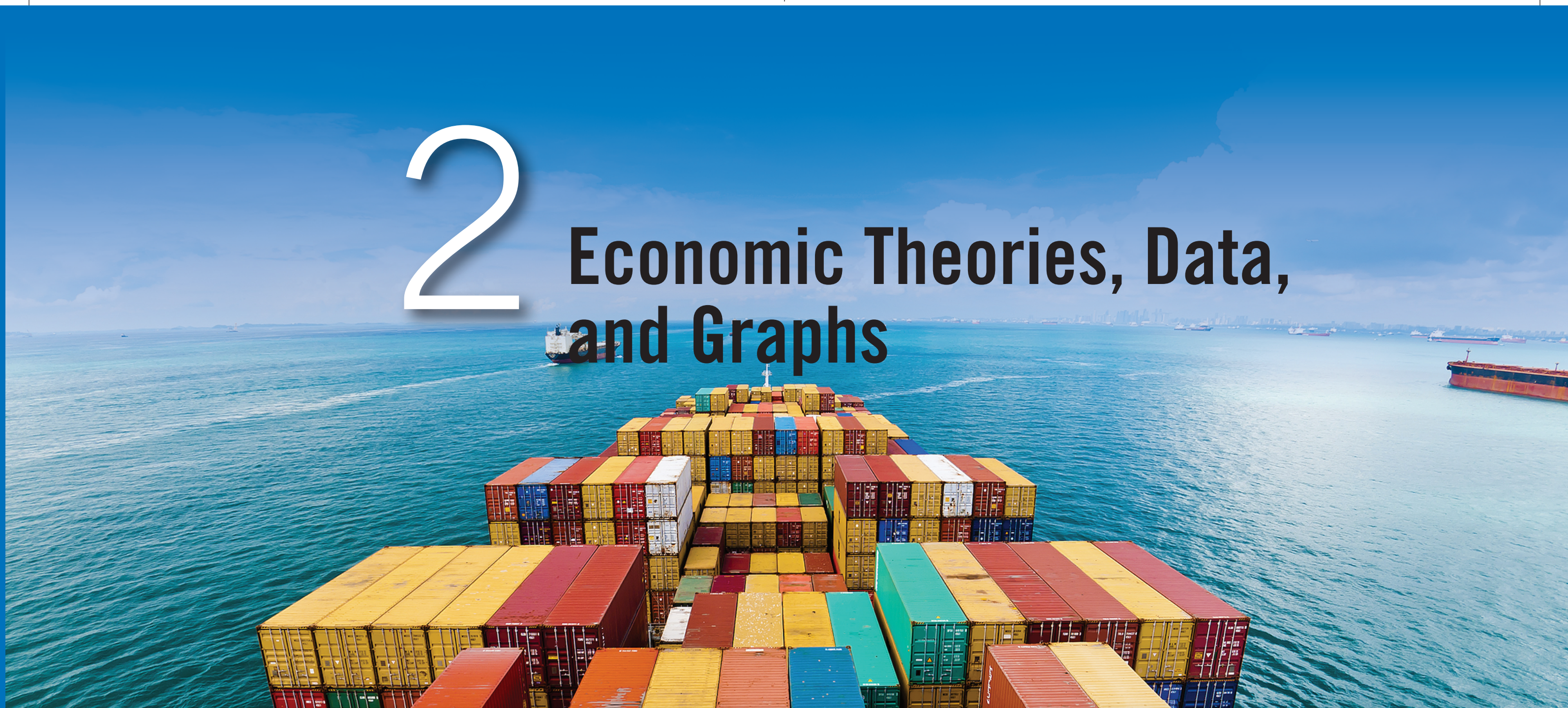
2 Economic Theories, Data, and Graphs



CHAPTER OUTLINE	LEARNING OBJECTIVES (LO) After studying this chapter, you will be able to
2.1 POSITIVE AND NORMATIVE STATEMENTS	**1** distinguish between positive and normative statements.
2.2 BUILDING AND TESTING ECONOMIC THEORIES	**2** explain why and how economists use theories to help them understand the economy. **3** understand the interaction between economic theories and empirical observation.
2.3 ECONOMIC DATA	**4** identify several types of economic data, including index numbers, time-series and cross-sectional data, and scatter diagrams.
2.4 GRAPHING ECONOMIC THEORIES	**5** see that the slope of a line on a graph relating two variables shows the “marginal response” of one variable to a change in the other.

IF you follow the news, whether online, TV, newspaper, or radio, you are likely to hear the views of economists being discussed—about debt crises, unemployment, income inequality, attempts to reform the health-care system, environmental policy, changes to corporate income-tax rates, or a myriad of other issues. Where do economists’ opinions come from? Are they supported by hard evidence, and if so, why do economists sometimes disagree with each other over important issues?

Economics is a social science, and in this chapter we explore what it means to be “scientific” in the study of economics. Along the way we will learn much about theories, predictions, data, testing, and graphing—economists use all of these tools and techniques in their attempt to understand the economic world. We begin with the important distinction between positive and normative statements.

2.1 POSITIVE AND NORMATIVE STATEMENTS

Economists give two broad types of advice, called *normative* and *positive*. For example, they sometimes advise that the government ought to try harder to reduce unemployment. When they say such things, they are giving normative advice; in this case, they are making judgements about the value of the various things that the government could do with its limited resources and about the costs and benefits of reducing unemployment. Advice that depends on a value judgement is normative—it tells others what they *ought* to do.

Another type of advice is illustrated by the statement "If the government wants to reduce unemployment, reducing unemployment insurance benefits is an effective way of doing so." This is positive advice. It does not rely on a judgement about the value of reducing unemployment. Instead, the expert is saying, "If this is what you want to do, here is a way to do it."

Normative statements depend on value judgements and cannot be evaluated solely by a recourse to facts. In contrast, **positive statements** do not involve value judgements. They are statements about matters of fact, and so disagreements about them are appropriately dealt with by an appeal to evidence. The distinction between positive and normative is fundamental to scientific progress. Much of the success of modern science depends on the ability of scientists to separate their views on *what does happen* in the world from their views on *what they would like to happen*. For example, until the eighteenth century almost everyone believed that Earth was only a few thousand years old. Evidence then began to accumulate that Earth was billions of years old. This evidence was hard for most people to accept, since it ran counter to a literal reading of many religious texts. Many did not want to believe the evidence. Nevertheless, scientists, many of whom were religious, continued their research because they refused to allow their feelings about what they wanted to believe to affect their scientific search for the truth. Eventually, all scientists and most members of the public came to accept that Earth is about 4.5 billion years old.

normative statement A statement about what ought to be; it is based on a value judgement.

positive statement A statement about what actually is, was, or will be; it is not based on a value judgement.

Distinguishing what is actually true from what we would like to be true requires distinguishing between positive and normative statements.

Examples of both types of statements are given in Table 2-1. All five positive statements in the table are assertions about the nature of the world in which we live. In contrast, the five normative statements involve value judgements. Notice two things about the positive/normative distinction. First, positive statements need not be true. Statement C is almost certainly false, and yet it is positive, not normative. Second, the inclusion of a value judgement in a statement does not necessarily make the statement itself normative. Statement D is a positive statement about the value judgements that people hold. We could conduct a survey to check if people really do prefer low unemployment to low inflation. We could ask them and we could observe how they voted. There is no need for the economist to rely on a value judgement to check the validity of the statement itself.

We leave you to analyze the remaining eight statements to decide precisely why each is either positive or normative. Remember to apply the two tests. First, is the statement only about actual or alleged facts? If so, it is a positive one. Second, are value judgements necessary to assess the truth of the statement? If so, it is normative.

TABLE 2-1 Positive and Normative Statements

Positive		Normative	
A	Raising interest rates encourages people to save.	F	People should be encouraged to save.
B	High rates of income tax encourage people to evade paying taxes.	G	Governments should arrange taxes so that people cannot avoid paying them.
C	Lowering the price of cigarettes leads people to smoke less.	H	The government should raise the tax on cigarettes to discourage people from smoking.
D	The majority of the population would prefer a policy that reduced unemployment to one that reduced inflation.	I	Unemployment is a more important social problem than inflation.
E	Government financial assistance to commercial banks is ineffective at preventing job losses.	J	Government should not spend taxpayers' money on supporting commercial banks.

Disagreements Among Economists

Economists often disagree with one another in public discussions, frequently because of poor communication. They often fail to define their terms or their points of reference clearly, and so they end up "arguing past" each other, with the only certain result being that the audience is left confused.

Economists often disagree with one another in the media or at conferences, but their debates are more often about normative issues than positive ones.

Another source of disagreement stems from some economists' failure to acknowledge the full state of their ignorance. There are many points on which the evidence is far from conclusive. In such cases, a responsible economist makes clear the extent to which his or her view is based on judgements about the relevant (and uncertain) facts.

