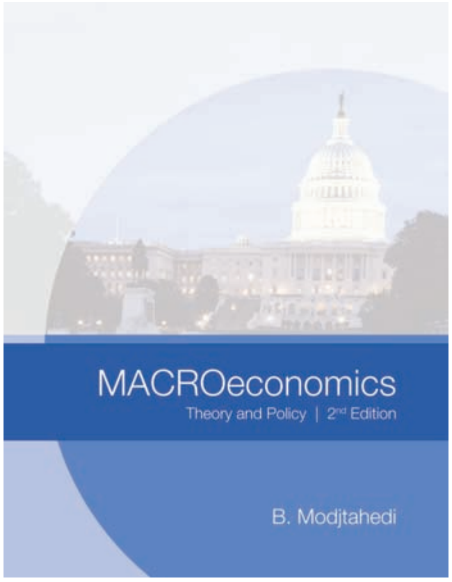

Macroeconomics

Theory and Policy - 2nd Edition

B. Modjtahedi

Included in this preview:

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- Table of Contents
- Excerpt of Chapter 1

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MACROeconomics

Theory and Policy | 2nd Edition

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Preface

This book has been written for students taking an economics course for the first time. In writing this text I had in mind not only the traditional full-time student, but also a large number of professionals who seek to pursue degrees in economics, finance, or related fields. This book has grown out of the decade's worth of lectures that I have given both at the University of California, Davis and other universities.

Around the beginning of the twentieth century, Alfred Marshal, a British economist, defined economics as the study of human beings in their ordinary business of life. Economics, and especially microeconomics, studies the economic decisions made by people in their everyday lives. You have made a decision to go to college, to buy this book, and to read it. I have made a decision to write this book so that you buy and read it. For us, the definition conveys two messages. First, economics should not be a terribly difficult topic to study. Second, the issues discussed in economics texts and classes should be relevant to our lives.

Keeping with the sprit of Marshal's definition, I have tried to explain everything using simple language without sacrificing rigor. Both microeconomic and macroeconomic portions of the text pursue an overarching objective of achieving a desired or optimal economic outcome. In the macro portion this is full employment, price stability, and long-term growth. In the micro portion it is economic efficiency. I have tried to have tight transitions from one chapter to the next. Every chapter explains what we have learned, what we don't know yet, and what we are going to learn in the upcoming chapter.

Students learn from repetition and continuity. I have tried to apply this concept in the book to the extent possible. In every chapter I repeat the background materials necessary to understand the discussions in the chapter. At the end of each chapter I also provide a summary of the main points covered in that chapter. Continuity derives from pursuing the goals of full employment and price stability and the role of economic policy throughout the book. Unlike many other texts, I define the concepts of potential output, natural unemployment rate, inflation, and economic growth early on so that students know from the beginning what the overall goal is.

This book is both analysis and policy oriented. From the beginning, the book emphasizes the fact that we need models in order to analyze the real-world economic problems. The text develops the basic macroeconomic model step by step using real-life examples. The main objective of the book is to teach students how to conduct macroeconomic analysis, rather than bombarding them with massive amounts of disparate facts and figures. However, in almost every chapter I present the empirical evidence to support the particular model or theory.

The core closed-economy macroeconomic portion of the text consists of chapters 4 through 19. Chapter 4 defines the concept of gross domestic product (GDP). The definition of GDP in this book is somewhat different than those presented in other textbooks and, I believe, more accurate. Interestingly enough this accuracy makes the concept more, rather than less, intuitive and understandable. Like most other chapters, I have written this chapter in such a way as to provide instructors with a degree of flexibility as to how to cover it. Some may confine the coverage to the basic definitions and move on to the remaining chapters. Others may cover the whole chapter.

Chapters 5 and 6 define the basic macroeconomic concepts such as inflation, unemployment, and growth. These chapters lay down the main reasons why macroeconomists concentrate on the study of these concepts. They discuss the costs and benefits of these phenomena using simple examples.

