AP MACROECONOMICS SUMMER ASSIGNMENT

WELCOME TO AP MACRO!

FOR THIS ASSIGNMENT, THERE IS A COPY OF MOD 1 AND THE GRAPHING PARTS OF THE TEXTBOOK.

There will be a **test** on the summer assignment the first cycle of school.

Part 1:

Using the copy of the textbook, define the following:

Economics

Economy

Market economy

Command economy

Marginal analysis

Scarcity

Opportunity cost

Microeconomics

Macroeconomics

List and define the 4 factors of production

There are 26 terms to define—for **10 pts extra credit**, define all 42 terms, which are found throughout the textbook copies attached. These are the bold terms in the yellow boxes.

Part 2:

Read pages 2-8 and 33-44

Complete the Check You Understanding found on pages 8 and 44

(You do not need to copy the question)

Complete the Multiple Choice Questions on page 8. Write out the question and the correct answer.

SECTION 1

Basic Economic Concepts

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Common Ground

The annual meeting of the American Economic Association draws thousands of economists, young and old, famous and obscure. There are booksellers, business meetings, and quite a few job interviews. But mainly the economists gather to talk and listen. During the busiest times, 60 or more presentations may be taking place simultaneously, on questions that range from the future of the stock market to who does the cooking in two-earner families.

What do these people have in common? An expert on the stock market probably knows very little about the economics of housework, and vice versa. Yet an economist who wanders into the wrong seminar and ends up listening to presentations on some unfamiliar topic is nonetheless likely to hear much that is familiar. The reason is that all economic analysis is based on a set of common principles that apply to many different issues.

Some of these principles involve *individual choice*—for economics is, at its core, about the choices that individuals make. Do you choose to work during the summer or take a backpacking trip? Do you text with friends or meet them at a movie? These decisions involve *making a choice* from among a limited number of alternatives—limited because no one can have everything that he or she wants. Every question in economics at its most basic level involves individuals making choices.

To understand how an economy works, you need to understand more than how individuals make choices. None of us lives like Robinson Crusoe, alone on an island. We must make decisions in an environment that is shaped by the decisions of others. Indeed, in our global economy even the simplest decisions you make—say, what to have for breakfast—are shaped by the decisions of thousands of other people, from the banana grower in Costa Rica who decided to grow the fruit you eat to the farmer in Iowa who provided the corn in your cornflakes. Because each of us depends on so many others—and they, in turn, depend on us—our choices interact. So, although all economics at a basic level is about individual choice, in order to understand behavior within an economy we must also understand economic *interaction*—how my choices affect your choices, and vice versa.

Microeconomics helps us understand many important economic interactions by looking at individual choice and the markets for individual goods—for example, the market for cereal. *Macroeconomics* is our window for viewing economy-wide interactions in order to understand how they lead to the ups and downs we see in the economy as a whole.

In this section we discuss the study of economics and the difference between microeconomics and macroeconomics. We also introduce the major topics within macroeconomics and the use of models to study the economy. Finally, we present the *production possibilities curve* model and use it to understand basic economic activity, including trade between two economies. Because the study of economics relies on graphical models, an appendix on the use of graphs follows the end of this section.

MOD 1

The Study of Economics

In this Module, you will learn to:

- Explain how scarcity and choice are central to the study of economics
- Discuss the importance of opportunity cost in decision making
- Distinguish between microeconomic concepts and macroeconomic concepts
- Explain the difference between positive economics and normative economics
- Identify areas of agreement and disagreement among economists

Individual Choice: The Core of Economics

Economics is the study of scarcity and choice.

Individual choice is decisions by individuals about what to do, which necessarily involve decisions about what not to do.

Economics is the study of scarcity and choice. Every economic issue involves, at its most basic level, **individual choice**—decisions by individuals about what to do and what *not* to do. In fact, you might say that it isn't economics if it isn't about choice.

When you shop online there are thousands of different products available, and it is extremely unlikely that you—or anyone else—could afford to buy everything you might want to have. Besides, there's only so much space in your room. Given the limitations on your budget and your living space, you must choose which products to buy and which to pass up.

Casimiro/Alamy

The fact that those products are available in the first place involves choice—the online stores chose to put them there, and the manufacturers of the products chose to produce them. An **economy** is a system that coordinates choices about production with choices about consumption and distributes goods and services to the people who want them. The United States has a **market economy**, in which production and consumption are the result of decentralized decisions by many firms and individuals. There is no central authority telling people what to produce or where to ship it. Each individual producer makes what he or she thinks will be most profitable, and each consumer buys what he or she chooses.

An alternative to a market economy is a **command economy**, in which industry is publicly owned and there *is* a central authority making production and consumption decisions. Command economies have been tried, most notably in the Soviet Union between 1917 and 1991 and in North Korea today, but they don't work very well. Producers in the Soviet Union routinely found themselves unable to produce because they did not have crucial raw materials, or they succeeded in producing but then found that nobody wanted what the central authority had them produce. Consumers were often unable to find necessary items—command economies are famous for long lines at shops.

An **economy** is a system for coordinating a society's productive and consumptive activities.

In a **market economy**, the decisions of individual producers and consumers largely determine what, how, and for whom to produce, with little government involvement in the decisions.

In a **command economy**, industry is publicly owned and a central authority makes production and consumption decisions.

Incentives are rewards or punishments that motivate particular choices.

Property rights establish ownership and grant individuals the right to trade goods and services with each other.

At the root of the problem with command economies is a lack of **incentives**, which are rewards or punishments that motivate particular choices. In market economies, producers are free to charge higher prices when there is a shortage of something, and to keep the resulting profits. High prices and profits provide incentives for producers to make more of the most-needed goods and services and to eliminate shortages.

In fact, economists tend to be skeptical of any attempt to change people's behavior that doesn't change their incentives. For example, a plan that calls on manufacturers to reduce pollution voluntarily probably won't be effective; a plan that gives them a financial incentive to do so is more likely to succeed.

Property rights, which establish ownership and grant individuals the right to trade goods and services with each other, create many of the incentives in market economies. With the right to own property comes the incentive to produce things of value, either to keep, or to trade for mutual gain. And ownership creates an incentive to put resources to their best possible use. Property rights to a lake, for example, give the owners an incentive not to pollute that lake if its use for recreation, serenity, or sale has great value.

In any economy, the decisions of what to do with the next ton of pollution, the next hour of free time, and the next dollar of spending money are *marginal decisions*. They involve trade-offs at the margin: comparing the costs and benefits of doing a little bit more of an activity versus a little bit less. The gain from doing something one more time is called the *marginal benefit*. The cost of doing something one more time is the *marginal cost*. If the marginal benefit of making another car, reading another page, or buying another latte exceeds the marginal cost, the activity should continue. But if the cost of one more exceeds the benefit of one more—that is, if the marginal cost exceeds the marginal benefit—the activity should stop. The study of such decisions, known as **marginal analysis**, plays a central role in economics because the formula of doing things until the marginal benefit no longer exceeds the marginal cost is the key to deciding "how much" to do of any activity.

All economic activities involve individual choice. Let's take a closer look at what this means for the study of economics.

Marginal analysis is the study of the costs and benefits of doing a little bit more of an activity versus a little bit less.

AP® EXAM TIP

Students of microeconomics should pay close attention to *marginal analysis*, as it is often tested on the AP® exam. Any time you see "marginal," think "additional."

Resources Are Scarce

You can't always get what you want. Almost everyone would like to have a beautiful home in a great location, help with the housecleaning, a luxury car, and frequent vacations at fancy resorts. But even in a rich country like the United States, not many families can afford all of that. So each family must make choices—whether to go to Disney World this year or buy a better car, whether to make do with a small backyard or accept a longer commute in order to live where land is cheaper.

Limited income isn't the only thing that keeps people from having everything they want. Time is also in limited supply: there are only 24 hours in a day. And because the time we have is limited, choosing to spend time on one activity also means choosing not to spend time on a different activity—spending time studying for an exam means forgoing a night at the movies. Indeed, many people feel so limited by the number of hours in the day that they are willing to trade money for time. For example, convenience stores usually charge higher prices than larger supermarkets. But they fulfill a valuable role by catering to customers who would rather pay more than spend the time traveling farther to a supermarket where they might also have to wait in longer lines.

Why do individuals have to make choices? The ultimate reason is that *resources are scarce*. A **resource** is anything that can be used to produce something else. The economy's resources, sometimes called *factors of production*, can be classified into four categories: **land** (including timber, water, minerals, and all other resources that come from nature), **labor** (the effort of workers), **capital** (machinery, buildings, tools, and all other manufactured goods used to make other goods and services), and **entrepreneurship** (risk taking, innovation, and the organization of resources for production). A resource is **scarce** when there is not enough of it available to satisfy the various ways a society wants to use it. For example, there are limited supplies of oil and coal, which currently provide most of the energy used to produce and deliver everything we buy. And in a growing world economy with a rapidly increasing human population, even clean air and water have become scarce resources.

Just as individuals must make choices, the scarcity of resources means that society as a whole must make choices. One way for a society to make choices is simply to allow them to emerge as the result of many individual choices. For example, there are only so many hours in a week, and Americans must decide how to spend their time. How many hours will they spend going to supermarkets to get lower prices rather than saving time by shopping at convenience stores? The answer is the sum of individual decisions: society's choice about where to shop is simply the sum of the choices made by the millions of individuals in the economy.