Many other public disagreements are based on the positive/normative distinction. Different economists have different values, and these normative views play a large part in most discussions of public policy. Many economists stress the importance of individual responsibility and argue, for example, that lower employment insurance benefits would be desirable because people would have a greater incentive to search for a job. Other economists stress the need for a generous "social safety net" and argue that higher employment insurance benefits are desirable because human hardship would be reduced. In such debates, and there are many in economics, it is the responsibility of the economist to state clearly what part of the proffered advice is normative and what part is positive.

Because the world is complex and because no issue can be settled beyond any doubt, economists rarely agree unanimously on an issue. Nevertheless, there is an impressive amount of agreement on many aspects of how the economy works and what happens when governments intervene to alter its workings. A survey published in the *American Economic Review,* perhaps the most influential economics journal, showed strong

APPLYING ECONOMIC CONCEPTS 2-1

Where Economists Work

This chapter discusses the theoretical and empirical tools that economists use. After reading this material, you might wonder where economists find jobs and what kind of work they actually do. The skills of economists are demanded in many parts of the economy by governments, private businesses and crown corporations, non-profit organizations, and universities.

In Ottawa and the provincial and territorial capitals, economists are hired in most government departments to analyze the effects of government policies and to design ways to improve those policies. At Finance Canada, economists design and analyze the income-tax system and the effects of current spending programs. At Environment Canada, they help design and evaluate policies aimed at reducing water and air pollution. At Industry Canada, they study the sources of productivity growth and design policies to encourage innovation in the private sector. At the Bank of Canada, economists research the link between interest rates, the aggregate demand for goods and services, and the rate of increase in prices. They also monitor developments in the global economy and their effects on the Canadian economy. Statistics Canada employs many economists to design methods of collecting and analyzing data covering all aspects of Canadian society.

The analysis of economic policies also takes place in independent research organizations, often called "think tanks." The C.D. Howe Institute in Toronto is one of Canada's best-known think tanks, and it regularly publishes papers on topics ranging from monetary policy and the state of public pensions to the effects of immigration and the challenges in reforming Canada's policies for foreign development assistance. Other think tanks include the Institute for Research on Public Policy, the Canadian Centre for Policy Alternatives, the Fraser Institute, the Centre for the Study of Living Standards, and the Conference Board of Canada. All of these independent and non-profit organizations hire economists to study economic issues and then write and edit the economic publications that address them.

Private and public (crown) corporations in many sectors of the economy also hire economists in a variety of positions. Economists at Canadian Pacific Railway monitor how changes in world commodity prices will lead to changes in Canadian resource production and thus to changes in the demand for their rail transport services. Economists at Manitoba Hydro study the link between economic growth and electricity demand to help the firm with its long-run investment decisions. Those at Export Development Canada examine how economic and political risks in various countries influence the demand for the products of Canadian exporters. Economists at Bombardier are hired to determine how ongoing negotiations within the World Trade Organization will affect tariff levels in various countries and how these changes will affect the demand for Bombardier jets.

Finally, many economists are hired by universities all over the world to teach students like you and to conduct research on a wide variety of economic topics. Some of this research is theoretical and some is empirical, using data to test economic theories. Other academic economists focus their research on the design and implementation of better economic policy, and often spend considerable time interacting with the economists employed by government departments.

Training in economics provides useful analytical skills that are valuable for learning about the workings of a complex economic world. There is no shortage of demand for people who can think clearly and analytically about economic issues. This course could well be the start of a great career for you. Study hard!

agreement among economists on many propositions, including "Rent control leads to a housing shortage" (85 percent yes), "Tariffs usually reduce economic welfare" (93 percent yes), and "A minimum wage increases unemployment among young workers" (79 percent yes). Notice that all these are positive rather than normative statements. Other examples of these areas of agreement will be found in many places throughout this book.

Whether they agree or disagree with one another, economists are in demand in many sectors of the economy. See *Applying Economic Concepts 2-1* for a discussion of the many organizations that employ economists.

2.2 BUILDING AND TESTING ECONOMIC THEORIES

The economic world is complex. Many things are changing at the same time, and it is difficult to distinguish cause from effect. By examining data carefully, however, regularities and trends can be detected. To better understand these patterns in the data, economists develop *theories,* which they sometimes call *models*. Theories are used to both explain events that have already happened and to help predict events that might happen in the future.

What Are Theories?

Theories are constructed to explain things. For example, economists may seek to explain what determines the quantity of eggs bought and sold in a particular month in Manitoba and the price at which they are sold. Or they may seek to explain what determines the quantity of oil bought and sold around the world on a particular day and the price at which it is traded. As part of the answer to such questions, economists have developed theories of demand and supply—theories that we will study in detail in the next three chapters. These and all other theories are distinguished by their *variables, assumptions,* and *predictions*.

variable Any well-defined item, such as the price or quantity of a commodity, that can take on various specific values.

Variables The basic elements of any theory are its variables. A **variable** is a well-defined item, such as a price or a quantity, that can take on different possible values.

In a theory of the egg market, the variable *quantity of eggs* might be defined as the number of cartons of 12 Grade A large eggs. The variable *price of eggs* is the amount of money that must be given up to purchase each carton of eggs. The particular values taken by those two variables might be 20 000 cartons per week at a price of $2.60 in July 2014, 18 000 cartons per week at a price of $2.75 in July 2015, and 19 500 cartons per week at a price of $2.95 in July 2016.

endogenous variable A variable that is explained within a theory. Sometimes called an *induced variable* or a *dependent variable*.

exogenous variable A variable that is determined outside the theory. Sometimes called an *autonomous variable* or an *independent variable*.

There are two broad categories of variables that are important in any theory. An **endogenous variable** is one whose value is determined within the theory. An **exogenous variable** influences the endogenous variables but is itself determined outside the theory. To illustrate the difference, the price of eggs and the quantity of eggs are endogenous variables in our theory of the egg market—our theory is designed to explain them. The state of the weather, however, is an exogenous variable. It may well affect the number of eggs consumers demand or producers supply, but we can safely assume that the state of the weather is not influenced by the market for eggs.

Assumptions A theory's assumptions concern motives, directions of causation, and the conditions under which the theory is meant to apply.

Motives. The theories we study in this book make the fundamental assumption that everyone pursues his or her own self-interest when making economic decisions. Individuals are assumed to strive to maximize their *utility,* while firms are assumed to try to maximize their *profits*. Not only are they assumed to know what they want, but we also assume that they know how to go about getting it within the constraints they face.

Direction of Causation. When economists assume that one variable is related to another, they are usually assuming some causal link between the two. For example, when the amount of wheat that producers want to supply is assumed to increase when the weather improves, the causation runs from the weather to the supply of wheat. Producers supply more wheat because the growing conditions improve; they are not assumed to experience better weather as a result of their increased supply of wheat.

Conditions of Application. Assumptions are often used to specify the conditions under which a theory is meant to hold. For example, a theory that assumes there is "no government" usually does not mean literally the absence of government but only that the theory is meant to apply when governments are not significantly affecting the situation being studied.

Although assumptions are an essential part of all theories, students are often concerned about those that seem unrealistic. An example will illustrate some of the issues involved. Much of the theory that we are going to study in this book uses the assumption that owners of firms attempt to make as much money as they can—that is, to maximize their profits. The assumption of profit maximization allows economists to make predictions about the behaviour of firms, such as "firms will supply more output if the market price increases."

Profit maximization may seem like a rather crude assumption. Surely, for example, the managers of firms sometimes choose to protect the environment rather than pursue certain highly polluting but profitable opportunities. Does this not discredit the assumption of profit maximization by showing it to be unrealistic?

The answer is no; to make successful predictions, the theory does not require that managers be solely and unwaveringly motivated by the desire to maximize profits at all times. All that is required is that profits be a sufficiently important consideration that a theory based on the assumption of profit maximization will lead to explanations and predictions that are substantially correct. It is not always appropriate to criticize a theory because its assumptions seem unrealistic. A good theory abstracts in a useful way; a poor theory does not. If a theory has ignored some genuinely important factors, its predictions will usually be contradicted by the evidence.

All theory is an abstraction from reality. If it were not, it would merely duplicate the world in all its complexity and would add little to our understanding of it.

Predictions A theory's predictions are the propositions that can be deduced from it. They are often called *hypotheses*. For example, a prediction from a theory of the oil market is that a rise in the world price for oil will lead Canadian oil producers to produce and supply more oil. Another prediction in the same market is that a decision by the members of the OPEC cartel to reduce their annual output of oil will lead to an increase in the world price. The economic logic behind such predictions will be explained in several chapters of this book; for now we can proceed to see how economists *test* such predictions or hypotheses.

