

# Introduction

## I.1 What Is Econometrics?

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Literally interpreted, *econometrics* means “economic measurement.” Although measurement is an important part of econometrics, the scope of econometrics is much broader, as can be seen from the following quotations:

Econometrics, the result of a certain outlook on the role of economics, consists of the application of mathematical statistics to economic data to lend empirical support to the models constructed by mathematical economics and to obtain numerical results.<sup>1</sup>

... econometrics may be defined as the quantitative analysis of actual economic phenomena based on the concurrent development of theory and observation, related by appropriate methods of inference.<sup>2</sup>

Econometrics may be defined as the social science in which the tools of economic theory, mathematics, and statistical inference are applied to the analysis of economic phenomena.<sup>3</sup>

Econometrics is concerned with the empirical determination of economic laws.<sup>4</sup>

The art of the econometrician consists in finding the set of assumptions that are both sufficiently specific and sufficiently realistic to allow him to take the best possible advantage of the data available to him.<sup>5</sup>

Econometricians ... are a positive help in trying to dispel the poor public image of economics (quantitative or otherwise) as a subject in which empty boxes are opened by assuming the existence of can-openers to reveal contents which any ten economists will interpret in 11 ways.<sup>6</sup>

The method of econometric research aims, essentially, at a conjunction of economic theory and actual measurements, using the theory and technique of statistical inference as a bridge pier.<sup>7</sup>

<sup>1</sup>Gerhard Tintner, *Methodology of Mathematical Economics and Econometrics*, The University of Chicago Press, Chicago, 1968, p. 74.

<sup>2</sup>P. A. Samuelson, T. C. Koopmans, and J. R. N. Stone, “Report of the Evaluative Committee for *Econometrica*,” *Econometrica*, vol. 22, no. 2, April 1954, pp. 141–146.

<sup>3</sup>Arthur S. Goldberger, *Econometric Theory*, John Wiley & Sons, New York, 1964, p. 1.

<sup>4</sup>H. Theil, *Principles of Econometrics*, John Wiley & Sons, New York, 1971, p. 1.

<sup>5</sup>E. Malinvaud, *Statistical Methods of Econometrics*, Rand McNally, Chicago, 1966, p. 514.

<sup>6</sup>Adrian C. Darnell and J. Lynne Evans, *The Limits of Econometrics*, Edward Elgar Publishing, Hants, England, 1990, p. 54.

<sup>7</sup>T. Haavelmo, “The Probability Approach in Econometrics,” Supplement to *Econometrica*, vol. 12, 1944, preface p. iii.

## I.2 Why a Separate Discipline?

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As the preceding definitions suggest, econometrics is an amalgam of economic theory, mathematical economics, economic statistics, and mathematical statistics. Yet the subject deserves to be studied in its own right for the following reasons.

Economic theory makes statements or hypotheses that are mostly qualitative in nature. For example, microeconomic theory states that, other things remaining the same, a reduction in the price of a commodity is expected to increase the quantity demanded of that commodity. Thus, economic theory postulates a negative or inverse relationship between the price and quantity demanded of a commodity. But the theory itself does not provide any numerical measure of the relationship between the two; that is, it does not tell by how much the quantity will go up or down as a result of a certain change in the price of the commodity. It is the job of the econometrician to provide such numerical estimates. Stated differently, econometrics gives empirical content to most economic theory.

The main concern of mathematical economics is to express economic theory in mathematical form (equations) without regard to measurability or empirical verification of the theory. Econometrics, as noted previously, is mainly interested in the empirical verification of economic theory. As we shall see, the econometrician often uses the mathematical equations proposed by the mathematical economist but puts these equations in such a form that they lend themselves to empirical testing. And this conversion of mathematical into econometric equations requires a great deal of ingenuity and practical skill.

Economic statistics is mainly concerned with collecting, processing, and presenting economic data in the form of charts and tables. These are the jobs of the economic statistician. It is he or she who is primarily responsible for collecting data on gross national product (GNP), employment, unemployment, prices, and so on. The data thus collected constitute the raw data for econometric work. But the economic statistician does not go any further, not being concerned with using the collected data to test economic theories. Of course, one who does that becomes an econometrician.

