ECONOMIC STATISTICS

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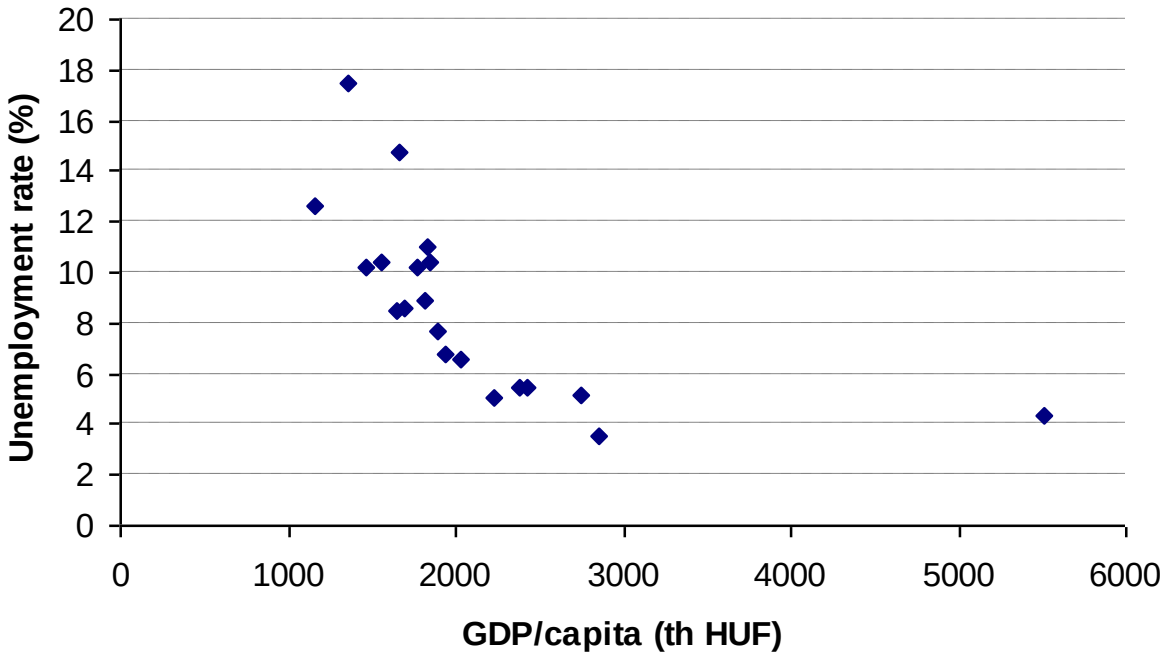
Week 3

Correlation, simple regression – introduction

Example from week 2

Negative relationship between two variables – point diagram (KSH):



Correlation

- Relationship between two variables numerically
- Notation: correlation between X and Y is r_{XY}
- Square of correlation (r_{XY}^2): what percentage of Y's variation is explained by X = what percentage of X's variation is explained by Y

Supplement: form ula of correlation

$$r = \frac{\sum_{i=1}^{N}(Y_i - \bar{Y})(X_i - \bar{X})}{\sqrt{\sum_{i=1}^{N}(Y_i - \bar{Y})^2}\sqrt{\sum_{i=1}^{N}(X_i - \bar{X})^2}}$$

Properties of correlation

- Value between -1 and 1
- Positive value – positive relationship. r=0: no correlation between the variables
- Larger positive value – stronger positive relationship
- Correlation between X and Y = correlation between Y and X
- Correlation of a variable with itself = 1
- Correlation with a constant = 0

Example

Correlation between unemployment rate and GDP/capita = -0,62

- Negative relationship
- Higher GDP/capita – lower unemployment
- The standard deviation of county level GDP/capita explains 38% of the standard deviation of unemployment rate (0,62*0,62=0,384)

Causality?

- Does one variable ”cause” the other?
- Correlation does not reveal the direction of causality
- There might be no causality at all
- Previous examples? (GDP – unemployment, GDP – number of enterprises)

Correlation between more variables

- M variables – M(M-1)/2 correlations
- Correlation matrix of 3 variables (X, Y, Z):

	X	Y	Z
X	1		
Y	r_{XY}	1	
Z	r_{XZ}	r_{ZY}	1

Strength of relationship graphically

- Point diagram between two variables
- See: textbook graphs
- ”How difficult is to draw a line fitting the points?”
- ”How scattered are the points?”

Correlation vs. regression

- Numerical analysis of the relationship between variables:
- Correlation:
  - Between 2 variables
  - Causality?
- Regression:
  - Complex relationships (more variables)
  - There might be an underlying economic model – causality
  - Examples: wage regression (education, …), inflation regression (interest rate, …)