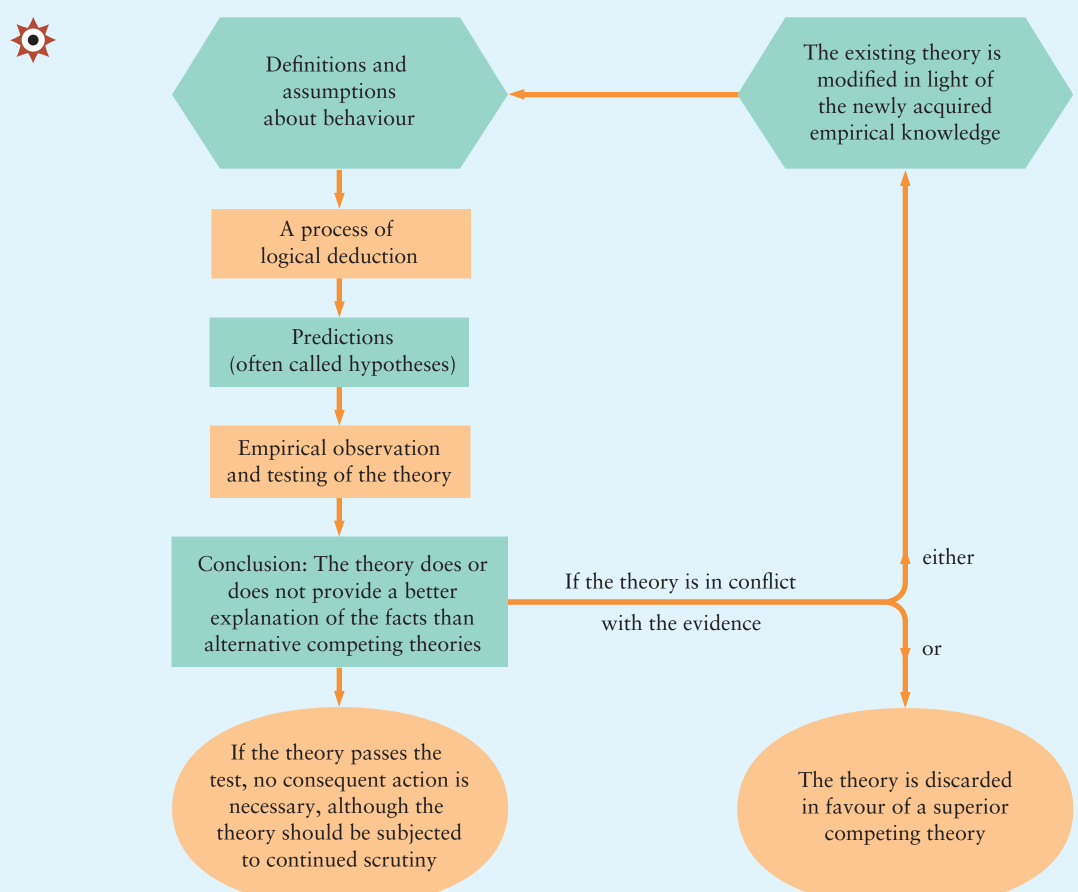
Testing Theories

A theory is tested by confronting its predictions with empirical evidence. For example, is an increase in the world price of oil *actually* followed by an increase in oil production by Canadian producers? A theory ceases to be useful when it cannot predict better than an alternative theory. When a theory consistently fails to predict better than an available alternative, it is either modified or replaced. Figure 2-1 illustrates the interaction between theory and empirical observation that occurs in economics.

The scientific approach is central to the study of economics: Empirical observation leads to the construction of theories, theories generate specific predictions, and the predictions are tested by more detailed empirical observation.

Statistical Analysis Most theories generate a prediction of the form "If X increases, then Y will also increase." A specific example is "If national income rises, the level

FIGURE 2-1 The Interaction Between Theory and Empirical Observation



Theory and observation are in continuous interaction. Starting (at the top left) with the assumptions of a theory and the definitions of relevant terms, the theorist deduces by logical analysis everything that is implied by the assumptions. These implications are the predictions or the hypotheses of the theory. The theory is then tested by confronting its predictions with evidence. If the theory is in conflict with facts, it will usually be amended to make it consistent with those facts (thereby making it a better theory), or it will be discarded, to be replaced by a superior theory. The process then begins again: The new or amended theory is subjected first to logical analysis and then to empirical testing.

of employment will rise." Statistical analysis can be used to test such predictions. In practice, the same data can be used simultaneously to test whether a relationship exists between *X* and *Y*, and, if it does exist, to provide an estimate of the magnitude of that relationship.

Because economics is primarily a non-laboratory science, it lacks the controlled experiments central to such sciences as physics and chemistry. Economics must therefore use millions of uncontrolled "experiments" that are going on every day in the marketplace. Households are deciding what to purchase given changing prices and incomes, firms are deciding what to produce and how, and governments are involved in the economy through their various taxes, subsidies, and regulations. Because all these activities can be observed and recorded, a mass of data is continually being produced by the economy.

The variables that interest economists—such as the level of employment, the price of a laptop, and the output of automobiles—are generally influenced by many forces that vary simultaneously. If economists are to test their theories about relations among specific variables, they must use statistical techniques designed for situations in which other things *cannot* be held constant. Fortunately, such techniques exist, although their application is usually neither simple nor straightforward.

Later in this chapter we provide a discussion of some graphical techniques for describing data and displaying some of the more obvious relationships. Further examination of data involves techniques studied in elementary statistics courses. More advanced courses in econometrics deal with the array of techniques designed to test economic hypotheses and to measure economic relations in the complex circumstances in which economic evidence is often generated.

Correlation Versus Causation Suppose you want to test your theory's prediction that "If *X* increases, *Y* will also increase." You are looking for a *causal* relationship from *X* to *Y*, because a change in *X* is predicted to *cause* a change in *Y*. When you look at the data, suppose you find that *X* and *Y* are positively correlated—that is, when *X* rises, *Y* also tends to rise. Is your theory supported? It might appear that way, but there is a potential problem.

A finding that *X* and *Y* are positively correlated means only that *X* and *Y* tend to move together. This correlation is *consistent* with the theory that *X* causes *Y*, but it is *not* direct evidence of this causal relationship. The causality may be in the opposite direction—from *Y* to *X*. Or *X* and *Y* may have no direct causal connection; they may instead be jointly caused by some third variable, *Z*.

Here is an example. Suppose your theory predicts that individuals who get more education will earn higher incomes as a result—the causality in this theory runs from education to income. In the data, suppose we find that education and income are positively correlated (as they are). This should not, however, be taken as direct evidence for the causal prediction. The data are certainly consistent with that theory, but they are also consistent with others. For example, individuals who grow up in higher-income households may "buy" more education, just as they buy more clothes or entertainment. In this case, income causes education, rather than the other way around. Another possibility is that education and income are positively correlated because the personal characteristics that lead people to become more educated—ability and motivation—are the same characteristics that lead to high incomes. In this case, the *causal* relationship runs from personal characteristics to both income and education.

Most economic predictions involve causality. Economists must take care when testing predictions to distinguish between correlation and causation. Correlation can establish that the data are consistent with the theory; establishing causation usually requires advanced statistical techniques.

2.3 ECONOMIC DATA

Economists use real-world observations to test their theories. For example, did the amount that people saved last year rise—as the theory predicts it should have—when a large tax cut increased their after-tax incomes? To test this prediction we need reliable data for people's incomes and their savings.

Political scientists, sociologists, anthropologists, and psychologists often collect for themselves the data they use to formulate and test their theories. Economists are unusual among social scientists in mainly using data collected by others, often government statistical agencies. In economics there is a division of labour between collecting data and using them to test theories. The advantage is that economists do not need to spend much of their scarce research time collecting the data they use. The disadvantage is that they are often not as well informed about the limitations of the data collected by others as they would be if they had collected the data themselves.

index number A measure of some variable, conventionally expressed relative to a base period, which is assigned the value 100.

After data are collected, they can be displayed in various ways, many of which we will see later in this chapter. They can be laid out in tables. They can be displayed in various types of graphs. And when we are interested in relative movements rather than absolute ones, the data can be expressed in *index numbers*. We begin with a discussion of index numbers.

TABLE 2-2 Volume of Steel and Newsprint Output

Year	Volume of Steel (thousands of tonnes)	Volume of Newsprint (thousands of rolls)
2007	200	3200
2008	210	3100
2009	225	3000
2010	215	3200
2011	250	3100
2012	220	3300
2013	265	3100
2014	225	3300
2015	255	3100
2016	230	3200
2017	245	3000

Comparing the time paths of two data series is difficult when absolute numbers are used. Since steel output and newsprint output have quite different absolute numbers, it is difficult to detect which time series is more volatile.

Index Numbers

Economists frequently look at data on prices or quantities and explore how specific variables change over time. For example, they may be interested in comparing the time paths of output in two industries: steel and newsprint. The problem is that it may be difficult to compare the time paths of the two different variables if we just look at the "raw" data.

Table 2-2 shows some hypothetical data for the volume of output in the steel and newsprint industries. Because the two variables are measured in different units, it is not immediately clear which of the two variables is more volatile or which, if either, has an upward or a downward trend.

It is easier to compare the two paths if we focus on *relative* rather than *absolute* changes. One way to do this is to construct some **index numbers**.