Although mathematical statistics provides many tools used in the trade, the econometrician often needs special methods in view of the unique nature of most economic data, namely, that the data are not generated as the result of a controlled experiment. The econometrician, like the meteorologist, generally depends on data that cannot be controlled directly. As Spanos correctly observes:

In econometrics the modeler is often faced with **observational** as opposed to **experimental** data. This has two important implications for empirical modeling in econometrics. First, the modeler is required to master very different skills than those needed for analyzing experimental data. . . . Second, the separation of the data collector and the data analyst requires the modeler to familiarize himself/herself thoroughly with the nature and structure of data in question.<sup>8</sup>

## I.3 Methodology of Econometrics

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How do econometricians proceed in their analysis of an economic problem? That is, what is their methodology? Although there are several schools of thought on econometric methodology, we present here the **traditional** or **classical** methodology, which still dominates empirical research in economics and other social and behavioral sciences.<sup>9</sup>

<sup>8</sup>Aris Spanos, *Probability Theory and Statistical Inference: Econometric Modeling with Observational Data*, Cambridge University Press, United Kingdom, 1999, p. 21.

<sup>9</sup>For an enlightening, if advanced, discussion on econometric methodology, see David F. Hendry, *Dynamic Econometrics*, Oxford University Press, New York, 1995. See also Aris Spanos, *op. cit.*

Broadly speaking, traditional econometric methodology proceeds along the following lines:

1. Statement of theory or hypothesis.
2. Specification of the mathematical model of the theory.
3. Specification of the statistical, or econometric, model.
4. Obtaining the data.
5. Estimation of the parameters of the econometric model.
6. Hypothesis testing.
7. Forecasting or prediction.
8. Using the model for control or policy purposes.

To illustrate the preceding steps, let us consider the well-known Keynesian theory of consumption.

## 1. Statement of Theory or Hypothesis

Keynes stated:

The fundamental psychological law . . . is that men [women] are disposed, as a rule and on average, to increase their consumption as their income increases, but not as much as the increase in their income.<sup>10</sup>

In short, Keynes postulated that the **marginal propensity to consume (MPC)**, the rate of change of consumption for a unit (say, a dollar) change in income, is greater than zero but less than 1.

## 2. Specification of the Mathematical Model of Consumption

Although Keynes postulated a positive relationship between consumption and income, he did not specify the precise form of the functional relationship between the two. For simplicity, a mathematical economist might suggest the following form of the Keynesian consumption function:

$$Y = \beta_1 + \beta_2 X \quad 0 < \beta_2 < 1 \quad (\text{I.3.1})$$

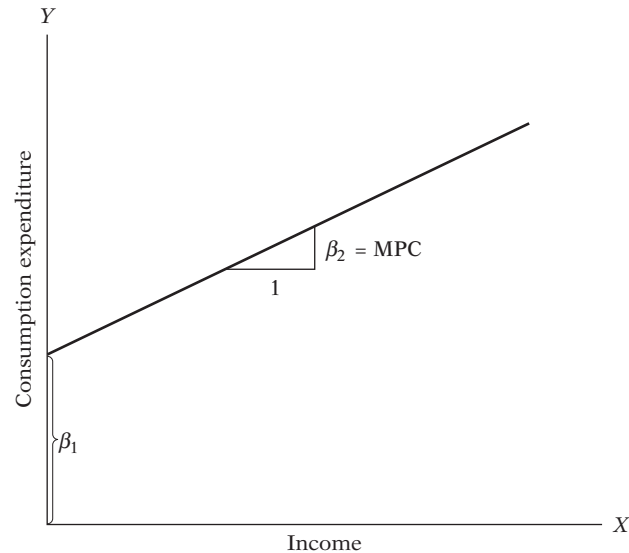
where  $Y$  = consumption expenditure and  $X$  = income, and where  $\beta_1$  and  $\beta_2$ , known as the **parameters** of the model, are, respectively, the **intercept** and **slope** coefficients.