For various reasons, there are some decisions that are best not left to individual choice. For example, the authors of this book live in areas that until recently

A **resource** is anything that can be used to produce something else.

Land refers to all resources that come from nature, such as minerals, timber, and petroleum.

Labor is the effort of workers.

Capital refers to manufactured goods used to make other goods and services.

Entrepreneurship describes the efforts of entrepreneurs in organizing resources for production, taking risks to create new enterprises, and innovating to develop new products and production processes.

A **scarce** resource is not available in sufficient quantities to satisfy all the various ways a society wants to use it.

AP® EXAM TIP

Be careful when you see key terms you think you already know, because economists have special meanings for many words. For example, economists use the term *land* in reference to all sorts of natural resources and raw materials such as silicon, cotton, and even water.

AP® EXAM TIP

Questions on the AP® exam generally use the term *capital* to refer to the category of factors of production made up of manufactured goods used to make other goods and services. Don't confuse this type of capital with *financial capital* such as money, stocks, and bonds.

were mainly farmland but are now being rapidly built up. Most local residents feel that their communities would be more pleasant places to live if some land were left undeveloped. But the benefit an individual landowner receives from his or her undeveloped land is often small relative to the financial incentive to sell the land to a developer. So a trend has emerged in many communities across the United States of local governments purchasing undeveloped land and preserving it as open space with broad appeal to residents and visitors. Decisions about how to use scarce resources are often best left to individuals but sometimes should be made at a higher, community-wide, level.

Opportunity Cost: The Real Cost of Something Is What You Must Give Up to Get It

Suppose it is your last year of high school and you must decide which college to attend. You have narrowed your choices to a small liberal arts college near home or a large state university several hours away. If you decide to attend the local liberal arts college, what is the cost of that decision? Of course, you will have to pay for tuition, books, and housing no matter which college you choose. Added to the cost of choosing the local college is the forgone opportunity to attend the large state university, your next best alternative. Economists call the value of the next best alternative that you must give up when you make a particular choice an **opportunity cost**.

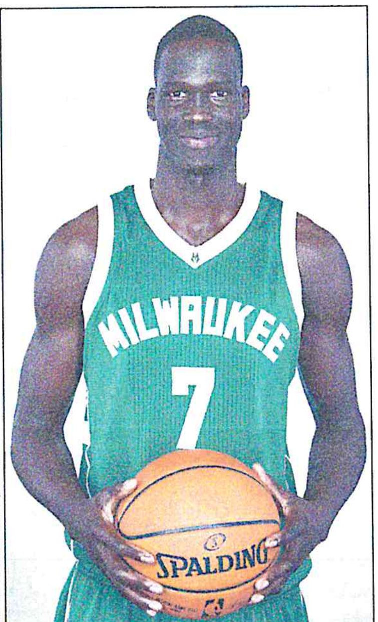
The real cost of an item is its **opportunity cost**: the value of the next best alternative that you must give up in order to get the item.

Opportunity costs are crucial to individual choice because, in the end, all costs are opportunity costs. That's because with every choice, an alternative is forgone—money or time spent on one thing can't be spent on another. If you spend $15 on a pizza, you forgo the opportunity to spend that $15 on a hamburger. If you spend Saturday afternoon at the swimming pool, you can't spend Saturday afternoon doing homework. And if you attend one school, you can't attend another.

The pool and school examples show that economists are concerned with more than just costs paid in dollars and cents. The forgone opportunity to do homework has no direct monetary cost, but it is an opportunity cost nonetheless. And if the local college and the state university have the same tuition and fees, the cost of choosing one school over the other has nothing to do with payments and everything to do with forgone opportunities.

Now suppose tuition and fees at the state university are $5,000 less than at the local college. In that case, what you give up to attend the local college is the ability to attend the state university *plus* the enjoyment you could have gained from spending $5,000 on other things. So the opportunity cost of a choice includes all the costs—whether or not they are monetary costs—of making that choice.

The choice to go to college *at all* provides an important final example of opportunity costs. High school graduates can either go to college or seek immediate employment. Even with a full scholarship that would make college "free" in terms of monetary costs, going to college would still be an expensive proposition because most young people, if they were not in college, would have a job. By going to college, students forgo the income they could have earned if they had gone straight to work instead. Therefore, the opportunity cost of attending college is the value of all necessary monetary payments for tuition and fees *plus* the forgone income from the best available job that could take the place of going to college.



Jennifer Pottheiser/Getty Images

Thon Maker understood the concept of opportunity cost.

For most people the value of a college degree far exceeds the value of alternative earnings, with notable exceptions. The opportunity cost of going to college is high for people who could earn a lot during what would otherwise be their college years. Basketball star Thon Maker bypassed college because the opportunity cost would have included his $11.6 million contract with the Milwaukee Bucks. Facebook co-founder Mark Zuckerberg, Microsoft co-founder Bill Gates, and singer Taylor Swift are among the high achievers who decided that the opportunity cost of completing college was prohibitive.

Microeconomics Versus Macroeconomics

We have presented economics as the study of choices and described how, at its most basic level, economics is about individual choice. The branch of economics concerned with how individuals make decisions and how those decisions interact is called **microeconomics**. Microeconomics focuses on choices made by individuals, households, or firms—the smaller parts that make up the economy as a whole.

Microeconomics is the study of how individuals, households, and firms make decisions and how those decisions interact.

Macroeconomics focuses on the bigger picture—the overall ups and downs of the economy. When you study macroeconomics, you learn how economists explain these fluctuations and how governments can use economic policy to minimize the damage they cause. Macroeconomics focuses on **economic aggregates**—economic measures such as the unemployment rate, the inflation rate, and gross domestic product—that summarize data across many different markets.

Macroeconomics is concerned with the overall ups and downs of the economy.

Economic aggregates are economic measures that summarize data across many different markets.

Table 1.1 lists some typical questions that involve economics. A microeconomic version of the question appears on the left, paired with a similar macroeconomic question on the right. By comparing the questions, you can begin to get a sense of the difference between microeconomics and macroeconomics.

Table 1.1 Microeconomic Versus Macroeconomic Questions

Microeconomic Questions	Macroeconomic Questions
Should I go to college or get a job after high school?	How many people are employed in the economy as a whole this year?
What determines the salary that Citibank offers to a new college graduate?	What determines the overall salary levels paid to workers in a given year?
What determines the cost to a high school of offering a new course?	What determines the overall level of prices in the economy as a whole?
What government policies should be adopted to make it easier for low-income students to attend college?	What government policies should be adopted to promote employment and growth in the economy as a whole?
What determines the number of iPhones exported to France?	What determines the overall trade in goods, services, and financial assets between the United States and the rest of the world?

As these questions illustrate, microeconomics focuses on how individuals and firms make decisions, and the consequences of those decisions. For example, a school will use microeconomics to determine how much it would cost to offer a new course, which includes the instructor's salary, the cost of class materials, and so on. By weighing the costs and benefits, the school can then decide whether or not to offer the course. Macroeconomics, in contrast, examines the *overall* behavior of the economy—how the actions of all of the individuals and firms in the economy interact to produce a particular economy-wide level of economic performance. For example, macroeconomics is concerned with the general level of prices in the economy and how high or low they are relative to prices last year, rather than with the price of a particular good or service.

Positive Versus Normative Economics

Economic analysis draws on a set of basic economic principles. But how are these principles applied? That depends on the purpose of the analysis. Economic analysis that is used to answer questions about the way the economy works, questions that have definite right and wrong answers, is known as **positive economics**. In contrast, economic analysis that involves saying how the economy *should* work is known as **normative economics**.

Positive economics is the branch of economic analysis that describes the way the economy actually works.

Normative economics makes prescriptions about the way the economy should work.

Imagine you are an economic adviser to the governor of your state and the governor is considering an increase in the toll charged along the state turnpike. Below are three questions the governor might ask you.

1. How much revenue will the tolls yield next year without an increase?
2. How much higher would that revenue be if the toll were raised from $1.00 to $1.50?
3. Should the toll be raised, bearing in mind that a toll increase would lower the volume of traffic and air pollution in the area but impose a financial hardship on frequent commuters?

There is a big difference between the first two questions and the third one. The first two are questions about facts. Your forecast of next year's toll revenue without any increase will be proved right or wrong when the numbers actually come in. Your estimate of the impact of a change in the toll is a little harder to check—the increase in revenue depends on other factors besides the toll, and it may be hard to disentangle the causes of any change in revenue. Still, in principle there is only one right answer.

AP® EXAM TIP

In economics, positive statements are about *what is*, while normative statements are about *what should be*.

But the question of whether or not tolls should be raised may not have a "right" answer—two people who agree on the effects of a higher toll could still disagree about whether raising the toll is a good idea. For example, someone who lives near the turnpike but doesn't commute on it will care a lot about noise and air pollution but not so much about commuting costs. A regular commuter who doesn't live near the turnpike will have the opposite priorities.

This example highlights a key distinction between the two roles of economic analysis and presents another way to think about the distinction between positive and normative analysis: positive economics is about description and normative economics is about prescription. Positive economics occupies most of the time and effort of economists.

Looking back at the three questions the governor might ask, it is worth noting a subtle but important difference between questions 1 and 2. Question 1 asks for a simple prediction about next year's revenue—a forecast. Question 2 is a "what if" question, asking how revenue would change if the toll were to increase. Economists are often called upon to answer both types of questions. Economic *models*, which provide simplified representations of reality using, for example, graphs or equations, are especially useful for answering "what if" questions.