TABLE 2-3 Constructing Index Numbers

	Steel			Newsprint		
Year	Procedure		Index	Procedure		Index
2007	(200/200) × 100	=	100.0	(3200/3200) × 100	=	100.0
2008	(210/200) × 100	=	105.0	(3100/3200) × 100	=	96.9
2009	(225/200) × 100	=	112.5	(3000/3200) × 100	=	93.8
2010	(215/200) × 100	=	107.5	(3200/3200) × 100	=	100.0
2011	(250/200) × 100	=	125.0	(3100/3200) × 100	=	96.9
2012	(220/200) × 100	=	110.0	(3300/3200) × 100	=	103.1
2013	(265/200) × 100	=	132.5	(3100/3200) × 100	=	96.9
2014	(225/200) × 100	=	112.5	(3300/3200) × 100	=	103.1
2015	(255/200) × 100	=	127.5	(3100/3200) × 100	=	96.9
2016	(230/200) × 100	=	115.0	(3200/3200) × 100	=	100.0
2017	(245/200) × 100	=	122.5	(3000/3200) × 100	=	93.8

Index numbers are calculated by dividing the value in the given year by the value in the base year and multiplying the result by 100. The 2017 index number for steel tells us that steel output in 2017 was 22.5 percent greater than in the base year, 2007. The 2017 index number for newsprint tells us that newsprint output in 2017 was 93.8 percent of the output in the base year, 2007.

How to Build an Index Number We start by taking the value of the variable at some point in time as the "base" with which the values in other periods will be compared. We call this the *base period*. In the present example, we choose 2007 as the base year for both series. We then take the output in each subsequent year, called the "given year," divide it by the output in the base year, and then multiply the result by 100. This gives us an index number for the output of steel and a separate index number for the output of newsprint. For each index number, the value of output in the base year is equal to 100. The details of the calculations are shown in Table 2-3.

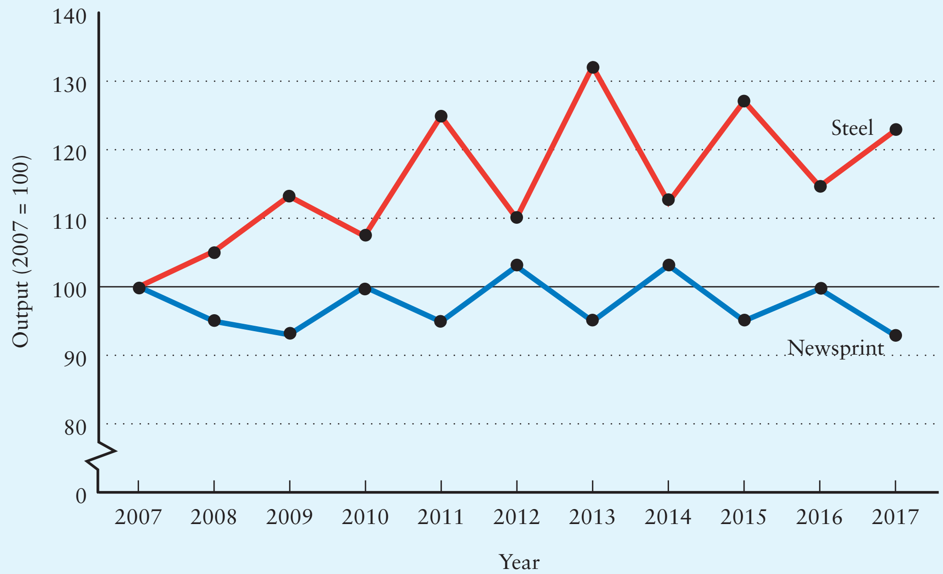
An index number simply expresses the value of some variable in any given year as a percentage of its value in the base year. For example, the 2017 index of steel output of 122.5 tells us that steel output in 2017 was 22.5 percent greater than in 2007. In contrast, the 2017 index for newsprint output of 93.8 tells us that newsprint output in 2017 was only 93.8 percent of the output in 2007—that is, output was 6.2 percent lower in 2017 than in 2007. The results in Table 2-3 allow us to compare the relative fluctuations in the two series. It is apparent from the values in the table that the output of steel has shown significantly more percentage variability than has the output of newsprint. This is also clear in Figure 2-2.

The formula of any index number is

$$\begin{array}{c}\text{Value of index}\\ \text{in any given period}\end{array} = \frac{\text{Absolute value in given period}}{\text{Absolute value in base period}} \times 100$$

Care must be taken, however, when using index numbers. The index number always tells you the percentage change compared with the base year, but when comparing an

FIGURE 2-2 **Index Values for Steel and Newsprint Output**



Comparing the time paths of two variables is much easier when index numbers are used. Since both index numbers are equal to 100 in the base year, relative volatility and trends become clear. Steel output is clearly more volatile in percentage terms than newsprint output. Steel output also has an upward trend, whereas newsprint output appears to have little or no trend.

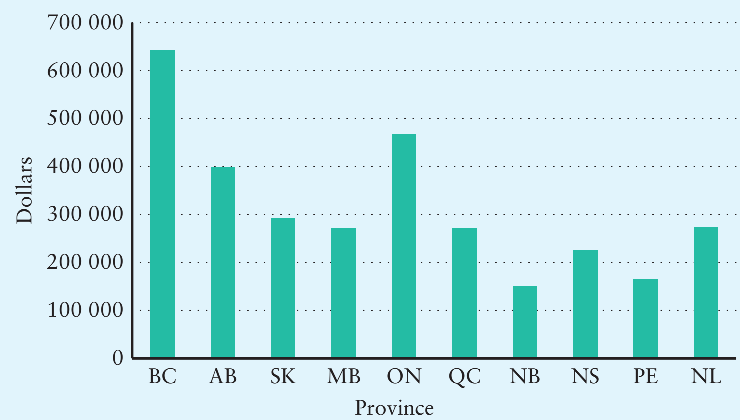
index number across non-base years, the percentage change in the index number is *not* given by the absolute difference in the values of the index number. For example, if you want to know how much steel output changed from 2011 to 2013, we know from Table 2-3 that the index number for steel output increased from 125.0 to 132.5. But this is not an increase of 7.5 percent. The *percentage* increase in steel output is computed as $(132.5 - 125.0)/125.0 = 7.5/125.0 = 0.06$, or 6 percent.

More Complex Index Numbers Perhaps the most famous index number used by economists is the index of average prices—the Consumer Price Index (CPI). This is a price index of the *average* price paid by consumers for the typical basket of goods that they buy. The inclusion of the word "average," however, makes the CPI a more complex index number than the ones we have constructed here.

With what you have just learned, you could construct separate index numbers for the price of beef, the price of coffee, and the price of orange juice. But to get the Consumer Price Index, we need to take the *average* of these separate price indexes (plus thousands of others for the goods and services we have ignored here). But it cannot be a simple average. Instead, it must be a *weighted* average, in which the weight assigned to each price index reflects the relative importance of that good in the typical consumer's basket of goods and services. For example, since the typical consumer spends a tiny fraction of income on sardines but a much larger fraction of income on housing, the weight on the "sardines" price index in the CPI is very small and the weight on the "housing" price index is very large. The result is that even huge swings in the price of sardines have negligible effects on the CPI, whereas much more modest changes in the price of housing have noticeable effects on the CPI.

We will spend much more time discussing the Consumer Price Index when we study macroeconomics beginning in Chapter 19. For now, keep in mind the usefulness of the simple index numbers we have constructed here. They allow us to compare the time paths of different variables.

FIGURE 2-3 A Cross-Sectional Graph of Average House Prices for 10 Canadian Provinces, 2015



(*Source:* Adapted from MLS® Statistics ©2015 The Canadian Real Estate Association; www.crea.ca/content/national-average-price-map)

Graphing Economic Data

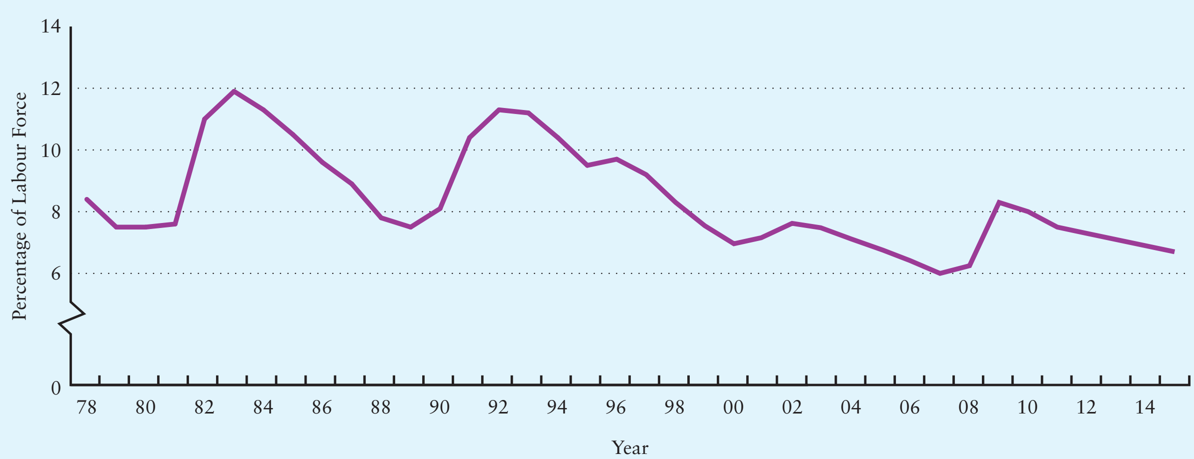
A single economic variable, such as unemployment, national income, or the average price of a house, can come in two basic forms.