The slope coefficient  $\beta_2$  measures the MPC. Geometrically, Equation I.3.1 is as shown in Figure I.1. This equation, which states that consumption is linearly related to income, is an example of a mathematical model of the relationship between consumption and income that is called the **consumption function** in economics. A model is simply a set of mathematical equations. If the model has only one equation, as in the preceding example, it is called a **single-equation model**, whereas if it has more than one equation, it is known as a **multiple-equation model** (the latter will be considered later in the book).

In Eq. (I.3.1) the variable appearing on the left side of the equality sign is called the **dependent variable** and the variable(s) on the right side is called the **independent, or explanatory, variable(s)**. Thus, in the Keynesian consumption function, Eq. (I.3.1), consumption (expenditure) is the dependent variable and income is the explanatory variable.

<sup>10</sup>John Maynard Keynes, *The General Theory of Employment, Interest and Money*, Harcourt Brace Jovanovich, New York, 1936, p. 96.

FIGURE I.1

Keynesian  
consumption function.

### 3. Specification of the Econometric Model of Consumption

The purely mathematical model of the consumption function given in Eq. (I.3.1) is of limited interest to the econometrician, for it assumes that there is an *exact* or *deterministic* relationship between consumption and income. But relationships between economic variables are generally inexact. Thus, if we were to obtain data on consumption expenditure and disposable (i.e., aftertax) income of a sample of, say, 500 American families and plot these data on a graph paper with consumption expenditure on the vertical axis and disposable income on the horizontal axis, we would not expect all 500 observations to lie exactly on the straight line of Eq. (I.3.1) because, in addition to income, other variables affect consumption expenditure. For example, size of family, ages of the members in the family, family religion, etc., are likely to exert some influence on consumption.

To allow for the inexact relationships between economic variables, the econometrician would modify the deterministic consumption function in Eq. (I.3.1) as follows:

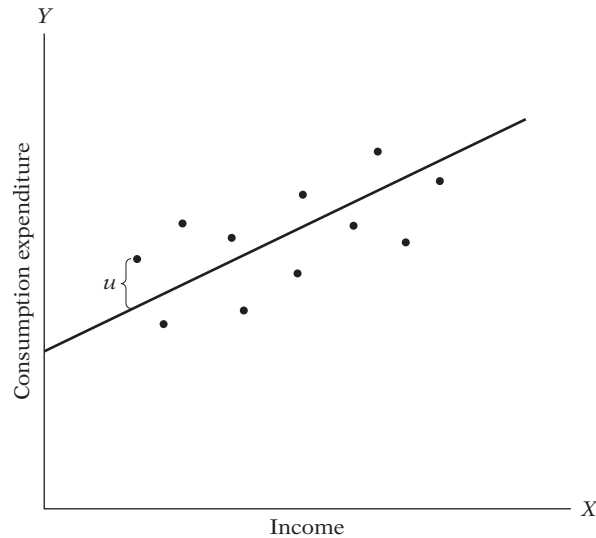
$$Y = \beta_1 + \beta_2 X + u \quad (\text{I.3.2})$$

where  $u$ , known as the **disturbance**, or **error term**, is a **random (stochastic) variable** that has well-defined probabilistic properties. The disturbance term  $u$  may well represent all those factors that affect consumption but are not taken into account explicitly.

Equation I.3.2 is an example of an **econometric model**. More technically, it is an example of a **linear regression model**, which is the major concern of this book. The econometric consumption function hypothesizes that the dependent variable  $Y$  (consumption) is linearly related to the explanatory variable  $X$  (income) but that the relationship between the two is not exact; it is subject to individual variation.

The econometric model of the consumption function can be depicted as shown in Figure I.2.

**FIGURE I.2**  
Econometric model  
of the Keynesian  
consumption function.



#### 4. Obtaining Data

To estimate the econometric model given in Eq. (I.3.2), that is, to obtain the numerical values of  $\beta_1$  and  $\beta_2$ , we need data. Although we will have more to say about the crucial importance of data for economic analysis in the next chapter, for now let us look at the data given in Table I.1, which relate to the U.S. economy for the period 1960–2005. The  $Y$  variable in this table is the *aggregate* (for the economy as a whole) personal consumption expenditure (PCE) and the  $X$  variable is gross domestic product (GDP), a measure of aggregate income, both measured in billions of 2000 dollars. Therefore, the data are in “real” terms; that is, they are measured in constant (2000) prices. The data are plotted in Figure I.3 (cf. Figure I.2). For the time being neglect the line drawn in the figure.

