Chapter 1
An Introduction to Econometrics

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1.1
Why Study Econometrics

■ Econometrics fills a gap between being a "student of economics" and being a "practicing economist"

- It lets you tell your employer:
  - "I can predict the sales of your product"
  - "I can estimate the effect on your sales if your competition lowers its price by $1 per unit"
  - "I can test whether your new ad campaign is actually increasing your sales"
- Helps you develop "intuition" about how things work and is invaluable if you go to graduate school

1.2
What is Econometrics About

Econometrics is about how we can use theory and data from economics, business, and the social sciences, along with tools from statistics, to answer ''how much'' questions.

■ In economics we express our ideas about relationships between economic variables using the mathematical concept of a function

$$Consumption = f(Income)$$

$$Q^d = f(P, P^s, P^C, INC)$$

$$Q^s = f(P, P^C, P^f)$$

■ Every day, decision-makers face ''how much'':

– A city council ponders the question of how much violent crime will be reduced if an additional million dollars is spent putting uniformed police on the street

– The owner of a local Pizza Hut must decide how much advertising space to purchase in the local newspaper, and thus must estimate the relationship between advertising and sales

– Louisiana State University must estimate how much enrollment will fall if tuition is raised by $300 per semester, and thus whether its revenue from tuition will rise or fall

– The CEO of Proctor & Gamble must estimate how much demand there will be in ten years for the detergent Tide, and how much to invest in new plant and equipment

■ Every day, decision-makers face ''how much'' questions (Continued):

– A real estate developer must predict by how much population and income will increase to the south of Baton Rouge, Louisiana, over the next few years, and whether it will be profitable to begin construction of a gambling casino and golf course

– You must decide how much of your savings will go into a stock fund, and how much into the money market. This requires you to make predictions of the level of economic activity, the rate of inflation, and interest rates over your planning horizon

– A public transportation council in Melbourne, Australia, must decide how an increase in fares for public transportation (trams, trains, and buses) will affect the number of travelers who switch to car or bike, and the effect of this switch on revenue going to public transportation

1.3
The Econometric Model

■ An econometric model consists of a systematic part and a random and unpredictable component e that we will call a **random error**

$$Q^d = f\left(P, P^s, P^c, INC\right) + e$$

$$f\left(P, P^s, P^c, INC\right) = \beta_1 + \beta_2 P + \beta_3 P^s + \beta_4 P^c + \beta_5 INC$$

$$Q^d = \beta_1 + \beta_2 P + \beta_3 P^s + \beta_4 P^c + \beta_5 INC + e$$

■ The coefficients β_1, β_2, …, β_5 are unknown parameters of the model that we estimate using economic data and an econometric technique

– The functional form represents a hypothesis about the relationship between the variables

– In any particular problem, one challenge is to determine a functional form that is compatible with economic theory and the data

■ The systematic portion is the part we obtain from economic theory, and includes an assumption about the functional form

■ The random component represents a "noise" component, which obscures our understanding of the relationship among variables, and which we represent using the random variable e

■ We use the econometric model as a basis for statistical inference

■ The ways in which statistical inference are carried out include:

1. Estimating economic parameters, such as elasticities, using econometric methods

2. Predicting economic outcomes, such as the enrollment in two-year colleges in the United States for the next ten years

3. Testing economic hypotheses, such as the question of whether newspaper advertising is better than store displays for increasing sales

1.4
How are Data Generated?

■ We must have data

– Where do data come from?

– What type of real processes generate data?

■ Economists and other social scientists work in a complex world in which data on variables are ''observed'' and rarely obtained from a controlled experiment

– This makes the task of learning about economic parameters all the more difficult

■ One way to acquire information about the unknown parameters of economic relationships is to conduct or observe the outcome of an experiment

– Such controlled experiments are rare in business and the social sciences

– There are some examples of planned experiments in the social sciences

• A notable example of a planned experiment is Tennessee's Project Star

■ An example of nonexperimental data is survey data

  – Data on all variables are collected simultaneously, and the values are neither fixed nor repeatable

    • These are nonexperimental data

1.5
Economic Data Types

■ Economic data comes in a variety of "flavors."

– Data may be collected at various levels of aggregation: Micro or Macro

– Data may also represent a flow or a stock:

• Flow: measured over a period of time

• Stock: measured at a particular point in time

– Data may be quantitative or qualitative:

• Quantitative: expressed as numbers

• Qualitative: expressed as an "either-or" situation

■ A time-series is data collected over discrete intervals of time

– The key feature of time-series data is that the same economic quantity is recorded at a regular time interval

Table 1.1 Annual GDP of Real 2005 Dollars

Year	GDP
2001	11347.2
2002	11553.0
2003	11840.7
2004	12263.8
2005	12638.4
2006	12976.2
2007	13254.1
2008	13312.2