Cross-Sectional and Time-Series Data The first is called **cross-sectional data**, which means a number of different observations on one variable all taken in different places at the same point in time. Figure 2-3 shows an example. The variable in the figure is the average selling price of a house in each of the 10 Canadian provinces in March 2015. The second type of data is called **time-series data**. It refers to observations of one variable at successive points in time. The data in Figure 2-4 show the unemployment

cross-sectional data A set of observations of a variable made at the same time across several different units (such as households, firms, or countries).

time-series data A set of observations of a variable made at successive periods of time.

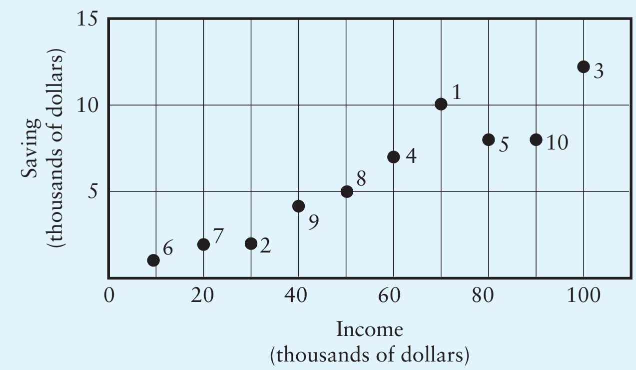
FIGURE 2-4 A Time-Series Graph of the Canadian Unemployment Rate, 1978–2015



(*Source:* Annual average of monthly, seasonally adjusted data from Statistics Canada, CANSIM Table 282-0087; both sexes, 15 years and over)

FIGURE 2-5 **A Scatter Diagram of Household Income and Saving in 2016**

Household	Annual Income	Annual Saving
1	$ 70 000	$10 000
2	30 000	2 500
3	100 000	12 000
4	60 000	7 000
5	80 000	8 000
6	10 000	500
7	20 000	2 000
8	50 000	5 000
9	40 000	4 200
10	90 000	8 000



Saving tends to rise as income rises. The table shows the amount of income earned by ten (hypothetical) households together with the amount they saved during the same year. The scatter diagram plots the income and saving for the ten households listed in the table. The number on each dot refers to the household in the corresponding row of the table.

rate for Canada from 1978 to 2015. Note in Figures 2-3 and 2-4 that in each case the figure is showing the behaviour of a *single* economic variable.

scatter diagram A graph showing two variables, one measured on the horizontal and the other on the vertical axis. Each point represents the values of the variables for a particular unit of observation.

Scatter Diagrams Another way data can be presented is in a **scatter diagram**. It is designed to show the relation between two different variables. To plot a scatter diagram, values of one variable are measured on the horizontal axis and values of the second variable are measured on the vertical axis. Any point on the diagram relates a specific value of one variable to a corresponding specific value of the other.

The data plotted on a scatter diagram may be either cross-sectional data or time-series data. An example of the former is shown in Figure 2-5. The table in the figure shows hypothetical data for the income and saving of 10 households during 2016, and these data are plotted on a scatter diagram. Each point in the figure represents one household, showing its income and its saving. The positive relation between the two stands out. The higher the household's income, the higher its saving tends to be.

2.4 GRAPHING ECONOMIC THEORIES

Theories are built on assumptions about relationships between variables. For example, the quantity of eggs demanded is assumed to fall as the price of eggs rises, and the total amount an individual saves is assumed to rise as his or her income rises. How can such relations be expressed?

Functions

When one variable, X, is related to another variable, Y, in such a way that to every value of X there is only one possible value of Y, we say that Y is a *function* of X. When we write this relation down, we are expressing a *functional relation* between the two variables.

Here is a specific but hypothetical example. Consider the relation between an individual's annual income, which we denote by the symbol Y, and the amount that person spends on goods and services during the year, which we denote by the symbol C (for consumption). Any particular example of the relation between C and Y can be expressed several ways: in words, in a table, in a mathematical equation, or in a graph.

Words. When income is zero, the person will spend \$800 a year (either by borrowing the money or by spending past savings), and for every extra \$1 of income the person will increase spending by 80 cents.

Table. This table shows selected values of the person's income and consumption.

Annual Income	Consumption	Reference Letter
\$ 0	\$ 800	*p*
2 500	2 800	*q*
5 000	4 800	*r*
7 500	6 800	*s*
10 000	8 800	*t*

Mathematical Equation. $C = \$800 + 0.8Y$ is the equation of the relation just described in words and displayed in the table. As a check, you can first see that when Y is zero, C is \$800. Further, you can see that every time Y increases by \$1, the level of C increases by 0.8(\$1), which is 80 cents.

Graph. Figure 2-6 shows the points from the preceding table and the line representing the equation given in the previous paragraph. Comparison of the values on the graph with the values in the table, and with the values derived from the equation just stated, shows that these are alternative expressions of the same relation between C and Y.

Graphing Functions

Different functions have different graphs, and we will see many of these in subsequent chapters. Figure 2-6 is an example of a relation in which the two variables move together. When income goes up, consumption goes up. In such a relation the two variables are *positively related* to each other.

Figure 2-7 is an example of variables that move in opposite directions. As the amount spent on pollution reduction goes up, the amount of remaining pollution goes down. In such a relation the two variables are *negatively related* to each other.

Both of these graphs are straight lines. In such cases the variables are *linearly related* to each other (either positively or negatively).

FIGURE 2-6 **Income and Consumption**

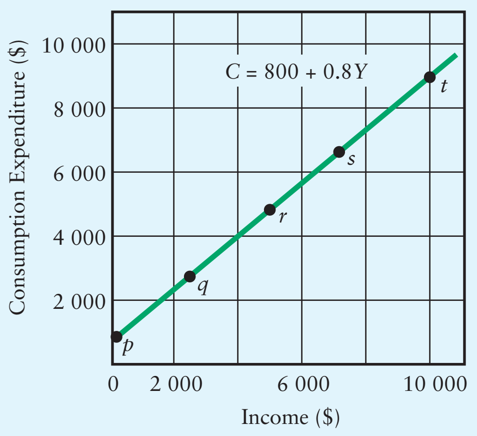
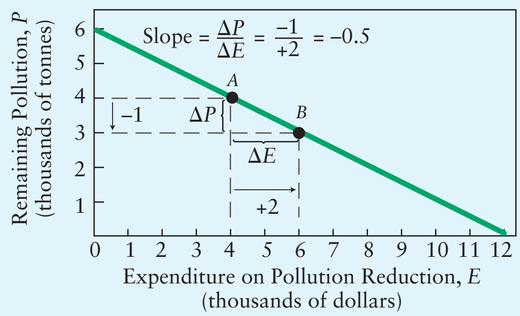


FIGURE 2-7 Linear Pollution Reduction



Pollution as a linear function of clean-up expenditure. Between points *A* and *B* it costs $2000 to reduce pollution by 1000 tonnes. The cost of pollution reduction is the same elsewhere on the line. The slope of the line, –0.5, indicates that any $1 expenditure on pollution clean-up reduces the amount of pollution by 0.5 tonnes.

The Slope of a Straight Line Slopes are important in economics. They show you how much one variable changes as the other changes. The slope is defined as the amount of change in the variable measured on the vertical axis per unit change in the variable measured on the horizontal axis. In the case of Figure 2-7 it tells us how many tonnes of pollution, symbolized by *P*, are removed per dollar spent on reducing pollution, symbolized by *E*. Consider moving from point *A* to point *B* in the figure. If we spend $2000 more on clean-up, we reduce pollution by 1000 tonnes. This is 0.5 tonnes per dollar spent. On the graph the extra $2000 is indicated by ΔE, the arrow indicating that *E* rises by 2000. The 1000 tonnes of pollution reduction is indicated by ΔP, the arrow showing that pollution falls by 1000. (The Greek uppercase letter delta, Δ, stands for "the change in.") To get the amount of pollution reduction per dollar of expenditure, we merely divide one by the other. In symbols this is $\Delta P/\Delta E$.