#### 5. Estimation of the Econometric Model

Now that we have the data, our next task is to estimate the parameters of the consumption function. The numerical estimates of the parameters give empirical content to the consumption function. The actual mechanics of estimating the parameters will be discussed in Chapter 3. For now, note that the statistical technique of **regression analysis** is the main tool used to obtain the estimates. Using this technique and the data given in Table I.1, we obtain the following estimates of  $\beta_1$  and  $\beta_2$ , namely,  $-299.5913$  and  $0.7218$ . Thus, the estimated consumption function is:

$$\hat{Y}_t = -299.5913 + 0.7218X_t \quad (\text{I.3.3})$$

The hat on the  $Y$  indicates that it is an estimate.<sup>11</sup> The estimated consumption function (i.e., regression line) is shown in Figure I.3.

<sup>11</sup>As a matter of convention, a hat over a variable or parameter indicates that it is an estimated value.

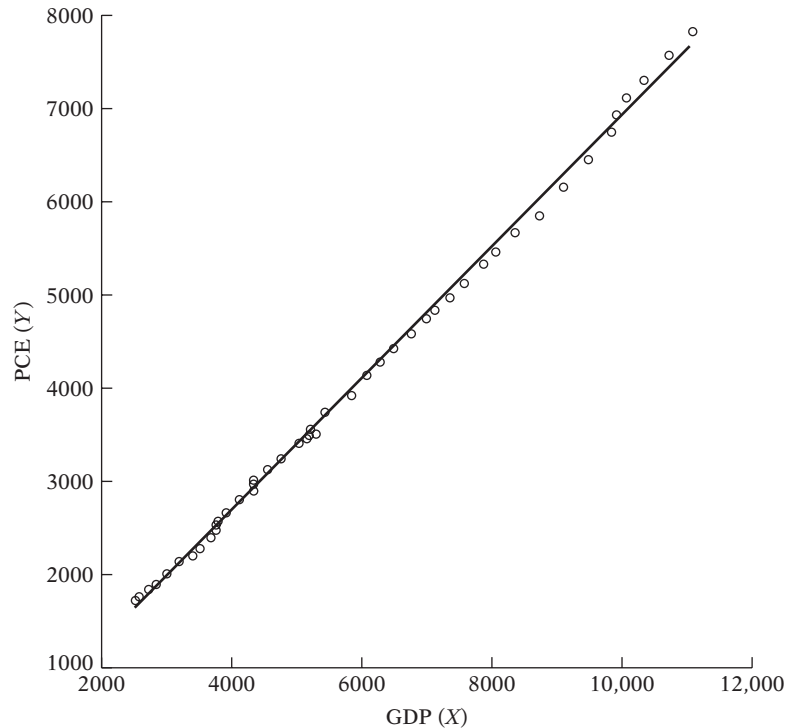
**TABLE I.1**  
**Data on  $Y$  (Personal Consumption Expenditure) and  $X$  (Gross Domestic Product, 1960–2005), both in 2000 Billions of Dollars**

Source: *Economic Report of the President*, 2007, Table B–2, p. 230.

