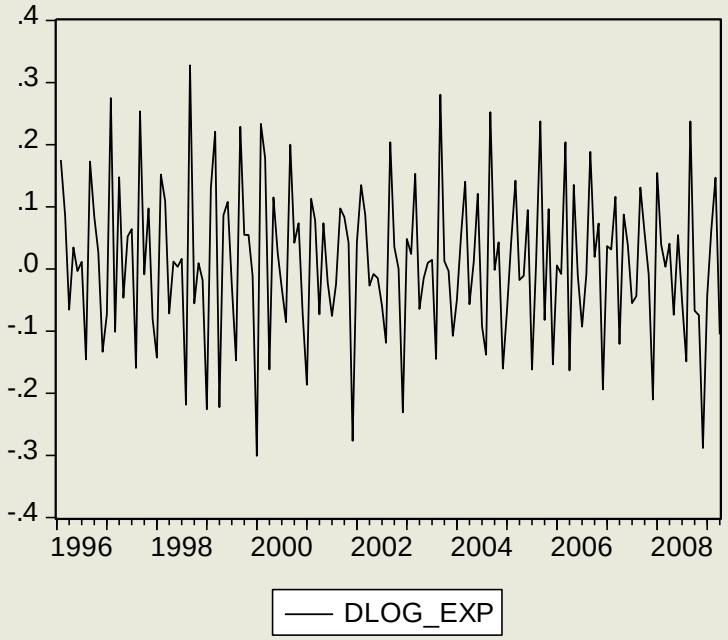
Example 1: monthly export (m EUR) MNB data



Example: monthly change of export

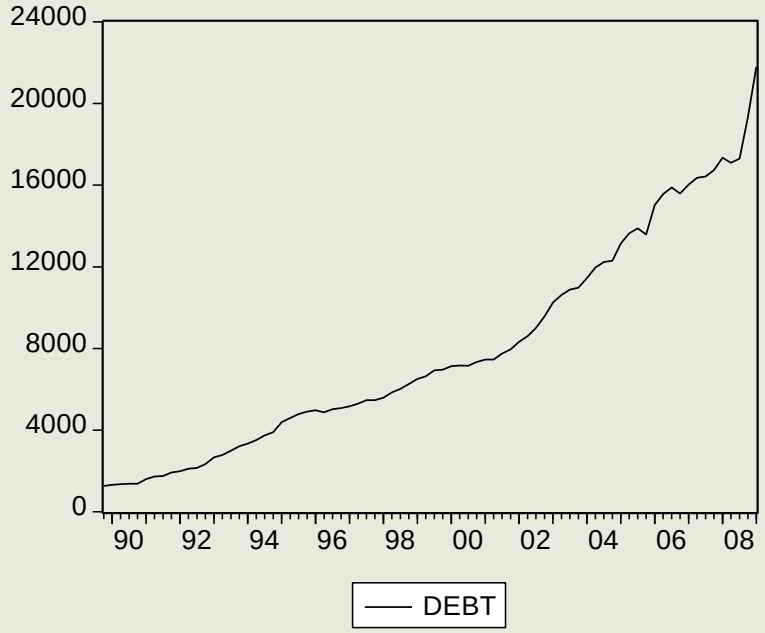
$$\Delta \ln(Exp) = \ln(Exp) - \ln(Exp_{-1})$$

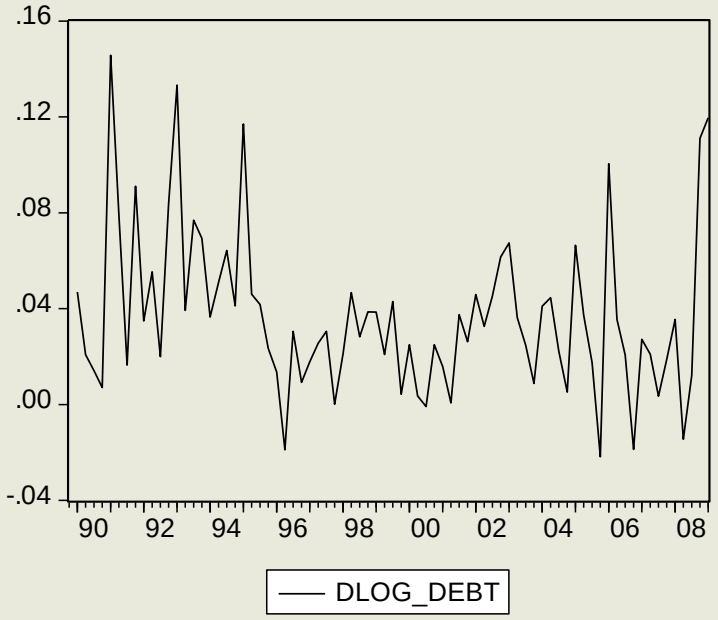
$$100 \cdot \Delta \ln(Exp) \approx \%\ \text{change}$$