If we let X stand for whatever variable is measured on the horizontal axis and Y for whatever variable is measured on the vertical axis, the slope of a straight line is $\Delta Y/\Delta X$. [1][1]

The equation of the line in Figure 2-7 can be computed in two steps. First, note that when $E = 0$, the amount of remaining pollution, *P*, is equal to 6 (thousand tonnes). Thus, the line meets the vertical axis ($E = 0$) when $P = 6$. Second, we have already seen that the slope of the line, $\Delta P/\Delta E$, is equal to -0.5, which means that for every one-unit increase in *E*, *P* falls by 0.5 unit. We can thus state the equation of the line as

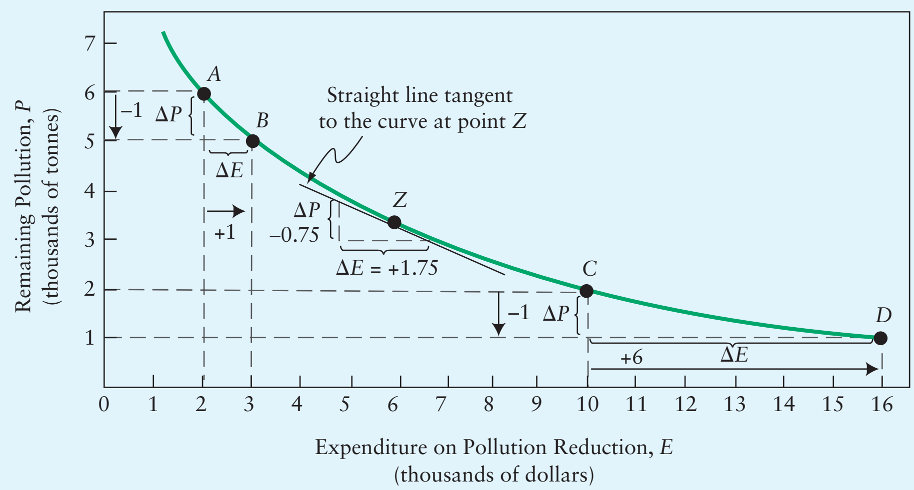
$$P = 6 - (0.5)E$$

where both *P* and *E* are expressed as thousands of units (tonnes and dollars, respectively).

Non-linear Functions Although it is sometimes convenient to simplify the situation by assuming two variables to be linearly related, this is seldom the case over their whole range. Non-linear relations are much more common than linear ones. In the case of reducing pollution, it is usually quite cheap to eliminate the first units of pollution. Then, as the environment gets cleaner and cleaner, the cost of further clean-up tends to increase because more and more sophisticated and expensive methods need to be used. As a result, Figure 2-8 is more realistic than Figure 2-7. Inspection of Figure 2-8 shows that as more and more is spent, the amount of pollution reduction for an additional $1 of clean-up expenditure gets smaller and smaller. This is shown by the diminishing slope of the curve as we move rightward along it. For example, as we move from point

[1] Red numbers in square brackets indicate mathematical notes that are found in a separate section at the back of the book.

FIGURE 2-8 **Non-linear Pollution Reduction**



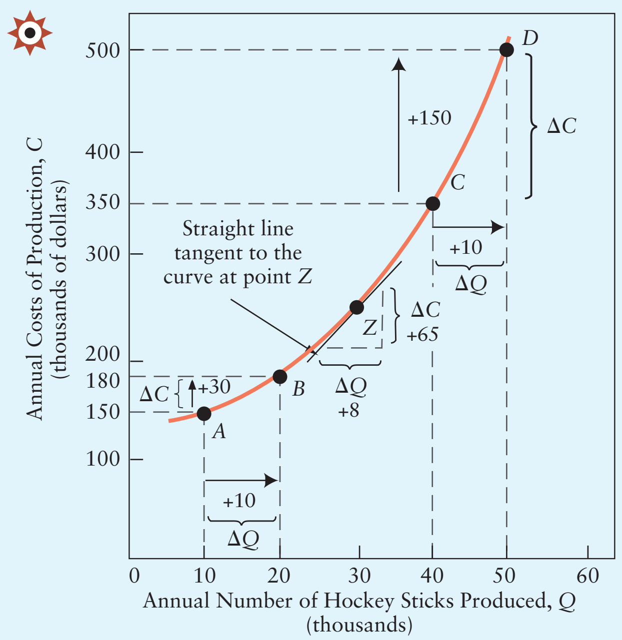
Pollution as a Non-linear function of clean-up expenditure. The slope of the curve changes as we move along it. Between points *A* and *B*, it costs $1000 to reduce pollution by 1000 tonnes. Between points *C* and *D*, it costs $6000 to reduce pollution by 1000 tonnes. At point *Z*, the slope of the curve is equal to the slope of the straight line tangent to the curve at point *Z*. The slope of the tangent line is $-0.75/1.75 = -0.43$.

A to point *B*, an increase in expenditure of $1000 is required to reduce pollution by 1000 tonnes. Thus, each tonne of pollution reduction costs $1. But as we move from point *C* (where we have already reduced pollution considerably) to point *D*, an extra $6000 must be spent in order to reduce pollution by 1000 tonnes. At that point, each tonne of pollution reduction therefore costs $6.

Economists call the change in pollution when a bit more or a bit less is spent on clean-up the *marginal* change. The figure shows that the slope of the curve at each point measures this marginal change. It also shows that in the type of curve illustrated, the marginal change per dollar spent is diminishing as we spend more on pollution reduction. There is always a payoff to more expenditure over the range shown in the figure, but the payoff diminishes as more is spent. This relation can be described as *diminishing marginal response*. We will see such relations many times in what follows, so we emphasize now that diminishing marginal response does not mean that the *total* response is diminishing. In Figure 2-8, the total amount of pollution continues to fall as more and more is spent on clean-up. But diminishing marginal response does mean that the amount of pollution reduced per dollar of expenditure gets less and less as the total expenditure rises.

Figure 2-9 shows a graph in which the marginal response is increasing. The graph shows the relationship between annual production costs and annual output for a firm that makes hockey sticks. Notice that the more sticks produced annually, the higher the firm's total costs. This is shown by the positive slope of the line. Notice also that as more and more hockey sticks are produced, the extra amount that the firm must pay to produce each extra stick rises. For example, as the firm moves from point *A* to point *B*, annual costs rise by $30 000 in order to increase its annual output by 10 000 hockey

FIGURE 2-9 Increasing Marginal Production Costs



Marginal costs increase as annual output rises. From point *A* to point *B*, an extra annual output of 10 000 hockey sticks increases annual costs by \$30 000. Each extra stick costs \$3. From point *C* to point *D*, an extra output of 10 000 hockey sticks increases annual costs by \$150 000. Each extra hockey stick then costs \$15. This is a case of increasing marginal cost. At point *Z*, the slope of the curve is equal to the slope of the straight line tangent to the curve at point *Z*. The slope of the tangent line is 65/8 = 8.13.

sticks. Each extra stick costs \$3 (\$30 000/10 000 = \$3). But when the firm is already producing many more hockey sticks, such as at point *C*, its factory is closer to its capacity and it becomes more costly to increase production. Moving from point *C* to point *D*, the firm's annual costs increase by \$150 000 in order to increase its annual output by 10 000 hockey sticks. Each extra stick then costs \$15 (\$150 000/10 000 = \$15). This figure illustrates a case of *increasing marginal cost*, a characteristic of production that we will see often in this book.

Figures 2-8 and 2-9 show that with Non-linear functions the slope of the curve changes as we move along the curve. For example, in Figure 2-8, the slope of the curve falls as the expenditure on pollution clean-up increases. In Figure 2-9, the slope of the curve increases as the volume of production increases.

How, exactly, do we measure the slope of a curved line? The answer is that we use the slope of a straight line *tangent to that curve* at the point that interests us. For example, in Figure 2-8, if we want to know the slope of the curve at point *Z*, we draw a straight line that touches the curve *only* at point *Z*; this is a tangent line. The slope of this line is $-0.75/1.75 = -0.43$. Similarly, in Figure 2-9, the slope of the curve at point *Z* is given by the slope of the straight line tangent to the curve at point *Z*. The slope of this line is $65/8 = 8.13$.

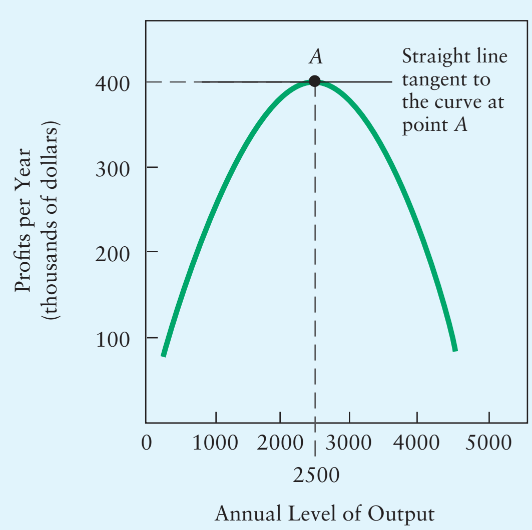
For Non-linear functions, the slope of the curve changes as *X* changes. Therefore, the marginal response of *Y* to a change in *X* depends on the value of *X*.