Year	PCE( $Y$ )	GDP( $X$ )
1960	1597.4	2501.8
1961	1630.3	2560.0
1962	1711.1	2715.2
1963	1781.6	2834.0
1964	1888.4	2998.6
1965	2007.7	3191.1
1966	2121.8	3399.1
1967	2185.0	3484.6
1968	2310.5	3652.7
1969	2396.4	3765.4
1970	2451.9	3771.9
1971	2545.5	3898.6
1972	2701.3	4105.0
1973	2833.8	4341.5
1974	2812.3	4319.6
1975	2876.9	4311.2
1976	3035.5	4540.9
1977	3164.1	4750.5
1978	3303.1	5015.0
1979	3383.4	5173.4
1980	3374.1	5161.7
1981	3422.2	5291.7
1982	3470.3	5189.3
1983	3668.6	5423.8
1984	3863.3	5813.6
1985	4064.0	6053.7
1986	4228.9	6263.6
1987	4369.8	6475.1
1988	4546.9	6742.7
1989	4675.0	6981.4
1990	4770.3	7112.5
1991	4778.4	7100.5
1992	4934.8	7336.6
1993	5099.8	7532.7
1994	5290.7	7835.5
1995	5433.5	8031.7
1996	5619.4	8328.9
1997	5831.8	8703.5
1998	6125.8	9066.9
1999	6438.6	9470.3
2000	6739.4	9817.0
2001	6910.4	9890.7
2002	7099.3	10048.8
2003	7295.3	10301.0
2004	7577.1	10703.5
2005	7841.2	11048.6

**FIGURE I.3**

Personal consumption expenditure ( $Y$ ) in relation to GDP ( $X$ ), 1960–2005, in billions of 2000 dollars.



As Figure I.3 shows, the regression line fits the data quite well in that the data points are very close to the regression line. From this figure we see that for the period 1960–2005 the slope coefficient (i.e., the **MPC**) was about 0.72, suggesting that for the sample period an increase in real income of one dollar led, *on average*, to an increase of about 72 cents in real consumption expenditure.<sup>12</sup> We say *on average* because the relationship between consumption and income is inexact; as is clear from Figure I.3, not all the data points lie exactly on the regression line. In simple terms we can say that, according to our data, the *average*, or *mean*, consumption expenditure went up by about 72 cents for a dollar's increase in real income.

## 6. Hypothesis Testing

Assuming that the fitted model is a reasonably good approximation of reality, we have to develop suitable criteria to find out whether the estimates obtained in, say, Equation I.3.3 are in accord with the expectations of the theory that is being tested. According to “positive” economists like Milton Friedman, a theory or hypothesis that is not verifiable by appeal to empirical evidence may not be admissible as a part of scientific enquiry.<sup>13</sup>

As noted earlier, Keynes expected the MPC to be positive but less than 1. In our example we found the MPC to be about 0.72. But before we accept this finding as confirmation of Keynesian consumption theory, we must enquire whether this estimate is sufficiently

<sup>12</sup>Do not worry now about how these values were obtained. As we show in Chapter 3, the statistical method of **least squares** has produced these estimates. Also, for now do not worry about the negative value of the intercept.

<sup>13</sup>See Milton Friedman, “The Methodology of Positive Economics,” *Essays in Positive Economics*, University of Chicago Press, Chicago, 1953.

below unity to convince us that this is not a chance occurrence or peculiarity of the particular data we have used. In other words, is 0.72 *statistically less than 1*? If it is, it may support Keynes's theory.

Such confirmation or refutation of economic theories on the basis of sample evidence is based on a branch of statistical theory known as **statistical inference (hypothesis testing)**. Throughout this book we shall see how this inference process is actually conducted.

## 7. Forecasting or Prediction

If the chosen model does not refute the hypothesis or theory under consideration, we may use it to predict the future value(s) of the dependent, or **forecast, variable**  $Y$  on the basis of the known or expected future value(s) of the explanatory, or **predictor, variable**  $X$ .

To illustrate, suppose we want to predict the mean consumption expenditure for 2006. The GDP value for 2006 was 11319.4 billion dollars.<sup>14</sup> Putting this GDP figure on the right-hand side of Eq. (1.3.3), we obtain:

$$\begin{aligned}\hat{Y}_{2006} &= -299.5913 + 0.7218(11319.4) \\ &= 7870.7516\end{aligned}\tag{1.3.4}$$

or about 7870 billion dollars. Thus, given the value of the GDP, the mean, or average, forecast consumption expenditure is about 7870 billion dollars. The actual value of the consumption expenditure reported in 2006 was 8044 billion dollars. The estimated model Eq. (1.3.3) thus **underpredicted** the actual consumption expenditure by about 174 billion dollars. We could say the **forecast error** is about 174 billion dollars, which is about 1.5 percent of the actual GDP value for 2006. When we fully discuss the linear regression model in subsequent chapters, we will try to find out if such an error is "small" or "large." But what is important for now is to note that such forecast errors are inevitable given the statistical nature of our analysis.