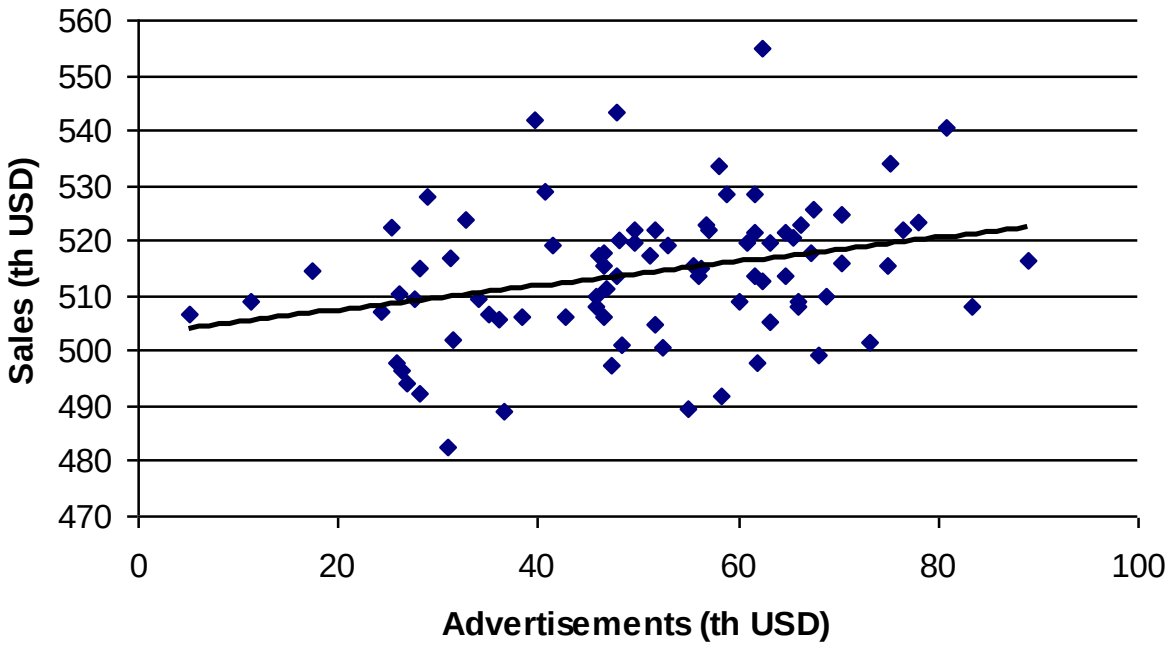
Simple (univariate) regression

- Y dependent variable, X explanatory variable (regressor)
- Assumption: linear relationship
- Regression line:

$$Y = \alpha + \beta X$$

- Reality: the data do not fit a line

Example: advertisement expenditures



Error term

- Linear regression: no perfect fit
  - Omitted, unobservable variables
  - Not linear relationship
- Regression model with error term:

$$Y = \alpha + \beta X + e$$

- Error term (disturbance): distance between the data point and the regression line
- Causality (model)? Generalization of correlation?

Estimation

- Unknown value of coefficients
- Estimated coefficients: coefficients of the best fitting line
  - Notation:

$$\hat{\alpha}, \hat{\beta}$$

- Residual:

$$Y = \hat{\alpha} + \hat{\beta} X + u$$

$$u \neq e$$

OLS estimation

- Best fitting line – minimal sum of square of residuals

$$SSR = \sum_{i=1}^{N} u_i^2$$

- Ordinary least squares (OLS) estimation

Advertisement example, cont.

- Estimated coefficients:
- 502,92 – intercept parameter (constant);
- 0,22 – coefficient of advertisements (slope)
- Interpretation?
- Slope:
  - Average change in Y if X increases by one unit
  - Marginal effect

Summary

- Correlation:
  - Strength of relationship between two variables
  - Properties of correlation
  - Interpretation: square of correlation
- Linear regression (univariate):

- Underlying economic model
- Error term
- Residual
- Estimation: OLS

Correlation, simple regression – introduction

Seminar 3

Correlation

- Relationship between two variables numerically
- Square of correlation (r_{XY}^2): what percentage of Y's variation is explained by X = what percentage of X's variation is explained by Y

- Excel: CORREL() function

Properties of correlation

- Value between -1 and 1
- Positive value – positive relationship. r=0: no correlation between the variables
- Correlation between X and Y = correlation between Y and X
- Correlation of a variable with itself = 1

Examples

Correlation and squared correlation?

- KSH county level data: unemployment and GDP/capita?
- KSH county level data: GDP/capita and number of registered enterprises?
- MNB: HUF/EUR and HUF/USD?

Correlation between more variables - example

- European sample, women aged 50+ (SHARE subsample)
  - Education (0–4 scale)
  - If ever smoked daily
  - Malignant tumor (cancer)
- Qualitative data
- What kind of correlation expected?

Example, cont.

- Immediate causality: smoking – cancer
- Proximate causality: higher education level – cancer

	Educ.	Smoke	Cancer
Educ.	1		
Smoke	0,18	1	
Cancer	0,01	0,04	1

Simple (univariate) regression

- Y dependent variable, X explanatory variable
- Assumption: linear relationship
- Regression line:

$$Y = \alpha + \beta X$$

- Error term vs. residual

Example: advertisement expenditures

Koop: Advert.xls file

- Correlation?

- Point diagram
- Regression line with Excel: Diagram/Trend line

OLS estimation

- Best fitting line – minimal sum of square of residuals

$$SSR = \sum_{i=1}^{N} u_i^2$$

- Ordinary least squares (OLS) estimation
- Excel: Data analysis/Regression – estimate and interpret coefficients of the advertisement examples
- Sensitivity of the coefficients to scaling (unit of measurement)?

Further examples

- KSH county level data: regression of unemployment rate on the number of registered enterprises
  Y: unemployment
  X: enterprises

- Forest.xls: effect of population growth on deforestation?

Homework 2 (individual)

Choose 3 variables from a database among which correlation is expected

- What kind of relationship is expected? Explain.
- Descriptive statistics (graphical + numerical)
- Analysis of correlations