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Lesson 2

What is Econometrics?

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Learning objectives

- To identify the objectives of Econometrics.

- To distinguish between economic model and econometric model.

- To identify the elements of an econometric model.

- To distinguish among different types of data structures.

- To search and organise information relevant to our empirical project.

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What is Econometrics about?

Econometrics deals with :

1. <u>Formulating</u> relationships among economic variables, <u>measuring</u> them and <u>validating</u> the results obtained.

2. Developing the methods necessary to carry out these tasks.

What is Econometrics about?

Economic relationships of interest: Finance, Marketing, International economics, Macroeconomics, Microeconomics, ...

- What are the quantitative effects of reducing class size on student achievement?
- How does another year of education change earnings?
- What is the price elasticity of cigarettes?
- What is the effect on housing prices of environmental improvements?
- What is the effect on investment of a 1 percentage point increase in interest rates by the ECB?

Question:

Economic theory suggests important relationships, often with policy implications, but virtually never suggests quantitative magnitudes of causal effects.

What is Econometrics about?

Objectives:

- To <u>specify</u> the economic relationships in such a way that makes it possible to quantify them.
- To <u>estimate</u> these relationships using available data.
- To <u>test hypothesis</u> about the nature of these relationships.
- To <u>predict</u> future behaviour.

Foundations:

ECONOMIC THEORY	DATA	MATHEMATICS STATISTICS

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The econometric model.

Basic tool: Econometric model.

A model is a simplification of reality intended to promote understanding.

An **econometric model** is formulated in order to:

- Describe how the system works.
- Compute predictions either for the future or under different scenarios.
- Help in the decision-making process.

The econometric model.

Example:

The manager of a famous brewery wants to check the impact of advertising on sales.

1. "Economic model"

$$\text{Sales} = f(\text{Advertising Expenditures}) \qquad ??????$$

Economic reasoning and common sense will provide some information about the factors that affect sales (S) such as prices (P), advertising expenditures (AE), competence prices (P^c), competence advertising expenditures (AE^c), the month of the year (M) and the general economic situation (EC).

$$S = f(P, AE, P^c, AE^c, \text{month}, \text{economic climate})$$

Economic theory may give as well some information about the nature of the relationship between the variables:

$$\Delta P \Rightarrow \triangledown S \qquad \Delta AE \Rightarrow \Delta S \qquad \Delta P^c \Rightarrow \Delta S \dots$$

The econometric model.

2. Data.

Monthly data from 2001 until 2012 are available.

Obs.	S	P	AE	P^c	AE^c	month	economic climate
1	100	1.1	1000	1.25	1100	Jan.	Good
2	120	1.3	1200	1.2	1050	Feb.	Good
3	90	1.0	1300	1.1	1250	Apr.	Good
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
120	105	1.2	1400	1.25	1300	Dec.	Crisis

$$S_t = f(P_t, AE_t, P_t^c, AE_t^c, M_t, EC_t) \qquad t = 1, 2, \ldots 100$$

The econometric model.

3. Apply mathematical methods to measure the effect of advertising on sales.

- Functional form, what is $f(.)$? Let's assume a linear relationship:

$$S_t = \beta_1 + \beta_2\, P_t + \beta_3\, AE_t + \beta_4\, P_t^c + \beta_5\, AE_t^c + \beta_6\, M_t + \beta_7\, EC_t$$

The coefficients β measure the marginal effect on sales of each factor included in the model.

- How do we compute the coefficients β? Solving the equation system we get after quantifying variables month and economic climate?

$t = 1$ $100 = \beta_1 + \beta_2\, 1.1 + \beta_3\, 1000 + \beta_4\, 1.25 + \beta_5\, 1100 + \beta_6\, 1 + \beta_7\, 138$

$t = 2$ $120 = \beta_1 + \beta_2\, 1.3 + \beta_3\, 1200 + \beta_4\, 1.2 + \beta_5\, 1050 + \beta_6\, 2 + \beta_7\, 115$

$\vdots$ $\vdots$

$t = 120$ $105 = \beta_1 + \beta_2\, 1.2 + \beta_3\, 1400 + \beta_4\, 1.25 + \beta_5\, 1300 + \beta_6\, 12 + \beta_7\, 150$

There is not a UNIQUE solution for the coefficients $\beta_1, \beta_2, \ldots, \beta_7$!!