The answers to such questions often serve as a guide to policy, but they are still predictions, not prescriptions. That is, they tell you what will happen if a policy is changed, but they don't tell you whether or not that result is good. Suppose that your economic model tells you that the governor's proposed increase in highway tolls will raise property values in communities near the road but will tax or inconvenience people who currently use the turnpike to get to work. Does that information make this proposed toll increase a good idea or a bad one? It depends on whom you ask. As we've just seen, someone who is very concerned with the communities near the road will support the increase, but someone who is very concerned with the welfare of drivers will feel differently. That's a value judgment—it's not a question of positive economic analysis.

John Grein/LOOP IMAGES/Getty images

Should the toll be raised?

Still, economists often do engage in normative economics and give policy advice. How can they do this when there may be no "right" answer? One answer is that economists are also citizens, and we all have our opinions. But economic analysis can often be used to show that some policies are clearly better than others, regardless of individual opinions.

Suppose that policies A and B achieve the same goal, but policy A makes everyone better off than policy B—or at least makes some people better off without making other people worse off. Then A is clearly more beneficial than B. That's not a value judgment: we're talking about how best to achieve a goal, not about the goal itself.

For example, two different policies have been used to help low-income families obtain housing: rent control, which limits the rents landlords are allowed to charge, and rent subsidies, which provide families with additional money with which to pay rent. Almost all economists agree that subsidies are the preferable policy. (In Module 75 we'll see why this is so.) And so the great majority of economists, whatever their personal politics, favor subsidies over rent control.

When policies can be clearly ranked in this way, then economists generally agree. But it is no secret that economists sometimes disagree.

When and Why Economists Disagree

Economists have a reputation for disagreeing with each other. Where does this reputation come from? One important answer is that media coverage tends to exaggerate the real differences in views among economists. If nearly all economists agree on an issue—for example, the proposition that rent controls lead to housing shortages—reporters and editors are likely to conclude that there is no story worth covering, and so the professional consensus tends to go unreported. But when there is some issue on which prominent economists take opposing sides, such as whether cutting taxes right now would help the economy, that does make a good news story. So you hear much more about the areas of disagreement among economists than you do about the many areas of agreement.

It is also worth remembering that economics, unavoidably, is often tied up in politics. On a number of issues, powerful interest groups know what opinions they want to hear. Therefore, they have an incentive to find and promote economists who profess those opinions, which gives these economists a prominence and visibility out of proportion to their support among their colleagues.

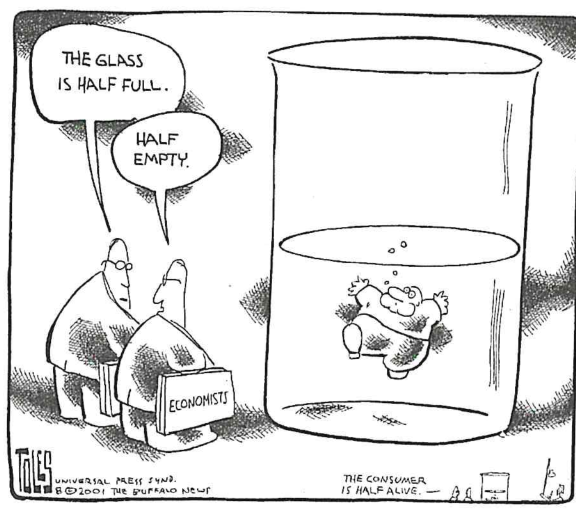
Although the appearance of disagreement among economists exceeds the reality, it remains true that economists often *do* disagree about important things. For example, some highly respected economists argue vehemently that the U.S. government should replace the income tax with a *value-added tax* (a national sales tax, which is the main source of government revenue in many European countries). Other equally respected economists disagree. What are the sources of this difference of opinion?

One important source of differences is in values: as in any diverse group of individuals, reasonable people can differ. In comparison to an income tax, a value-added tax typically falls more heavily on people with low incomes. So an economist who values a society with more social and income equality will likely oppose a value-added tax. An economist with different values will be less likely to oppose it.

A second important source of differences arises from the way economists conduct economic analysis. Economists base their conclusions on models formed by making simplifying assumptions about reality. Two economists can legitimately disagree about which simplifications are appropriate—and therefore arrive at different conclusions.

Suppose that the U.S. government were considering a value-added tax. One economist may rely on a simplification of reality that focuses on the administrative costs of tax systems—that is, the costs of monitoring compliance, processing tax forms, collecting the tax, and so on. This economist might then point to the well-known high costs of administering a value-added tax and argue against the change. Another economist may think that the right way to approach the question is to ignore the administrative costs and focus on how the proposed law would change individual savings behavior. The second economist might point to studies suggesting that value-added taxes promote higher consumer saving, a desirable result. Because the economists have made different simplifying assumptions, they arrive at different conclusions. And so the two economists may find themselves on different sides of the issue.

Most disputes like this are eventually resolved by the accumulation of evidence that shows which of the various simplifying assumptions made by economists does a better job of fitting the facts. However, in economics, as in any science, it can take a long time before research



settles important disputes—decades, in some cases. And since the economy is always changing in ways that make old approaches invalid or raise new policy questions, there are always new issues on which economists disagree. The policy maker must then decide which economist to believe.

MODULE 1 REVIEW

Check Your Understanding

1. Provide an example of a resource from each of the four categories of resources.
2. What type of resource is each of the following?
   a. time spent making pizzas at a restaurant
   b. a bulldozer
   c. a river
3. You make $45,000 per year at your current job with Whiz Kids Consultants. You are considering a job offer from Brainiacs, Inc., which would pay you $50,000 per year. Is each of the following elements an opportunity cost of accepting the new job at Brainiacs, Inc.? Answer yes or no, and explain your answer.
   a. the increased time spent commuting to your new job
   b. the $45,000 salary from your old job
   c. the more spacious office at your new job
4. Identify each of the following statements as positive or normative, and explain your answer.
   a. Society should take measures to prevent people from engaging in dangerous personal behavior.
   b. People who engage in dangerous personal behavior impose higher costs on society through higher medical costs.

TACKLE THE AP® TEST: Multiple-Choice Questions

1. Which of the following is an example of capital?
   a. a cheeseburger dinner
   b. a construction worker
   c. petroleum
   d. a factory
   e. an acre of farmland
2. Which of the following is not an example of resource scarcity?
   a. There is a finite amount of petroleum in the world.
   b. Farming communities are experiencing droughts.
   c. There are not enough physicians to satisfy all desires for health care in the United States.
   d. Cassette tapes are no longer being produced.
   e. Teachers would like to have more instructional technology in their classrooms.
3. Suppose that you prefer reading a book you already own to watching videos and that you prefer watching videos to listening to music. If these are your only three choices, what is the opportunity cost of reading?
   a. watching videos and listening to music
   b. watching videos
   c. listening to music
   d. sleeping
   e. the price of the book
4. Which of the following statements is normative?
   a. The price of gasoline is rising.
   b. The price of gasoline is too high.
   c. Gas prices are expected to fall in the near future.
   d. Cars can run on gasoline, electricity, or diesel fuel.
   e. When the price of gasoline rises, drivers buy less gasoline.
5. Which of the following questions is studied in microeconomics?
   a. Should I go to college or get a job after I graduate?
   b. What government policies should be adopted to promote employment in the economy?
   c. How many people are employed in the economy this year?
   d. Has the overall level of prices in the economy increased or decreased this year?
   e. What determines the overall salary levels paid to workers in a given year?
6. Which of the following exist(s) in a command economy but not in a market economy?
   a. property rights for individuals
   b. land, labor, capital, and entrepreneurship
   c. plenty of incentives to motivate firms to produce what consumers need
   d. an absence of long lines of customers at shops
   e. a central authority making production and consumption decisions
7. All opportunity costs are
   a. nonmonetary.
   b. forgone monetary payments.
   c. losses of time.
   d. values of alternatives that must be given up.
   e. related to educational opportunities.

2. Suppose the country of Lunchland produces only peanut butter and jelly using resources that are not equally useful for producing both goods.
   a. Draw a correctly labeled production possibilities curve graph for Lunchland and label the following:
      i. point *A*, indicating an inefficient use of resources.
      ii. point *B*, indicating quantities of peanut butter and jelly that are currently not possible.
   b. Identify two things that could happen to enable Lunchland to produce or consume the quantities identified in part a (ii). **(5 points)**
3. Fields Farm and Romano Farm have identical resources and produce oranges and/or peaches at a constant opportunity cost. The table below shows the maximum quantity of oranges and peaches each farm could produce if it devoted all of its resources to that fruit.

	Output (bushels per day)	
	Oranges	**Peaches**
Fields Farm	80	40
Romano Farm	60	20

   a. On a correctly labeled graph and using the numbers in the table, draw the production possibilities curve for Romano Farm.
   b. What is Fields Farm's opportunity cost of producing one bushel of peaches?
   c. Suppose each farm agrees to specialize in one good and trade for the other good.
      i. Which farm should specialize in peaches? Explain.
      ii. If the farms specialize as indicated in part c (i), would the terms of trade of four oranges in exchange for one peach be acceptable to both farms? Explain.
   d. Now suppose Romano Farm obtains new technology used only for the production of peaches. Show the effect of this change on the graph drawn for part a. **(5 points)**

SECTION 1 APPENDIX

Graphs in Economics

In this Appendix, you will learn to:
- Recognize the importance of graphs in studying economics
- Describe the basic components of a graph
- Explain how graphs illustrate the relationship between variables
- Explain how to calculate the slope of a curve and discuss what the slope value means
- Describe how to calculate areas represented on graphs
- Explain how to interpret numerical graphs

Getting the Picture

Whether you're reading about economics in the *Wall Street Journal* or in your economics textbook, you will see many graphs. Visual presentations can make it much easier to understand verbal descriptions, numerical information, or ideas. In economics, graphs are the type of visual presentation used to facilitate understanding. To fully understand the ideas and information being discussed, you need to know how to interpret these visual aids. This Module explains how graphs are constructed and interpreted and how they are used in economics.