Example: public debt

Quarterly data (bn HUF, source: MNB)





Trend

- Most of the macroeconomic variables (consumption, income, debt) typically follow a trend
- Trend: permanent change throughout time

- Time series of differenced variables (difference or log difference): typically not trending

Autocorrelation

Correlation between a variable and its lagged value

r_p: correlation between Y and its p-th lag (Y_{-p})

$$r_p = corr(Y, Y_{-p})$$

Trend: positive autocorrelation

Autocorrelation function

- Series of autocorrelations as a function of lag length

- Longer lag length – fewer observations
- ”Long run memory”

Example: public debt

Autocorrelation	Partial Correlation		AC	PAC
. |******* |	. |******* |	1	0,940	0,940
. |******* |	. |*. |	2	0,893	0,072
. |******* |	. |*. |	3	0,857	0,085
. |****** |	. | . |	4	0,820	-0,004
. |****** |	. | . |	5	0,778	-0,054
. |****** |	. | . |	6	0,739	-0,008
. |***** |	. | . |	7	0,700	-0,023
. |***** |	. | . |	8	0,659	-0,037
. |***** |	. | . |	9	0,618	-0,023
. |**** |	. | . |	10	0,579	-0,014

Partial autocorrelation: autocorrelation between X_t and X_{t-k}, with the effects of X_{t-1}, …, X_{t-k+1} filtered out

Univariate autoregression model

- Regression: more sophisticated than correlation
- AR(1) model:

$$Y_t = \alpha + \phi Y_{t-1} + e_t$$

- Φ=0: random variation around α
- Φ=1: trending pattern

Stationarity – AR(1) model

- Y is stationary in an AR(1) model if $|\Phi| < 1$
- Y is nonstationary if $\Phi = 1$
  - Y has unit root
  - Autocorrelation is close to 1
  - Trending pattern
  - ΔY is stationary:

$$\Delta Y_t = \alpha + (\phi - 1)Y_{t-1} + e_t$$

- Random walk: $Y_t = Y_{t-1} + e_t$
  - Example: stock exchange rates

Examples

AR(1) models of public debt and export – OLS

Estimated slope coefficients:

- Monthly export: 0.96
- Quarterly level of public debt: 1.04

Values close to 1 – test equality: t-test is not appropriate!

Summary

- Trend
- Autocorrelation, autocorrelation function
- Univariate autoregressive model and stationarity

Univariate time series analysis: autocorrelation, stationarity, AR(1) model

Seminar 10

Univariate time series analysis

- Model for a single time series
- Graphical analysis

Example 1: monthly export (m EUR, MNB)

Example 2: public debt, quarterly data (bn HUF, MNB)

Graphs of level and log difference (dlog)?

Trend?

Autocorrelation

Correlation between a variable and its lagged value

r_p: correlation between Y and its p-th lag (Y_{-p})

$$r_p = corr(Y, Y_{-p})$$

Trend: positive autocorrelation

EViews: View/Correlogram

Examples for analyzing autocorrelation functions

- Level (bn HUF) and first difference of public debt
- Level (m EUR) and first difference of export

Univariate autoregression model

- AR(1) model:

$$Y_t = \alpha + \phi Y_{t-1} + e_t$$

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Examples

AR(1) models for public debt and export data – OLS

- Estimated slope coefficient?
- Can we assume stationarity?
- Estimated slope coefficient in the model of differenced variables?

Homework 6 (groups)

Analyze 3 macroeconomic time series variables (from MNB database) with the EViews software

- Graphs of level and change, brief analysis
- Analysis of the autocorrelation function
- Estimation of AR(1) model – can stationarity be assumed?