Functions with a Minimum or a Maximum So far, all the graphs we have shown have had either a positive or a negative slope over their entire range. But many relations change directions as the independent variable increases. For example, consider a firm that is attempting to maximize its profits and is trying to determine how much output to produce. The firm may find that its unit production costs are lower than the market price of the good, and so it can increase its profit by producing more. But as it increases its level of production, the firm's unit costs may be driven up because the capacity of the factory is being approached. Eventually, the firm may find that extra output will actually cost so much that its profits are *reduced*. This is a relationship that we will study in detail in later chapters, and it is illustrated in Figure 2-10. Notice that when profits are maximized at point *A*, the slope of the curve is zero (because a tangent to the curve at point *A* is horizontal), and so the *marginal response* of profits to output is zero.

Now consider an example of a function with a minimum. You probably know that when you drive a car, the fuel consumption per kilometre depends on your speed. Driving very slowly uses a lot of fuel per kilometre travelled. Driving very fast also uses a lot of fuel per kilometre travelled. The best fuel efficiency—the lowest fuel consumption per kilometre travelled—occurs at a speed of approximately 95 kilometres per hour. The relationship between speed and fuel consumption is shown in Figure 2-11 and illustrates a function with a minimum. Note that at point *A* the slope of the curve is zero (because a tangent to the curve at point *A* is horizontal), and so the *marginal response* of fuel consumption to speed is zero.

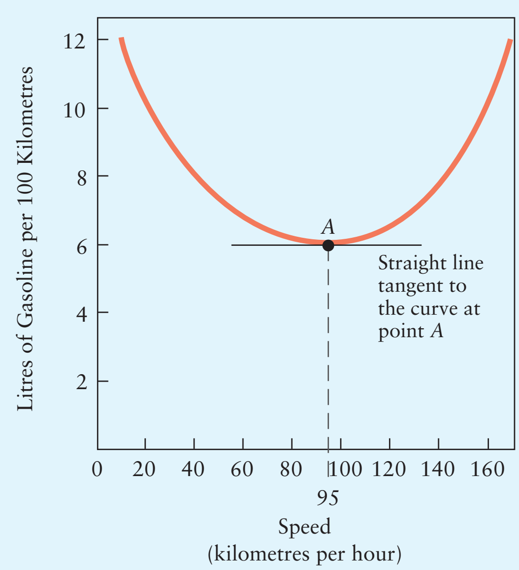
At either a minimum or a maximum of a function, the slope of the curve is zero. Therefore, at the minimum or maximum, the marginal response of *Y* to a change in *X* is zero.

FIGURE 2-10 Profits as a Function of Output



Profits rise and then eventually fall as output rises. When the firm is producing fewer than 2500 units annually, the marginal response of profit to output is positive—that is, an increase in output leads to an increase in profit. Beyond 2500 units annually, the marginal response is negative—an increase in output leads to a reduction in profit. At point *A*, profits are maximized and the marginal response of profit to output is zero. Because the tangent at point *A* is horizontal, the slope of the curve is zero at that point.

FIGURE 2-11 Average Fuel Consumption as a Function of Speed



Average fuel consumption falls and then rises as speed increases. Average fuel consumption in litres per kilometre travelled is minimized at point *A* at a speed of approximately 95 kilometres per hour (km/h). At speeds less than 95 km/h, the marginal response is negative—that is, an increase in speed reduces fuel consumption per kilometre. At speeds above 95 km/h, the marginal response is positive—an increase in speed increases fuel consumption per kilometre. At 95 km/h, the marginal response is zero and fuel consumption per kilometre is minimized.

A Final Word

We have done much in this chapter. We have discussed why economists develop theories (or models) to help them understand economic events in the real world. We have also discussed how they test their theories and how there is a continual back-and-forth process between empirical testing of predictions and refining the theory. Finally, we have devoted considerable time and space to exploring the many ways that data can be displayed in graphs and how economists use graphs to illustrate their theories.

Many students find themselves intimidated when they are first confronted with all the details about graphing. But try not to worry. You may not yet be a master of all the graphing techniques that we have discussed in this chapter, but you will be surprised at how quickly it all falls into place. And, as is true for most skills, there is no substitute for practice. In the next three chapters we will encounter many graphs. But we will start simply and then slowly attempt more complicated cases. We are confident that in the process of learning some basic economic theories you will get enough practice in graphing that you will very soon look back at this chapter and realize how straightforward it all is.

SUMMARY

2.1 POSITIVE AND NORMATIVE STATEMENTS — LO 1

- A key to the success of scientific inquiry lies in separating positive statements about the way the world works from normative statements about how one would like the world to work.
- Normative statements involve value judgements and cannot be disproven. Positive statements, at least in principle, can be disproven with an appeal to evidence.

2.2 BUILDING AND TESTING ECONOMIC THEORIES — LO 2, 3

- Theories (sometimes called models) are designed to explain and predict what we see. A theory consists of a set of definitions of the variables to be discussed, a set of assumptions about how things behave, and the conditions under which the theory is meant to apply.
- A theory provides predictions of the type "If one event occurs, then another event will also occur."
- Theories are tested by checking their predictions against evidence. In economics, testing is almost always done using the data produced by the world of ordinary events.
- Economists make use of statistical analysis when testing their theories. They must take care to make the distinction between correlation and causation.
- The progress of any science lies in finding better explanations of events than are now available. Thus, in any developing science, one must expect to discard some existing theories and replace them with demonstrably superior alternatives.

2.3 ECONOMIC DATA — LO 4

- Index numbers express economic series in relative form. Values in each period are expressed in relation to the value in the base period, which is given a value of 100.
- Economic data can be graphed in three different ways. Cross-sectional graphs show observations taken at the same time. Time-series graphs show observations on one variable taken over time. Scatter diagrams show many points, each of which refers to specific observations on two different variables.

2.4 GRAPHING ECONOMIC THEORIES

LO 5

- A functional relation can be expressed in words, in a table giving specific values, in a mathematical equation, or in a graph.
- A graph of two variables has a positive slope when they both increase or decrease together and a negative slope when they move in opposite directions.
- The marginal response of a variable gives the amount it changes in response to a change in a second variable. When the variable is measured on the vertical axis of a diagram, its marginal response at a specific point on the curve is measured by the slope of the line at that point.
- Some functions have a maximum or minimum point. At such points, the marginal response is zero.

KEY CONCEPTS

Positive and normative statements
Endogenous and exogenous variables
Theories and models
Variables, assumptions, and predictions
Correlation versus causation
Functional relations
Positive and negative relations between variables
Positively and negatively sloped curves
Marginal responses
Maximum and minimum values

STUDY EXERCISES

MyEconLab **Make the grade with MyEconLab: Study Exercises marked in # can be found on MyEconLab. You can practise them as often as you want, and most feature step-by-step guided instructions to help you find the right answer.**

1. Determine whether each of the following statements is positive or normative.
   a. The government should impose stricter regulations on the banking sector to avoid future financial crises.
   b. Financial aid to developing countries has no impact on per capita GDP in those countries.
   c. Tuition fee increases at Canadian universities lead to reduced access for low-income students.
   d. It is unfair that Canadians have universal access to health care but not to dental care.
   e. Canadians currently have too much personal debt.

2. In the following examples, identify the exogenous (or independent) variable and the endogenous (or dependent) variable.
   a. The amount of rainfall on the Canadian prairies determines the amount of wheat produced in Canada.
   b. When the world price of coffee increases, there is a change in the price of a cup of coffee at Tim Hortons.
   c. If student loans were no longer available, there would be fewer students attending university.
   d. An increase in the tax on gasoline leads people to drive more fuel-efficient vehicles.

3. Fill in the blanks to make the following statements correct.
   a. Economists have designed ____________ to better explain and predict the behaviour we observe in the world around us.
   b. A variable, such as price or quantity, that is determined within a theory is known as a(n) _______ variable. A variable that is determined outside the theory is known as a(n) __________ variable.
   c. When, based on a theory, we claim that "If A occurs, then B will follow," we are making a ________ that can then be tested by __________ observation.
   d. If we observe that when variable A decreases, variable B also decreases, we can say that the two variables are ____________. We cannot necessarily say that there is a __________ relationship between A and B.
   e. An important assumption that is made in economics is that individuals and firms pursue their own __________. We assume that individuals seek to maximize their ____________and firms seek to maximize their ___________.

4 An examination of data reveals a positive correlation between the demand for new homes and the price of lumber. Which of the following conclusions can be correctly inferred from the existence of this correlation? Why?

a. An increase in the demand for homes causes an increase in the price of lumber.
b. The observed correlation is consistent with a theory that an increase in demand for new homes causes an increase in the price of lumber.