There is another use of the estimated model Eq. (1.3.3). Suppose the president decides to propose a reduction in the income tax. What will be the effect of such a policy on income and thereby on consumption expenditure and ultimately on employment?

Suppose that, as a result of the proposed policy change, investment expenditure increases. What will be the effect on the economy? As macroeconomic theory shows, the change in income following, say, a dollar's worth of change in investment expenditure is given by the **income multiplier**  $M$ , which is defined as

$$M = \frac{1}{1 - \text{MPC}}\tag{1.3.5}$$

If we use the MPC of 0.72 obtained in Eq. (1.3.3), this multiplier becomes about  $M = 3.57$ . That is, an increase (decrease) of a dollar in investment will *eventually* lead to more than a threefold increase (decrease) in income; note that it takes time for the multiplier to work.

The critical value in this computation is MPC, for the multiplier depends on it. And this estimate of the MPC can be obtained from regression models such as Eq. (1.3.3). Thus, a quantitative estimate of MPC provides valuable information for policy purposes. Knowing MPC, one can predict the future course of income, consumption expenditure, and employment following a change in the government's fiscal policies.

<sup>14</sup>Data on PCE and GDP were available for 2006 but we purposely left them out to illustrate the topic discussed in this section. As we will discuss in subsequent chapters, it is a good idea to save a portion of the data to find out how well the fitted model predicts the out-of-sample observations.



## 8. Use of the Model for Control or Policy Purposes

Suppose we have the estimated consumption function given in Eq. (I.3.3). Suppose further the government believes that consumer expenditure of about 8750 (billions of 2000 dollars) will keep the unemployment rate at its current level of about 4.2 percent (early 2006). What level of income will guarantee the target amount of consumption expenditure?

If the regression results given in Eq. (I.3.3) seem reasonable, simple arithmetic will show that

$$8750 = -299.5913 + 0.7218(GDP_{2006}) \quad (I.3.6)$$

which gives  $X = 12537$ , approximately. That is, an income level of about 12537 (billion) dollars, given an MPC of about 0.72, will produce an expenditure of about 8750 billion dollars.

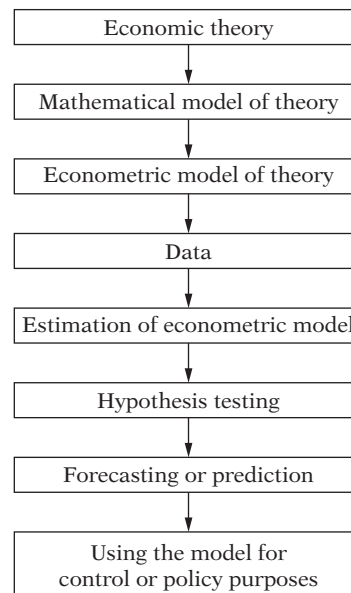
As these calculations suggest, an estimated model may be used for control, or policy, purposes. By appropriate fiscal and monetary policy mix, the government can manipulate the **control variable**  $X$  to produce the desired level of the **target variable**  $Y$ .

Figure I.4 summarizes the anatomy of classical econometric modeling.

### Choosing among Competing Models

When a governmental agency (e.g., the U.S. Department of Commerce) collects economic data, such as that shown in Table I.1, it does not necessarily have any economic theory in mind. How then does one know that the data really support the Keynesian theory of consumption? Is it because the Keynesian consumption function (i.e., the regression line) shown in Figure I.3 is extremely close to the actual data points? Is it possible that another consumption model (theory) might equally fit the data as well? For example, Milton Friedman has developed a model of consumption, called the *permanent income*

**FIGURE I.4**  
Anatomy of  
econometric modeling.



*hypothesis*.<sup>15</sup> Robert Hall has also developed a model of consumption, called the *life-cycle permanent income hypothesis*.<sup>16</sup> Could one or both of these models also fit the data in Table I.1?