Graphs, Variables, and Economic Models

One reason to attend college is that a bachelor's degree provides access to higher-paying jobs. Additional degrees, such as MBAs or law degrees, increase earnings even more. If you were to read an article about the relationship between educational attainment

A **variable** is a measure that can take on more than one value.

and income, you would probably see a graph showing the income levels for workers with different levels of education. This graph would depict the idea that, in general, having more education increases a person's income. This graph, like most graphs in economics, would depict the relationship between two economic variables. A **variable** is a measure that can take on more than one value, such as the number of years of education a person has, the price of a can of soda, or a household's income.

As you learned in this Section, economic analysis relies heavily on *models*, simplified representations of real situations. Most economic models describe the relationship between two variables, simplified by holding constant other variables that may affect the relationship. For example, an economic model might describe the relationship between the price of a can of soda and the number of cans of soda that consumers will buy, assuming that everything else that affects consumers' purchases of soda stays constant. This type of model can be depicted mathematically, but illustrating the relationship in a graph makes it easier to understand. Next, we show how graphs that depict economic models are constructed and interpreted.

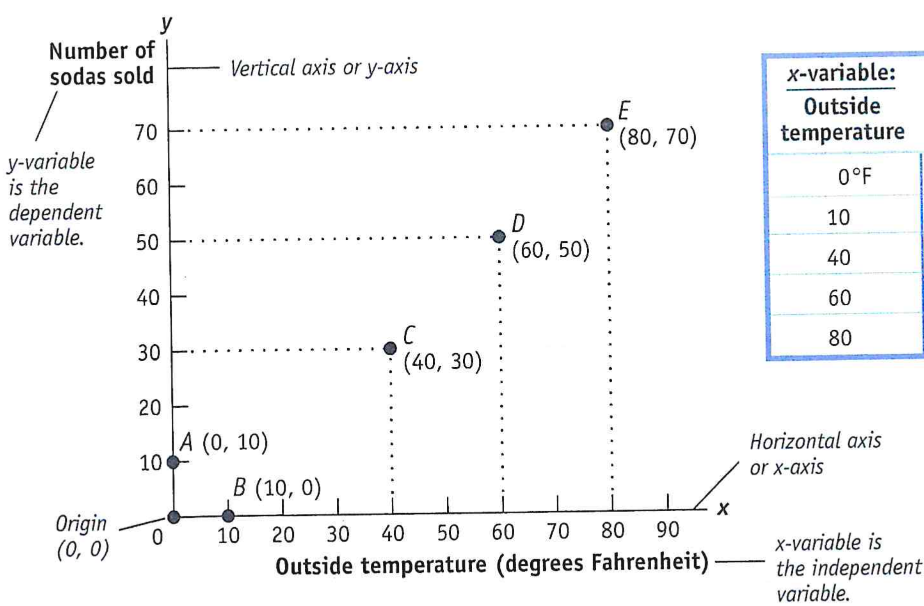
How Graphs Work

Most graphs in economics are built in a two-dimensional space defined by two perpendicular lines that show the values of two or more variables. These graphs help people visualize the relationship between the variables. A first step in understanding the use of such graphs is to see how the values of variables are indicated by the points on the graphs.

Two-Variable Graphs

Figure A.1 shows a typical two-variable graph. It illustrates the data in the accompanying table on outside temperature and the number of sodas a typical vendor can expect to sell at a baseball stadium during one game. The first column shows the values of outside temperature (the first variable) and the second column shows the values of

Figure A.1 Plotting Points on a Two-Variable Graph



x-variable: Outside temperature	y-variable: Number of sodas sold	Point
0°F	10	A
10	0	B
40	30	C
60	50	D
80	70	E

The data from the table are plotted where outside temperature (the independent variable) is measured along the horizontal axis and number of sodas sold (the dependent variable) is measured along the vertical axis. Each of the five combinations of temperature and sodas sold is represented by a point: *A, B, C, D,* or *E*. Each point in the graph is identified by a pair of values. For example, point *C* corresponds to the pair (40, 30)—an outside temperature of 40°F (the value of the *x*-variable) and 30 sodas sold (the value of the *y*-variable).

the number of sodas sold (the second variable). Five combinations or pairs of the two variables are shown, denoted by points *A* through *E* in the third column.

Now let's turn to graphing the data in this table. In any two-variable graph, one variable is called the *x*-variable and the other is called the *y*-variable. Here we have made outside temperature the *x*-variable and number of sodas sold the *y*-variable. The solid horizontal line in the graph is called the **horizontal axis** or ***x*-axis**, and values of the *x*-variable—outside temperature—are measured along it. Similarly, the solid vertical line in the graph is called the **vertical axis** or ***y*-axis**, and values of the *y*-variable—number of sodas sold—are measured along it. At the **origin**, the point where the two axes meet, each variable is equal to zero. As you move rightward from the origin along the *x*-axis, values of the *x*-variable are positive and increasing. As you move up from the origin along the *y*-axis, values of the *y*-variable are positive and increasing.

You can plot each of the five points *A* through *E* on this graph by using a pair of numbers—the values that the *x*-variable and the *y*-variable take on for a given point. In Figure A.1, at point *C*, the *x*-variable takes on the value 40 and the *y*-variable takes on the value 30. You plot point *C* by drawing a line straight up from 40 on the *x*-axis and a horizontal line across from 30 on the *y*-axis. We write point *C* as (40, 30). We write the origin as (0, 0).

Looking at point *A* and point *B* in Figure A.1, you can see that when one of the variables for a point has a value of zero, it will lie on one of the axes. If the value of the *x*-variable is zero, the point will lie on the vertical axis, like point *A*. If the value of the *y*-variable is zero, the point will lie on the horizontal axis, like point *B*. (The location of point *B* was chosen to illustrate this fact and not because soda sales will really decrease when the temperature rises.)

Most graphs that depict relationships between two economic variables represent a **causal relationship**, a relationship in which the value of one variable directly influences or determines the value of the other variable. In a causal relationship, the determining variable is called the **independent variable**; the variable it determines is called the **dependent variable**. In our example of soda sales, the outside temperature is the independent variable. It directly influences the number of sodas that are sold, which is the dependent variable in this case.

By convention, we put the independent variable on the horizontal axis and the dependent variable on the vertical axis. Figure A.1 is constructed consistent with this convention: the independent variable (outside temperature) is on the horizontal axis and the dependent variable (number of sodas sold) is on the vertical axis. An important exception to this convention is in graphs showing the economic relationship between the price and quantity of a product: although price is generally the independent variable that determines quantity, price is always measured on the vertical axis.

The solid horizontal line that goes through the origin on a graph is called the **horizontal axis** or ***x*-axis**.

The solid vertical line that goes through the origin on a graph is called the **vertical axis** or ***y*-axis**.

The two axes meet at the **origin**.

A **causal relationship** is one in which the value of one variable directly influences or determines the value of the other variable.

In a causal relationship, the determining variable is called the **independent variable** and the determined variable is called the **dependent variable**.

Curves on a Graph

Panel (a) of **Figure A.2** contains some of the same information as Figure A.1, with a line drawn through the points *B, C, D,* and *E*. Such a line on a graph is called a **curve**, regardless of whether it is a straight line or a curved line. If the curve that shows the relationship between two variables is a straight line, or linear, the variables have a **linear relationship**. When the curve is not a straight line, it is nonlinear, and the variables have a **nonlinear relationship**.

A point on a curve indicates the value of the *y*-variable for a specific value of the *x*-variable. For example, point *D* indicates that at a temperature of 60°F, a vendor can expect to sell 50 sodas. The shape and orientation of a curve reveal the general nature of the relationship between the two variables. The upward tilt of the curve in panel (a) of Figure A.2 suggests that vendors can expect to sell more sodas at higher outside temperatures.

When variables are related in this way—that is, when an increase in one variable is associated with an increase in the other variable—the variables are said to have a **positive relationship**. This relationship is illustrated by a curve that slopes upward from left to right. Because the relationship between outside temperature and number of sodas sold is also linear, as illustrated by the curve in panel (a) of Figure A.2, it is a positive linear relationship.