5 Use the appropriate graph—time-series, cross-sectional, or scatter diagram—to illustrate the economic data provided in each part below.

a. The Canadian-dollar price of one U.S. dollar (the "exchange rate") in 2011:

January	0.994
February	0.988
March	0.977
April	0.958
May	0.968
June	0.977
July	0.956
August	0.982
September	1.003
October	1.019
November	1.026
December	1.024

b. A comparison of average household expenditures across provinces in 2010:

British Columbia	$72 486
Alberta	84 087
Saskatchewan	69 237
Manitoba	66 330
Ontario	74 521
Quebec	61 536
New Brunswick	59 943
Nova Scotia	61 907
Prince Edward Island	58 194
Newfoundland and Labrador	60 139

c. Per capita growth rates of real GDP and investment rates for various countries, averaged over the period 1950–2009:

Country	Average Growth Rate (% per year)	Average Investment Rate (% of GDP)
Canada	2.0	18.2
Austria	3.1	22.0
Japan	4.0	26.6
United States	1.9	18.1
United Kingdom	2.0	14.5
Spain	3.4	23.0
Norway	2.8	27.4
South Korea	5.1	27.2
Iceland	2.7	28.0

6 Suppose you want to create a price index for the price of a particular physics textbook over ten years in your university bookstore. The price of the book on September 1 of each year is as follows:

Year	Price ($)	Year	Price ($)
2000	85	2006	120
2001	87	2007	125
2002	94	2008	127
2003	104	2009	127
2004	110	2010	130
2005	112		

a. The base year is 2000. Construct a physics textbook price index.
b. What is the percentage increase in the price of the book between the base year and 2005?
c. What is the percentage increase in the price of the book from 2007 to 2010?
d. Are the data listed above time-series or cross-sectional data? Explain why.

7 Suppose you want to create a price index for the price of a personal pizza across several Canadian university campuses, as of March 1, 2016. The data are as follows:

University	Price per Pizza
Dalhousie	$6.50
Laval	5.95
McGill	6.00
Queen's	8.00
Waterloo	7.50
Manitoba	5.50
Saskatchewan	5.75
Calgary	6.25
UBC	7.25
Victoria	7.00

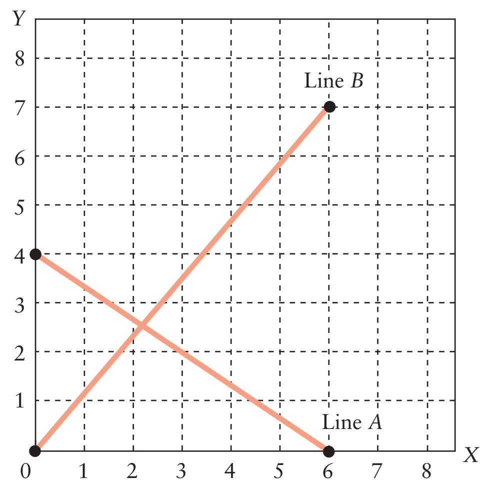
a. Using Calgary as the "base university," construct the Canadian university pizza price index.
b. At which university is pizza the most expensive, and by what percentage is the price higher than in Calgary?
c. At which university is pizza the least expensive, and by what percentage is the price lower than in Calgary?
d. Are the data listed above time-series or cross-sectional data? Explain why.

8 According to Statistics Canada, Canada's exports and imports of energy (combined totals of fossil fuels, hydro, and nuclear, all measured in petajoules) over a five-year period were as follows:

	Exports	Imports
2005	8662	3139
2006	8899	2977
2007	9331	3124
2008	9302	3010
2009	7902	2945

a. Using 2005 as the base year, construct index numbers for each of exports and imports.
b. Were exports or imports more volatile over this time period? Explain how you know.
c. Using your constructed index numbers, what was the percentage change in exports and imports from 2007 to 2009?
d. Can you provide a possible explanation for why Canada's exports of energy fell so dramatically from 2007 to 2009?

9 Use the following figure to answer the questions below.



a. Is the slope of Line A positive or negative? Line B?
b. Calculate the slope of Line A. Write the equation describing the line in the form $Y = mX + b$, where m is the slope of the line and b is a constant term.
c. Calculate the slope of Line B. Write the equation describing the line in the form $Y = mX + b$, where m is the slope of the line and b is a constant term.

10 Suppose the relationship between the government's tax revenue (T) and national income (Y) is represented by the following equation: $T = 10 + 0.25Y$. Plot this relationship on a scale diagram, with Y on the horizontal axis and T on the vertical axis. Interpret the equation.

11 Consider the following three specific functions for a functional relation between X and Y:

i) $Y = 50 + 2X$
ii) $Y = 50 + 2X + 0.05X^2$
iii) $Y = 50 + 2X - 0.05X^2$

a. For the values of X of 0, 10, 20, 30, 40, and 50, plot X and Y on a scale diagram for each specific function. Connect these points with a smooth line.
b. For each function, state whether the slope of the line is constant, increasing, or decreasing as the value of X increases.
c. Describe for each function how the marginal change in Y depends on the value of X.

12 For each of the functional relations listed below, plot the relations on a scale diagram (with X on the horizontal axis and Y on the vertical axis) and compute the slope of the line.

a. $Y = 10 + 3X$
b. $Y = 20 + 4X$
c. $Y = 30 + 5X$
d. $Y = 10 + 5X$

13 Suppose we divide Canada into three regions: the West, the Centre, and the East. Each region has an unemployment rate, defined as the number of people unemployed, expressed as a fraction of that region's labour force. The table that follows shows each region's unemployment rate and the size of its labour force.

Region	Unemployment Rate	Labour Force
West	5.5%	5.3 million
Centre	7.2%	8.4 million
East	12.5%	3.5 million

a. Compute an unemployment rate for Canada using a simple average of the rates in the three regions. Is this the "right" unemployment rate for Canada as a whole? Explain why or why not.

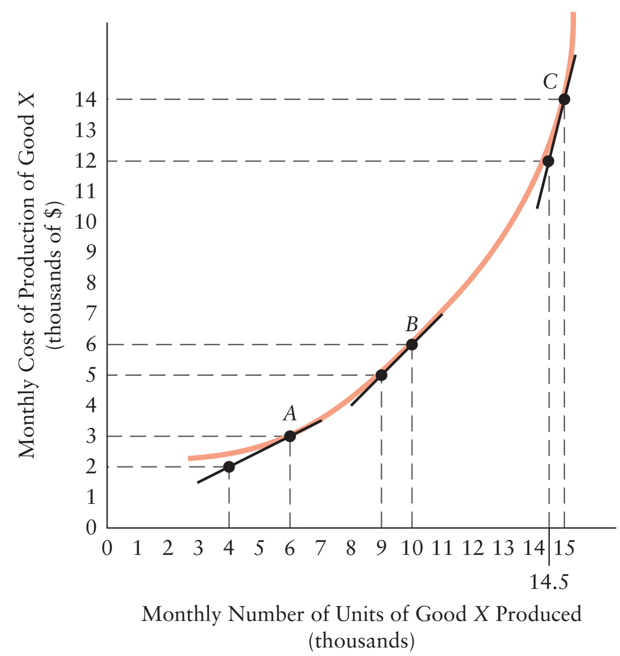
b. Now compute an unemployment rate for Canada using weights that reflect the size of that region's labour force as a proportion of the overall Canadian labour force. Explain the difference in this unemployment rate from the one in part (a). Is this a "better" measure of Canadian unemployment? Explain why.

14 Draw three graphs in which the dependent variable increases at an increasing rate, at a constant rate, and at a diminishing rate. Then draw three graphs in which it decreases at an increasing, constant, and diminishing rate. State a real relation that each of these graphs might describe, other than the ones given in the text of this chapter.

15 The following questions will provide practice working with simple linear functions. All questions refer to a coordinate graph with the variable X on the horizontal axis and the variable Y on the vertical axis.

a. If two points on a straight line are ($X = 3$, $Y = 2$) and ($X = 12$, $Y = 5$), what is the slope of the line?
b. If point A is at ($X = 20$, $Y = 20$) and point B is at ($X = 10$, $Y = 40$), what is the slope of the straight line joining points A and B?
c. What is the slope of the function described by $Y = 12\,000 - 0.5X$?
d. What is the slope of a line described by $Y = 6.5X$?
e. What is the slope of a line described by $Y = 27 + 3.2X$?
f. What is the Y-intercept of the function $Y = 1000 + mX$?
g. What is the Y-intercept of the function $Y = -100 + 10X$?
h. What is the X-intercept of the function $Y = 10 - 0.1X$?
i. Suppose ABC Corp. spends $100 000 per year on some basic level of advertising, regardless of its revenues. In addition, the company spends 15 percent of each dollar of revenue on extra advertising. Write a mathematical equation that describes the functional relation between advertising (A) and revenue (R).

16 The figure below shows a monthly cost curve for the production of Good X.



a. Calculate the slope of this non-linear function at points A, B, and C.
b. Is the marginal response of the cost of production of Good X to the change in the quantity produced of Good X increasing or decreasing?
c. Is the slope of this function increasing or decreasing as the volume of production increases?