The econometric model.

4. The disturbance or error term, u.

$$S_t = \beta_1 + \beta_2\, P_t + \beta_3\, AE_t + \beta_4\, P_t^c + \beta_5\, AE_t^c + \beta_6\, M_t + \beta_7\, EC_t \; + \; \mathbf{u}_t \quad t = 1, \ldots, 120$$

$$\boxed{S_t = \text{Systematic part} + \text{Random part}}$$

where:

$$\text{Systematic part} \;=\; \beta_1 + \beta_2\, P_t + \beta_3\, AE_t + \beta_4\, P_t^c + \beta_5\, AE_t^c + \beta_6\, M_t + \beta_7\, EC_t$$

$$\text{Random part} \;=\; \mathbf{u}_t$$

Systematic part:

1. Include all the relevant factors to determine sales and all the factors included are relevant.

2. Represents the expected behaviour of the variable of interest, sales, in the population.

The econometric model.

Random part:

$\mathbf{u}_t$ is a non observable random variable that:

- Makes the difference between the economic and the econometric models. It enables us to put together the stable relationship formulated by the economic theory and the individual behaviour in the sample.
- Includes:
  - factors other than income that affect sales not explicitly included in the model,
  - uncertainty of economic relationships,
  - small data discrepancies or measurement errors.

The econometric model is an stochastic model

therefore, it is possible to apply **statistical methods** to estimate its parameters, test hypothesis and forecast.

The econometric model.

Terminology and notation:

$$S_t = \beta_1 + \beta_2\, P_t + \beta_3\, AE_t + \beta_4\, P_t^c + \beta_5\, AE_t^c + \beta_6\, M_t + \beta_7\, EC_t + \mathbf{u}_t \quad t = 1, \ldots, 120$$

▷ Sales (S): dependent variable, explained variable, regressand (Y).

▷ Prices, advertising expenditures, etc. (P, AE, P^c, AE^c, M, EC): independent variables, explanatory variables, regressors ($X_2, X_3, \ldots, X_k$).

▷ $\beta_1, \beta_2, \ldots, \beta_k$: unknown constants that measure the relationship among variables.

▷ $\mathbf{u}_t$: disturbance, error term.

▷ t: index that stands for any observation of the sample.

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Steps in empirical economic analysis.

0. Careful formulation of the question of interest ($Y = f(X)$) !!

1. Specification of an econometric model. $\left\{ \begin{array}{l} \text{Explanatory variables.} \\ \text{Functional form.} \\ \text{Distribution of the error term } u. \end{array} \right.$

2. Data collection.

3. Parameter estimation: $\hat{\beta}_1, \hat{\beta}_2, \ldots, \hat{\beta}_k$.

4. Validation of the model.

5. Use of the model. $\left\{ \begin{array}{l} \text{Coefficient interpretation. Hypothesis testing.} \\ \text{Prediction.} \end{array} \right.$

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Data: types and characteristics.

Types of economic data.

- **Cross-sectional** data set: consists of a sample of individuals taken at a given moment of time.
  It is often assumed that these data have been obtained by random sampling from the underlying population.

- **Time series** data set: consists of observations on a variable over time.
  Key features:
  - a. economic observations can rarely be assumed to be independent over time,
  - b. data frequency at which the data are collected.

- **Panel data set**: consists of a time series for each cross-sectional member in the data set.

Data: types and characteristics.

Types of economic data.

- **Quantitative data:**

  prices, expenditures, demand, investment, ...

- **Qualitative data:**

  seasonality, gender, level of studies, ...

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Data sources.

Economic data may come from:

- National and international organizations, such as:
  - EUSTAT (http://www.eustat.es)
  - INE (http://www.ine.es)
  - Bank of Spain (http://www.bde.es)
  - EUROSTAT (http://ec.europa.eu/eurostat)
  - OECD (http://www.oecd.org)
  - International Monetary Fund (http://www.imf.org)
  - World Bank (http://www.worldbank.org)

- Other data sources.
  - http://www.nber.org/
  - http://www.estadief.minhac.es/
  - http://fisher.osu.edu/fin/osudown.htm
  - http://econ.queensu.ca/jae/
  - http://www.psidonline.isr.umich.edu/data/
  - http://www.census.gov/

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