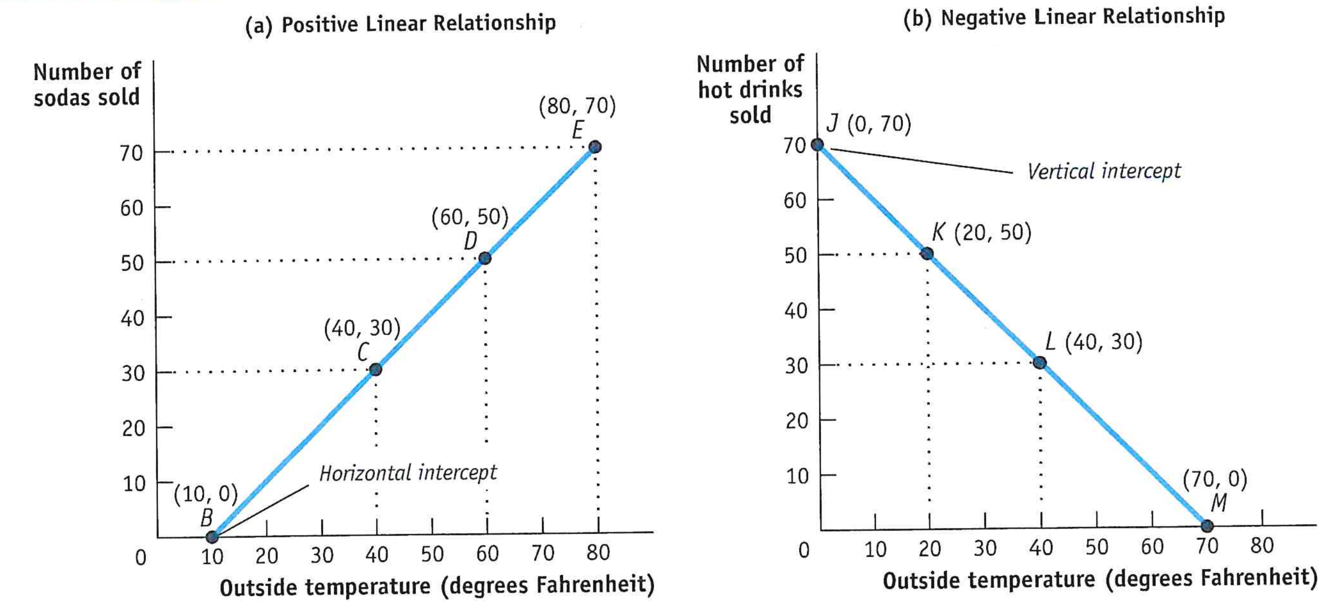
A line on a graph is called a **curve**, regardless of whether it is a straight line or a curved line.

If a curve that shows the relationship between two variables is a straight line, or linear, the variables have a **linear relationship**.

When a curve is not a straight line, it is nonlinear, and the variables have a **nonlinear relationship**.

When an increase in one variable is associated with an increase in the other variable, the variables are said to have a **positive relationship**.

Figure A.2 Drawing Curves



The curve in panel (a) illustrates the relationship between the two variables, outside temperature and number of sodas sold. The two variables have a positive linear relationship: positive because the curve has an upward tilt, and linear because it is a straight line. The curve implies that an increase in the *independent* variable (outside temperature) leads to an increase in the dependent variable (number of sodas sold). The curve in panel (b) is also a straight line, but it tilts downward. The two variables here, outside temperature and number of hot drinks sold, have a negative linear relationship: an increase in the *independent* variable (outside temperature) leads to a decrease in the dependent variable (number of hot drinks sold). The curve in panel (a) has a horizontal intercept at point *B*, where it hits the horizontal axis. The curve in panel (b) has a vertical intercept at point *J*, where it hits the vertical axis, and a horizontal intercept at point *M*, where it hits the horizontal axis.

When an increase in one variable is associated with a decrease in the other variable, the two variables are said to have a **negative relationship**.

When an increase in one variable is associated with a decrease in the other variable, the two variables are said to have a **negative relationship**. Two variables that have such a relationship are the outside temperature and the number of hot drinks a vendor can expect to sell at a baseball stadium. This relationship is illustrated by a curve that slopes downward from left to right, like the curve in panel (b) of Figure A.2. Because this curve is also linear, the relationship it depicts is a negative linear relationship.

We've been looking at positive and negative relationships between variables that also have causal relationships. In some other cases the relationships shown on graphs can be misleading in terms of causality. For example, a graph displaying the size of a city's police force on the horizontal axis and the city's crime rate on the vertical axis might show a positive relationship, but this does not indicate that having more police causes the crime rate to rise. Instead, it may be that cities with higher crime rates employ more police, meaning that a higher crime rate is the cause for a larger police force. Another explanation could be that having more police leads to an increase in the number of existing crimes that are detected. Or perhaps big cities with large police forces have higher crime rates for reasons quite unrelated to policing. The important point is that a positive or negative relationship between two variables does not provide sufficient information to conclude that one variable causes the other to change.

The **horizontal intercept** indicates the value of the *x*-variable when the value of the *y*-variable is zero.

The **vertical intercept** indicates the value of the *y*-variable when the value of the *x*-variable is zero.

Return for a moment to the curve in panel (a) of Figure A.2, and you can see that it hits the horizontal axis at point *B*. This point, known as the **horizontal intercept**, shows the value of the *x*-variable when the value of the *y*-variable is zero: for example, when it is 10°F, no sodas are sold. In panel (b) of Figure A.2, the curve hits the vertical axis at point *J*. This point, called the **vertical intercept**, indicates the value of the *y*-variable when the value of the *x*-variable is zero: 70 hot drinks are sold when the temperature is 0°F.

A Key Concept: The Slope of a Curve

The **slope** of a curve is a measure of how steep it is; the slope indicates how sensitive the y-variable is to a change in the x-variable. In our example of outside temperature and the number of cans of soda a vendor can expect to sell, the slope of the curve would indicate how many more cans of soda the vendor could expect to sell with each 1° increase in temperature. Interpreted this way, the slope gives meaningful information. Even without numbers for x and y, it is possible to arrive at important conclusions about the relationship between the two variables by examining the slope of a curve at various points.

The **slope** of a curve is a measure of how steep it is; the slope indicates how sensitive the y-variable is to a change in the x-variable.

The Slope of a Linear Curve

The slope, or steepness, of a linear curve is measured by dividing the "rise" between two points on the curve by the "run" between those same two points. The rise is the change in the value of the y-variable, and the run is the change in the value of the x-variable. Here is the formula:

$$\frac{\text{Change in } y}{\text{Change in } x} = \frac{\Delta y}{\Delta x} = \text{slope}$$

In the formula, the symbol Δ (the Greek uppercase delta) stands for "change in." When a variable increases, the change in that variable is positive; when a variable decreases, the change in that variable is negative.

The slope of a curve is positive when the rise (the change in the y-variable) has the same sign as the run (the change in the x-variable). That's because when two numbers have the same sign, the ratio of those two numbers is positive. The curve in panel (a) of Figure A.2 has a positive slope: along the curve, both the y-variable and the x-variable increase. The slope of a curve is negative when the rise and the run have different signs. That's because when two numbers have different signs, the ratio of those two numbers is negative. The curve in panel (b) of Figure A.2 has a negative slope: along the curve, an increase in the x-variable is associated with a decrease in the y-variable.

Figure A.3 illustrates how to calculate the slope of a linear curve. Let's focus first on panel (a). From point A to point B the value of the y-variable changes from 25 to 20 and the value of the x-variable changes from 10 to 20. So the slope of the line between these two points is

$$\frac{\text{Change in } y}{\text{Change in } x} = \frac{\Delta y}{\Delta x} = \frac{-5}{10} = -\frac{1}{2} = -0.5$$

Because a straight line is equally steep at all points, the slope of a straight line is the same at all points. In other words, a straight line has a constant slope. You can check this by calculating the slope of the linear curve between points A and B and between points C and D in panel (b) of Figure A.3.

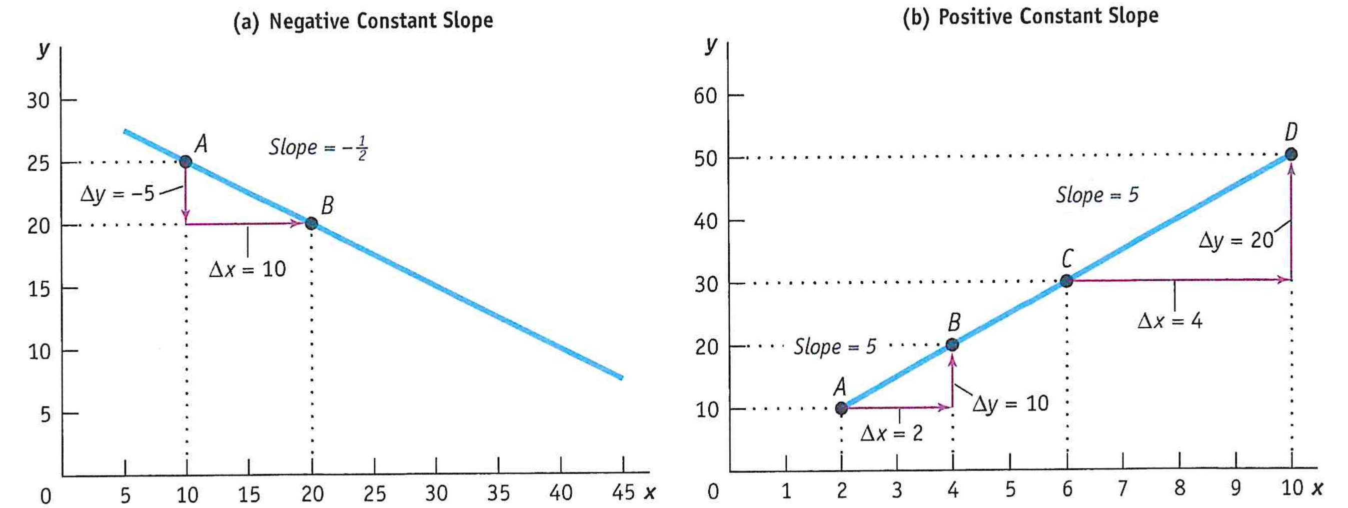
$$\frac{\Delta y}{\Delta x} = \frac{10}{2} = 5$$

$$\frac{\Delta y}{\Delta x} = \frac{20}{4} = 5$$

Horizontal and Vertical Curves and Their Slopes

When a curve is horizontal, the value of y along that curve never changes—it is constant. Everywhere along the curve, the change in y is zero. Now, zero divided by any number is zero. So regardless of the value of the change in x, the slope of a horizontal curve is always zero.