Figure 1.1 Real U.S. GDP, 1980–2008
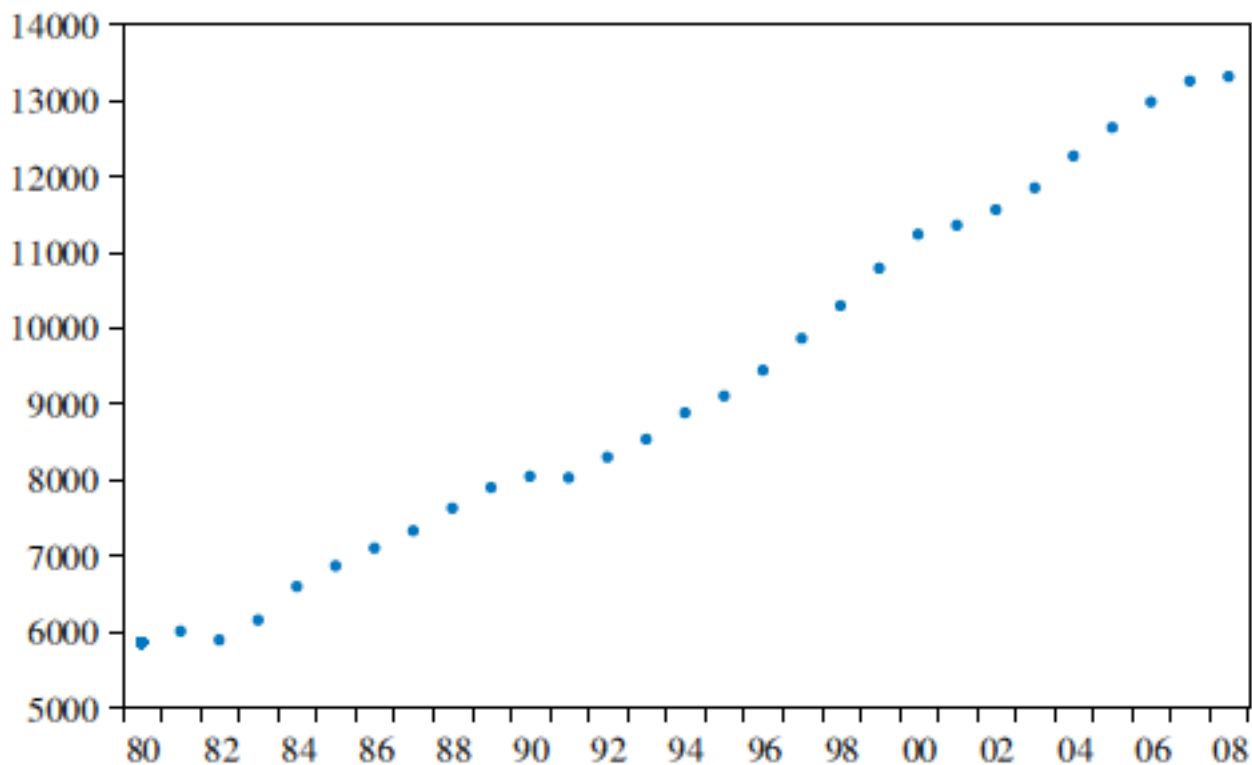
■ A cross-section of data is collected across sample units in a particular time period

– The ''sample units'' are individual entities and may be firms, persons, households, states, or countries

Table 1.2 Cross Section Data: CPS August 2009

			Variables			
Individual	RACE	EDUCATION	MARITAL_STATUS	SEX	HOURS	WAGE
1	White	10th Grade	Never Married	Male	2	8.00
2	White	Assoc Degree	Married	Male	40	10.81
3	Other	Some College No Degree	Divorced	Male	38	10.23
4	White	High School Grad or GED	Married	Female	32	11.50
5	White	Some College No Degree	Never Married	Male	50	12.50
6	White	High School Grad or GED	Divorced	Female	20	7.00
7	White	High School Grad or GED	Married	Female	10	8.00
8	White	5th or 6th Grade	Never Married	Female	15	9.30
9	White	High School Grad or GED	Married	Female	40	20.00

■ A "panel" of data, also known as "longitudinal" data, has observations on individual micro-units who are followed over time

- The key aspect of panel data is that we observe each micro-unit for a number of time periods

- If we have the same number of time period observations for each micro-unit, we have a **balanced panel**

- Usually the number of time series observations is small relative to the number of micro-units, but not always

Table 1.3 Panel Data from Two Rice Farms

FIRM	YEAR	PROD	AREA	LABOR	FERT
1	1990	7.87	2.50	160	207.5
1	1991	7.18	2.50	138	295.5
1	1992	8.92	2.50	140	362.5
1	1993	7.31	2.50	127	338.0
1	1994	7.54	2.50	145	337.5
1	1995	4.51	2.50	123	207.2
1	1996	4.37	2.25	123	345.0
1	1997	7.27	2.15	87	222.8
2	1990	10.35	3.80	184	303.5
2	1991	10.21	3.80	151	206.0
2	1992	13.29	3.80	185	374.5
2	1993	18.58	3.80	262	421.0
2	1994	17.07	3.80	174	595.7
2	1995	16.61	4.25	244	234.8
2	1996	12.28	4.25	159	479.0
2	1997	14.20	3.75	133	170.0

1.6
The Research Process

■ Econometrics is ultimately a research tool

- Students of econometrics plan to do research or they plan to read and evaluate the research of others, or both

- Research is a process, and like many such activities, it flows according to an orderly pattern

  • Research is an adventure, and can be fun!

■ Steps in the research process:

1. Use economic theory to think about the problem

2. Develop a working economic model leading to an econometric model

3. Obtain sample data and choose a desirable method of statistical analysis based on initial assumptions and an understanding of how the data were collected

4. Estimate the unknown parameters with the help of a statistical software package, make predictions, and test hypotheses

■ Steps in the research process (Continued)

5. Perform model diagnostics to check the validity of assumptions

6. Analyze and evaluate the economic consequences and the implications of the empirical results