In short, the question facing a researcher in practice is how to choose among competing hypotheses or models of a given phenomenon, such as the consumption–income relationship. As Miller contends:

No encounter with data is [a] step towards genuine confirmation unless the hypothesis does a better job of coping with the data than some natural rival. . . . What strengthens a hypothesis, here, is a victory that is, at the same time, a defeat for a plausible rival.<sup>17</sup>

How then does one choose among competing models or hypotheses? Here the advice given by Clive Granger is worth keeping in mind:<sup>18</sup>

I would like to suggest that in the future, when you are presented with a new piece of theory or empirical model, you ask these questions:

- (i) What purpose does it have? What economic decisions does it help with?
- (ii) Is there any evidence being presented that allows me to evaluate its quality compared to alternative theories or models?

I think attention to such questions will strengthen economic research and discussion.

As we progress through this book, we will come across several competing hypotheses trying to explain various economic phenomena. For example, students of economics are familiar with the concept of the production function, which is basically a relationship between output and inputs (say, capital and labor). In the literature, two of the best known are the *Cobb–Douglas* and the *constant elasticity of substitution* production functions. Given the data on output and inputs, we will have to find out which of the two production functions, if any, fits the data well.

The eight-step classical econometric methodology discussed above is neutral in the sense that it can be used to test any of these rival hypotheses.

Is it possible to develop a methodology that is comprehensive enough to include competing hypotheses? This is an involved and controversial topic. We will discuss it in Chapter 13, after we have acquired the necessary econometric theory.

## I.4 Types of Econometrics

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As the classificatory scheme in Figure I.5 suggests, econometrics may be divided into two broad categories: **theoretical econometrics** and **applied econometrics**. In each category, one can approach the subject in the **classical** or **Bayesian** tradition. In this book the emphasis is on the classical approach. For the Bayesian approach, the reader may consult the references given at the end of the chapter.

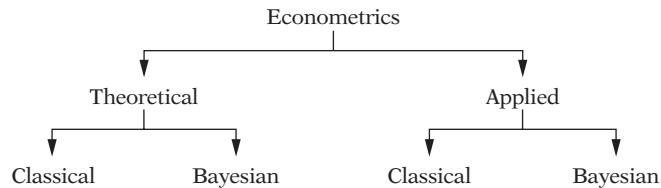
<sup>15</sup>Milton Friedman, *A Theory of Consumption Function*, Princeton University Press, Princeton, N.J., 1957.

<sup>16</sup>R. Hall, "Stochastic Implications of the Life Cycle Permanent Income Hypothesis: Theory and Evidence," *Journal of Political Economy*, vol. 86, 1978, pp. 971–987.

<sup>17</sup>R. W. Miller, *Fact and Method: Explanation, Confirmation, and Reality in the Natural and Social Sciences*, Princeton University Press, Princeton, N.J., 1978, p. 176.

<sup>18</sup>Clive W. J. Granger, *Empirical Modeling in Economics*, Cambridge University Press, U.K., 1999, p. 58.

**FIGURE I.5**  
Categories of  
econometrics.



Theoretical econometrics is concerned with the development of appropriate methods for measuring economic relationships specified by econometric models. In this aspect, econometrics leans heavily on mathematical statistics. For example, one of the methods used extensively in this book is **least squares**. Theoretical econometrics must spell out the assumptions of this method, its properties, and what happens to these properties when one or more of the assumptions of the method are not fulfilled.

In applied econometrics we use the tools of theoretical econometrics to study some special field(s) of economics and business, such as the production function, investment function, demand and supply functions, portfolio theory, etc.

This book is concerned largely with the development of econometric methods, their assumptions, their uses, and their limitations. These methods are illustrated with examples from various areas of economics and business. But this is *not* a book of applied econometrics in the sense that it delves deeply into any particular field of economic application. That job is best left to books written specifically for this purpose. References to some of these books are provided at the end of this book.