Figure A.3 Calculating the Slope



Panels (a) and (b) show two linear curves. Between points A and B on the curve in panel (a), the change in y (the rise) is -5 and the change in x (the run) is 10. So the slope from A to B is $\frac{\Delta y}{\Delta x} = \frac{-5}{10} = -\frac{1}{2} = -0.5$, where the negative sign indicates that the curve is downward-sloping. In panel (b), the curve has a slope from A to B of $\frac{\Delta y}{\Delta x} = \frac{10}{2} = 5$. The slope from C to D is $\frac{\Delta y}{\Delta x} = \frac{20}{4} = 5$. The slope is positive, indicating that the curve is upward-sloping. Furthermore, the slope between A and B is the same as the slope between C and D, making this a linear curve. The slope of a linear curve is constant: it is the same regardless of where it is calculated along the curve.

If a curve is vertical, the value of x along the curve never changes—it is constant. Everywhere along the curve, the change in x is zero. This means that the slope of a vertical line is a ratio with zero in the denominator. A ratio with zero in the denominator is an infinitely large number that is considered "undefined." So the slope of a vertical line is typically described as infinite or undefined.

A vertical or a horizontal curve has a special implication: it means that the x-variable and the y-variable are unrelated. Two variables are unrelated when a change in one variable (the independent variable) has no effect on the other variable (the dependent variable). If, as is usual, the y-variable is the dependent variable, the curve showing the relationship between the dependent variable and the unrelated independent variable is horizontal. For instance, suppose you eat lasagna once a week regardless of the number of hours you spend studying that week. Then the curve on a graph that shows lasagna meals per week on the vertical axis and study hours per week on the horizontal axis would be horizontal at the height of one. If the x-variable is the dependent variable and the independent variable is unrelated to the dependent variable, the curve is vertical.

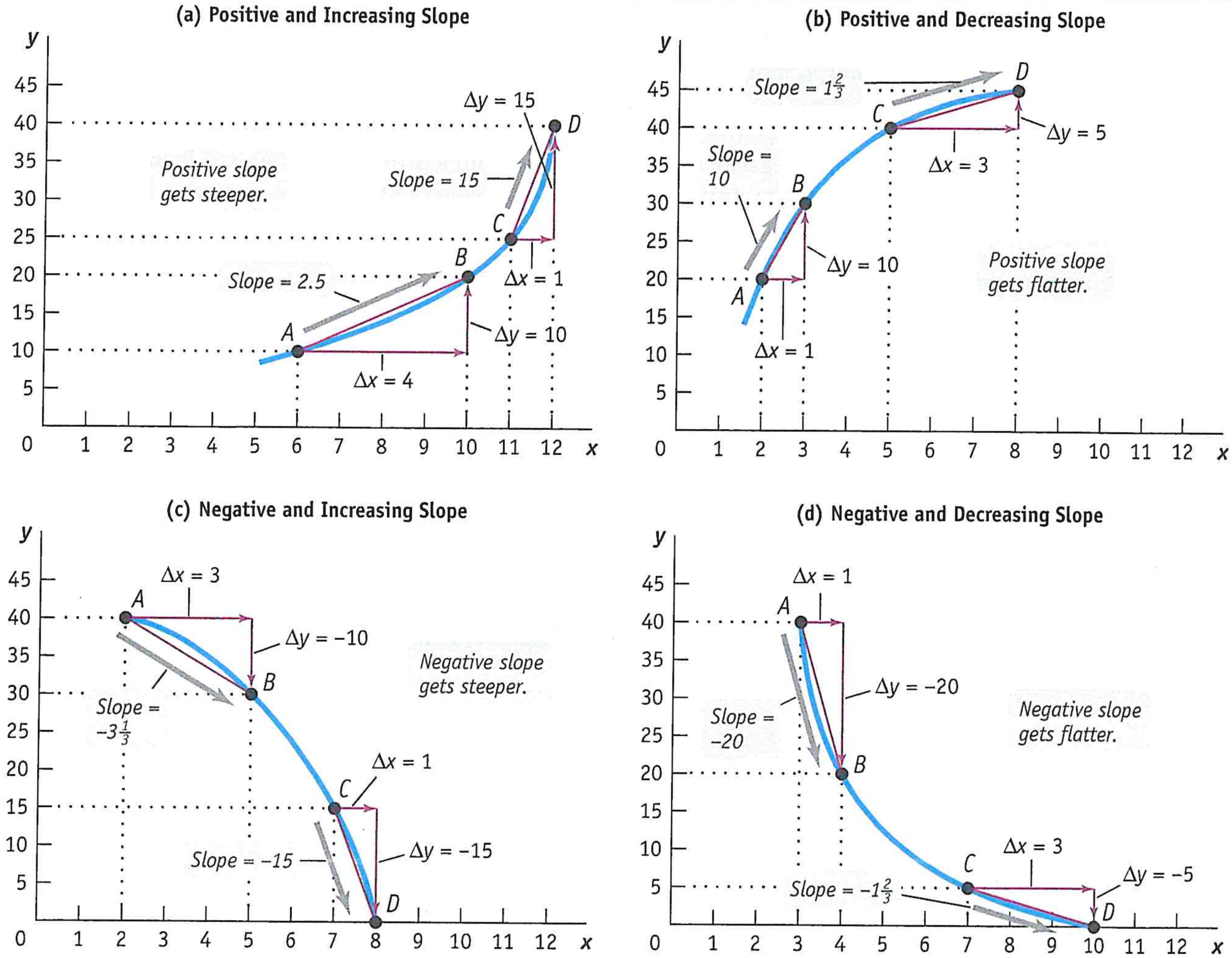
The Slope of a Nonlinear Curve

A **nonlinear curve** is one along which the slope changes.

A **nonlinear curve** is one along which the slope changes. Panels (a), (b), (c), and (d) of **Figure A.4** show various nonlinear curves. Panels (a) and (b) show nonlinear curves whose slopes change as you follow the line's progression, but the slopes always remain positive. Although both curves tilt upward, the curve in panel (a) gets steeper as the line moves from left to right in contrast to the curve in panel (b), which gets flatter. A curve that is upward-sloping and gets steeper, as in panel (a), is said to have a *positive and increasing* slope. A curve that is upward-sloping but gets flatter, as in panel (b), is said to have a *positive and decreasing* slope.

When we calculate the slope along these nonlinear curves, we obtain different values for the slope at different points. How the slope changes along the curve determines the curve's shape. For example, in panel (a) of Figure A.4, the slope of the curve is a

Figure A.4 Nonlinear Curves



In panel (a) the slope of the curve from A to B is $\frac{\Delta y}{\Delta x} = \frac{10}{4} = 2.5$, and from C to D it is $\frac{\Delta y}{\Delta x} = \frac{15}{1} = 15$. The slope is positive and increasing; it gets steeper as it moves to the right. In panel (b) the slope of the curve from A to B is $\frac{\Delta y}{\Delta x} = \frac{10}{1} = 10$, and from C to D, it is $\frac{\Delta y}{\Delta x} = \frac{5}{3} = 1\frac{2}{3}$. The slope is positive and decreasing; it gets flatter as it moves to the right. In panel (c) the slope from A to B is $\frac{\Delta y}{\Delta x} = \frac{-10}{3} = -3\frac{1}{3}$, and from C to D it is $\frac{\Delta y}{\Delta x} = \frac{-15}{1} = -15$. The slope is negative and increasing; it gets steeper as it moves to the right. And in panel (d) the slope from A to B is $\frac{\Delta y}{\Delta x} = \frac{-20}{1} = -20$, and from C to D it is $\frac{\Delta y}{\Delta x} = \frac{-5}{3} = -1\frac{2}{3}$. The slope is negative and decreasing; it gets flatter as it moves to the right. The slope in each case has been calculated by using the *arc method*—that is, by drawing a straight line connecting two points along a curve. The average slope between those two points is equal to the slope of the straight line between those two points.

positive number that steadily increases as the line moves from left to right, whereas in panel (b), the slope is a positive number that steadily decreases.

The slopes of the curves in panels (c) and (d) are negative numbers. For simplicity, economists often prefer to express a negative number as its **absolute value**, which is the value of the negative number without the minus sign. In general, we denote the absolute value of a number by two parallel bars around the number; for example, the absolute value of −4 is written as $|-4| = 4$. In panel (c), the absolute value of the slope steadily increases as the line moves from left to right. The curve therefore has a *negative and increasing* slope. And in panel (d), the absolute value of the slope of the curve steadily decreases along the curve. This curve therefore has a *negative and decreasing* slope.

The **absolute value** of a number is the value of that number without a minus sign, whether or not the number was negative to begin with.

Maximum and Minimum Points

The slope of a nonlinear curve can change from positive to negative or vice versa. When the slope of a curve changes from positive to negative, it creates what is called a *maximum point* on the curve. When the slope of a curve changes from negative to positive, it creates a *minimum point*.