## I.5 Mathematical and Statistical Prerequisites

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Although this book is written at an elementary level, the author assumes that the reader is familiar with the basic concepts of statistical estimation and hypothesis testing. However, a broad but nontechnical overview of the basic statistical concepts used in this book is provided in **Appendix A** for the benefit of those who want to refresh their knowledge. Insofar as mathematics is concerned, a nodding acquaintance with the notions of differential calculus is desirable, although not essential. Although most graduate level books in econometrics make heavy use of matrix algebra, I want to make it clear that it is not needed to study this book. It is my strong belief that the fundamental ideas of econometrics can be conveyed without the use of matrix algebra. However, for the benefit of the mathematically inclined student, **Appendix C** gives the summary of basic regression theory in matrix notation. For these students, **Appendix B** provides a succinct summary of the main results from matrix algebra.

## I.6 The Role of the Computer

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Regression analysis, the bread-and-butter tool of econometrics, these days is unthinkable without the computer and some access to statistical software. (Believe me, I grew up in the generation of the slide rule!) Fortunately, several excellent regression packages are commercially available, both for the mainframe and the microcomputer, and the list is growing by the day. Regression software packages, such as **ET**, **LIMDEP**, **SHAZAM**, **MICRO TSP**, **MINITAB**, **EVIEWES**, **SAS**, **SPSS**, **STATA**, **Microfit**, **PcGive**, and **BMD** have most of the econometric techniques and tests discussed in this book.

In this book, from time to time, the reader will be asked to conduct **Monte Carlo** experiments using one or more of the statistical packages. Monte Carlo experiments are “fun” exercises that will enable the reader to appreciate the properties of several statistical methods discussed in this book. The details of the Monte Carlo experiments will be discussed at appropriate places.

## I.7 Suggestions for Further Reading

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The topic of econometric methodology is vast and controversial. For those interested in this topic, I suggest the following books:

Neil de Marchi and Christopher Gilbert, eds., *History and Methodology of Econometrics*, Oxford University Press, New York, 1989. This collection of readings discusses some early work on econometric methodology and has an extended discussion of the British approach to econometrics relating to time series data, that is, data collected over a period of time.

Wojciech W. Charemza and Derek F. Deadman, *New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autogression*, 2d ed., Edward Elgar Publishing Ltd., Hants, England, 1997. The authors of this book critique the traditional approach to econometrics and give a detailed exposition of new approaches to econometric methodology.

Adrian C. Darnell and J. Lynne Evans, *The Limits of Econometrics*, Edward Elgar Publishing Ltd., Hants, England, 1990. The book provides a somewhat balanced discussion of the various methodological approaches to econometrics, with renewed allegiance to traditional econometric methodology.

Mary S. Morgan, *The History of Econometric Ideas*, Cambridge University Press, New York, 1990. The author provides an excellent historical perspective on the theory and practice of econometrics, with an in-depth discussion of the early contributions of Haavelmo (1990 Nobel Laureate in Economics) to econometrics. In the same spirit, David F. Hendry and Mary S. Morgan, *The Foundation of Econometric Analysis*, Cambridge University Press, U.K., 1995, have collected seminal writings in econometrics to show the evolution of econometric ideas over time.

David Colander and Reuven Brenner, eds., *Educating Economists*, University of Michigan Press, Ann Arbor, Michigan, 1992. This text presents a critical, at times agnostic, view of economic teaching and practice.

For Bayesian statistics and econometrics, the following books are very useful: John H. Dey, *Data in Doubt*, Basil Blackwell Ltd., Oxford University Press, England, 1985; Peter M. Lee, *Bayesian Statistics: An Introduction*, Oxford University Press, England, 1989; and Dale J. Porier, *Intermediate Statistics and Econometrics: A Comparative Approach*, MIT Press, Cambridge, Massachusetts, 1995. Arnold Zeller, *An Introduction to Bayesian Inference in Econometrics*, John Wiley & Sons, New York, 1971, is an advanced reference book. Another advanced reference book is the *Palgrave Handbook of Econometrics: Volume 1: Econometric Theory*, edited by Terence C. Mills and Kerry Patterson, Palgrave Macmillan, New York, 2007.