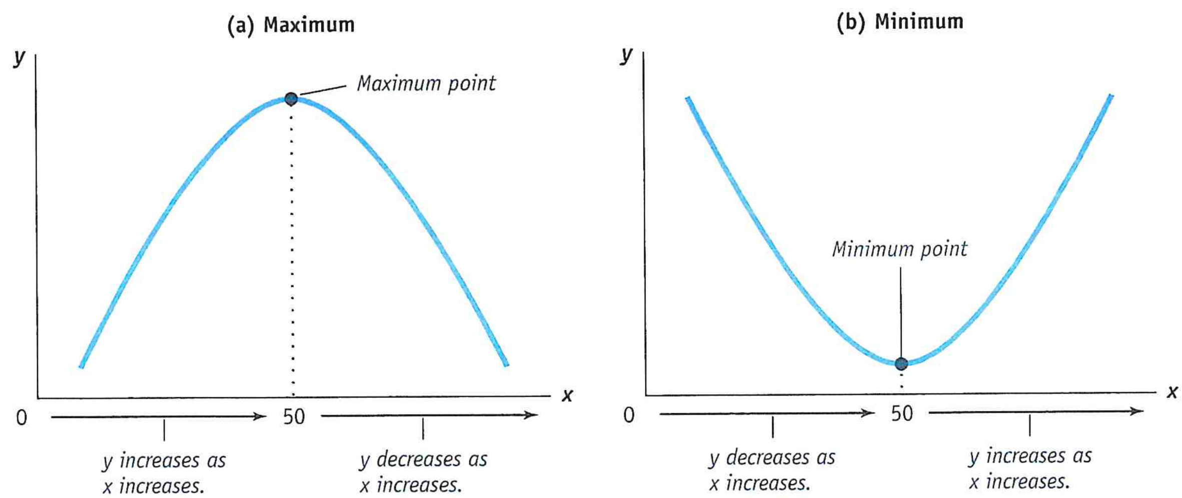
The point along a curve with the largest value of *y* is called the **maximum point** of the curve.

Panel (a) of **Figure A.5** illustrates a curve along which the slope changes from positive to negative as the line moves from left to right. When *x* is between 0 and 50, the slope of the curve is positive. When *x* equals 50, the curve attains its highest point—the largest value of *y* along the curve. This point is called the **maximum point** of the curve. When *x* exceeds 50, the slope becomes negative as the curve turns downward. Many important curves in economics are hill-shaped like this one. An example is the curve that shows how the profit of a firm changes as it produces more output—firms maximize profit by reaching the top of the hill.

The point along a curve with the smallest value of *y* is called the **minimum point** of the curve.

In contrast, the curve shown in panel (b) of Figure A.5 is U-shaped: it has a slope that changes from negative to positive. When *x* equals 50, the curve reaches its lowest point—the smallest value of *y* along the curve. This point is called the **minimum point** of the curve. Various important curves in economics, such as the curve that represents how a firm's cost per unit changes as output increases, are U-shaped like this one.

Figure A.5 Maximum and Minimum Points



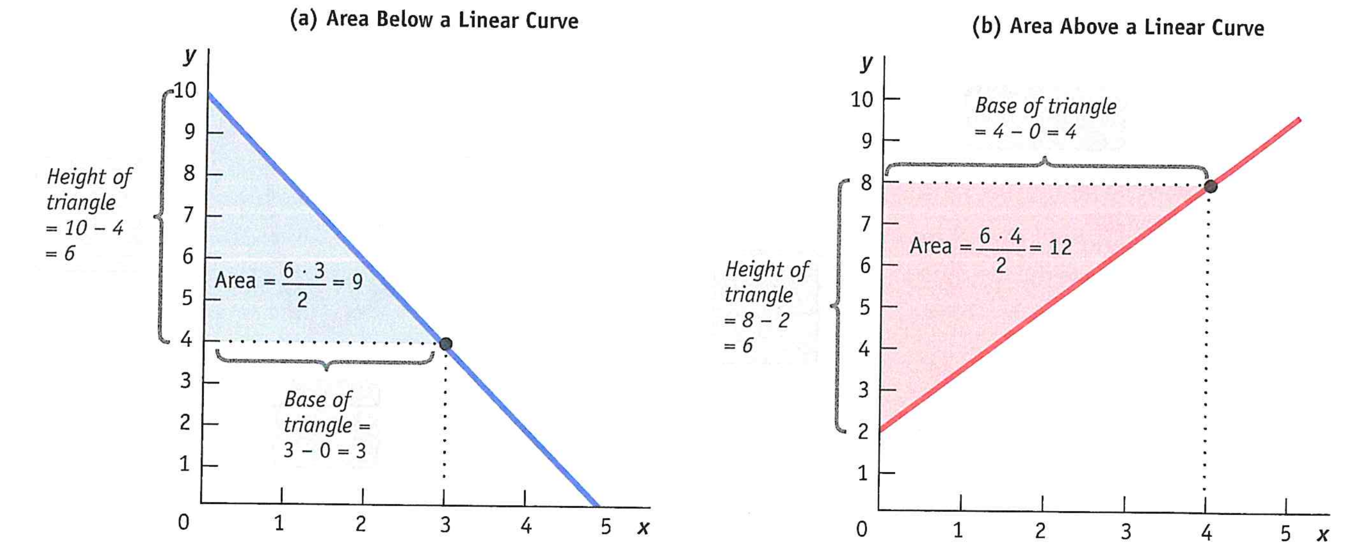
Panel (a) shows a curve with a maximum point, the point at which the slope changes from positive to negative. Panel (b) shows a curve with a minimum point, the point at which the slope changes from negative to positive.

Calculating the Area Below or Above a Curve

Sometimes it is useful to be able to measure the size of the area below or above a curve. To keep things simple, we'll only calculate the area below or above a linear curve.

How large is the shaded area below the linear curve in panel (a) of **Figure A.6**? First, note that this area has the shape of a right triangle. A right triangle is a triangle in which two adjacent sides form a 90° angle. We will refer to one of these sides as the *height* of the triangle and the other side as the *base* of the triangle. For our purposes, it doesn't matter which of these two sides we refer to as the base and which as the height. Calculating the area of a right triangle is straightforward: *multiply the height of the triangle by the base of*

Figure A.6 Calculating the Area Below and Above a Linear Curve



The area below or above a linear curve forms a right triangle. The area of a right triangle is calculated by multiplying the height of the triangle by the base of the triangle and dividing the result by 2. In panel (a) the area of the shaded triangle is 9. In panel (b) the area of the shaded triangle is 12.

the triangle and divide the result by 2. The height of the triangle in panel (a) of Figure A.6 is $10 - 4 = 6$ and the base of the triangle is $3 - 0 = 3$, so the area of that triangle is

$$\frac{6 \times 3}{2} = 9$$

How about the shaded area above the linear curve in panel (b) of Figure A.6? We can use the same formula to calculate the area of this right triangle. The height of the triangle is $8 - 2 = 6$ and the base of the triangle is $4 - 0 = 4$, so the area of that triangle is

$$\frac{6 \times 4}{2} = 12$$

Graphs That Depict Numerical Information

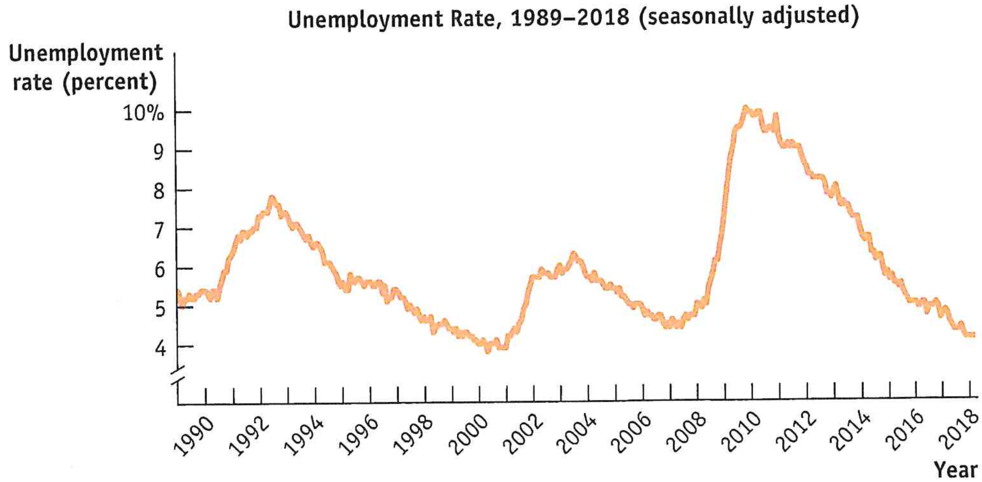
Graphs can also be used as a convenient way to summarize and display data without assuming some underlying causal relationship. Graphs that simply display numerical information are called *numerical graphs*. Here we will consider four types of numerical graphs: *time-series graphs, scatter diagrams, pie charts,* and *bar graphs*. These are widely used to display real empirical data about different economic variables, because they often help economists and policy makers identify patterns or trends in the economy.

Types of Numerical Graphs

You have probably seen graphs in newspapers that show what has happened over time to economic variables such as the unemployment rate or stock prices. A **time-series graph** has successive dates on the horizontal axis and the values of a variable that occurred on those dates on the vertical axis. For example, **Figure A.7** shows the unemployment rate in the United States from 1989 to 2018. A line connecting the points that correspond to the unemployment rate for each month during those years gives a clear idea of the overall trend in unemployment during that period.

A **time-series graph** has successive dates on the horizontal axis and the values of a variable that occurred on those dates on the vertical axis.

Figure A.7 Time-Series Graph



Time-series graphs show successive dates on the x-axis and values for a variable on the y-axis. This time-series graph shows the seasonally adjusted unemployment rate in the United States from 1989 to 2018. The two short diagonal lines toward the bottom of the y-axis are a *truncation sign* indicating that a piece of the axis was cut out to save space.
Data Source: Bureau of Labor Statistics.

Each point on a **scatter diagram** corresponds to an actual observation of the x-variable and the y-variable.

Figure A.8 is an example of a different kind of numerical graph. It represents information from a sample of 184 countries on average life expectancy and gross domestic product (GDP) per capita—a rough measure of a country's standard of living. Each point in the graph indicates an average resident's life expectancy and the log of GDP per capita for a given country. (Economists have found that the log of GDP rather than the simple level of GDP is more closely tied to average life expectancy.) The points lying in the upper right of the graph, which show combinations of high life expectancy and high log of GDP per capita, represent economically advanced countries such as the United States. Points lying in the bottom left of the graph, which show combinations of low life expectancy and low log of GDP per capita, represent economically less advanced countries such as Afghanistan and Sierra Leone. The pattern of points indicates that there is a positive relationship between life expectancy and log of GDP per capita: on the whole, people live longer in countries with a higher standard of living. This type of graph is called a **scatter diagram**, a diagram in which each point corresponds to an actual observation of the x-variable and the y-variable. In scatter diagrams, a curve is typically fitted to the scatter of points; that is, a curve is drawn that approximates as closely as possible the general relationship between the variables. As you can see, the

Figure A.8 Scatter Diagram

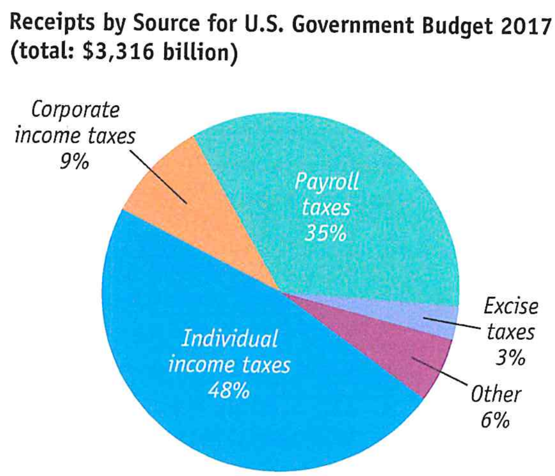
In a scatter diagram, each point represents the corresponding values of the x- and y-variables for a given observation. Here, each point indicates the observed average life expectancy and the log of GDP per capita of a given country for a sample of 184 countries. The upward-sloping fitted line here is the best approximation of the general relationship between the two variables.
Data Source: World Bank (2015).

fitted curve in Figure A.8 is upward-sloping, indicating the underlying positive relationship between the two variables. Scatter diagrams are often used to show how a general relationship can be inferred from a set of data.

A **pie chart** shows the share of a total amount that is accounted for by various components, usually expressed in percentages. For example, **Figure A.9** is a pie chart that depicts the various sources of revenue for the U.S. government budget in 2017, expressed in percentages of the total revenue amount, $3,316 billion. As you can see, payroll tax receipts (the revenues collected to fund Social Security, Medicare, and unemployment insurance) accounted for 35% of total government revenue, and individual income tax receipts accounted for 48%.

A **pie chart** shows the share of a total amount that is accounted for by various components, usually expressed in percentages.

Figure A.9 Pie Chart

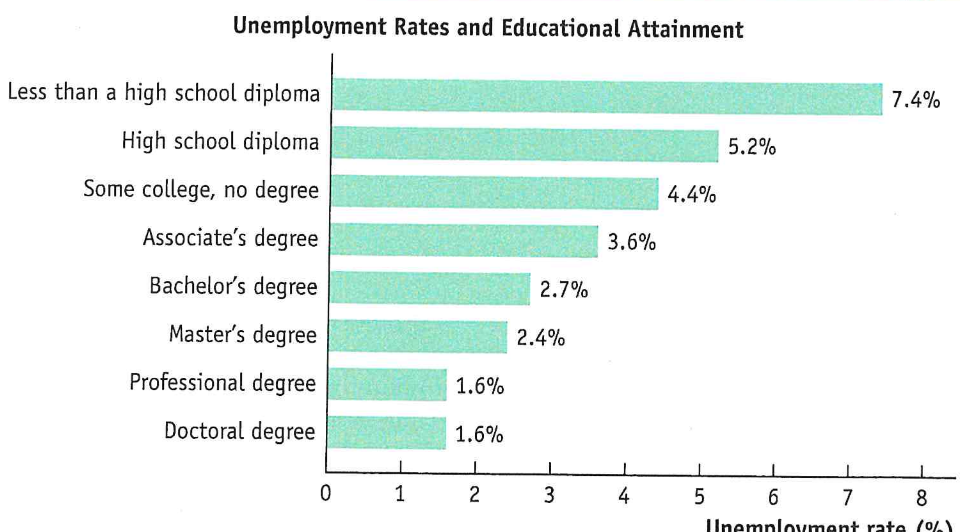


A pie chart shows the percentages of a total amount that can be attributed to various components. This pie chart shows the percentages of total federal revenues received from each source.
Data Source: Office of Management and Budget.

A **bar graph** uses bars of various heights or lengths to indicate values of a variable. In the bar graph in **Figure A.10**, the bars show the 2016 unemployment rates for workers with various levels of education. Exact values of the variable that is being measured may be written at the end of the bar, as in this figure. For instance, the unemployment rate for workers with a high school diploma but no college education was 5.2%. Even without the precise values, comparing the heights or lengths of the bars can give useful insight into the relative magnitudes of the different values of the variable.

A **bar graph** uses bars of various heights or lengths to indicate values of a variable.

Figure A.10 Bar Graph



A bar graph measures a variable by using bars of various heights or lengths. This bar graph shows the unemployment rate for workers with various education levels.
Data Source: Bureau of Labor Statistics.

SECTION 1

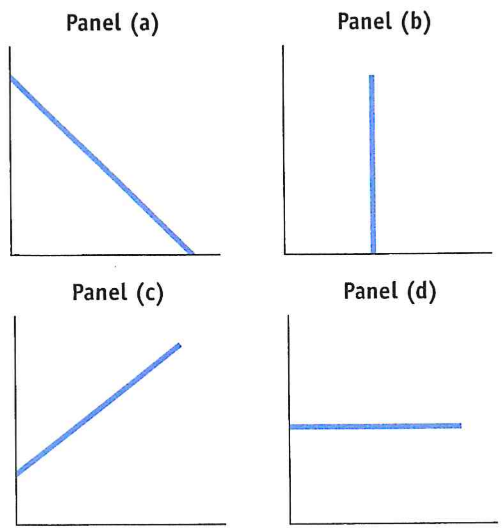
Appendix Review

Adventures in AP® Economics

Watch the video: *Graphing Tricks & Tips*

Check Your Understanding

1. Study the four accompanying diagrams. Consider the following statements and indicate which diagram matches each statement. For each statement, tell which variable would appear on the horizontal axis and which on the vertical. In each of these statements, is the slope positive, negative, zero, or undefined?



a. If the price of movies increases, fewer consumers go to see movies.

b. Workers with more experience typically have higher incomes than less experienced workers.

c. Regardless of the temperature outside, Americans consume the same number of hot dogs per day.

d. Consumers buy more frozen yogurt when the price of ice cream goes up.

e. Research finds no relationship between the number of diet books purchased and the number of pounds lost by the average dieter.

f. Regardless of its price, there is no change in the quantity of salt that Americans buy.

2. During the Reagan administration, economist Arthur Laffer argued in favor of lowering income tax rates in order to increase tax revenues. Like most economists, he believed that at tax rates above a certain level, tax revenue would fall (because high taxes would discourage some people from working) and that people would refuse to work at all if they received no income after paying taxes. This relationship between tax rates and tax revenue is graphically summarized in what is widely known as the Laffer curve. Plot the Laffer curve relationship, assuming that it has the shape of a nonlinear curve. The following questions will help you construct the graph.

a. Which is the independent variable? Which is the dependent variable? On which axis do you therefore measure the income tax rate? On which axis do you measure income tax revenue?

b. What would tax revenue be at a 0% income tax rate?

c. The maximum possible income tax rate is 100%. What would tax revenue be at a 100% income tax rate?

d. Estimates now show that the maximum point on the Laffer curve is (approximately) at a tax rate of 80%. For tax rates less than 80%, how would you describe the relationship between the tax rate and tax revenue, and how is this relationship reflected in the slope? For tax rates higher than 80%, how would you describe the relationship between the tax rate and tax revenue, and how is this relationship reflected in the slope?

Key Terms

Variable, p. 34
Horizontal axis/*x*-axis, p. 35
Vertical axis/*y*-axis, p. 35
Origin, p. 35
Causal relationship, p. 35
Independent variable, p. 35
Dependent variable, p. 35
Curve, p. 35
Linear relationship, p. 35
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Horizontal intercept, p. 36
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Time-series graph, p. 41
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