Chapters 7 through 15 develop the basic short-run and medium run models in a step-by-step manner. Chapter 7 is on the income-expenditure model. It has been written in such a way as to give instructors the option to pick and choose different sections to cover. The chapter starts with the simple graphical exposition of the whole model and becomes increasingly technical as it proceeds. Those who want to cover it briefly and disregard the details of the multiplier process can choose only the first and the last parts of the chapter. These self-contained short segments concentrate on the graphical exposition of the topic leaving aside the detailed derivation of the income-expenditure multiplier.

After considerable amount of investigation and experimentation, I have come to the conclusion that students grasp the standard aggregate-demand/aggregate-supply model with price and GDP *levels* much more easily than the new version with inflation rate and GDP level proposed by David Romer. The new model is basically the "inverse" of the Phillips curve. Therefore, I mention the problems with the standard model and proceed to derive the Phillips curve. Unlike most other texts I move beyond the Phillips curve as a descriptive device providing a menu of choices and use it as a macro model to analyze inflation and unemployment rates.

Interaction between theory and empirical evidence is at the heart of the exposition of macroeconomics in this book. For example, I provide data on the relationships between money supply growth rates, inflation rates, and GDP growth rates to build students' confidence in the models presented.

Chapter 18 is on economic growth. The fact that this topic is covered in a late rather than an early chapter does not mean that it is less important than the other chapters. This is only for pedagogical reasons. I think this particular sequence results in a better flow of the materials. Other instructors, however, may want to cover this chapter early on. The chapter has been written in such as way that it can be covered before Chapter 7. The other chapter that can be covered earlier is chapter 22, which is about fiscal policy. Chapter 11 on loanable funds theory could be skipped without too much loss of continuity in a quarter-based course.

The mathematics background for this book is minimal. Nevertheless, a section in Chapter 1 covers the entire math you need to know to follow the materials in the text.

Several individuals read and made valuable comments on different chapters of the microeconomics and macroeconomics texts. I would particularly like to thank Kevin Hoover, Esen Onur, Nahid Movassagh, Bob Modjtahedi, and Kate Griaznova for taking time to read and provide feedback on several chapters of the microeconomics and macroeconomics portions of the text. Special thanks are due to Theodore J. McCarthy who edited the entire manuscripts for both the micro and macro portions and provided numerous insightful comments that significantly improved the exposition of the materials in several places. I am also grateful to Fayha Lakhani who patiently and competently compiled the index, glossary, and the table of contents for both macro and micro portions of the text.

Last but not the least; I would like to thank my many past students at UC Davis and elsewhere for their comments and questions on the previous edition of the texts. In fact it was mostly my students who encouraged me to convert my lecture notes into a textbook. I am very grateful to them all.

B. Modjtahedi

University of California, Davis
Davis, California January 2008

Chapter 1
What Do Economists Do? We Model for Food

Introduction and Review

Alfred Marshall, a British economist, defined economics as "the study of mankind in his ordinary business of life." You can study "mankind" with respect to many different attributes. Economics generally analyzes the behavior of people and institutions that arise because of *scarcity*. Scarcity means that human wants are unlimited in relation to the available resources in the economy. Unlimited wants means that people in general prefer to have more of everything. They want to be able to buy more food, more appliances, better homes, better cars, and so on so forth. Resources are those things we use to produce goods and services. They are also called *production inputs* or *factors of production*. Economists distinguish three types of resources:

1. Land**.** Land is all the resources given to us by the nature. Perhaps "*natural resource*" would be a better term for this production factor. Land includes land itself that is used in agriculture as well as forests, underground resources, minerals, and underwater resources. If we stretch the definition a bit, we can also include such things as solar energy or wind power to produce electricity in this category. At any given point in time, these are limited in supply. In the long run we might be able to increase their supply somewhat using more efficient cultivation techniques, better fertilizers, new discoveries, and so on. In this book we will generally assume that the amount of land is constant and we will ignore it. This is to keep our stories simple without affecting any of our conclusions.

2. Labor. Labor is human effort. It is measured by the "person-hour." If we have one worker working 10 hours and another working 5 hours, then the total is 15 person-hours. This resource is limited for two reasons:

   a. There are a limited number of people in any society over a given period of time.
   b. Each person has a limited number of hours available to him or her during that time period.

3. Capital. By capital we mean all *produced means of production*. There are goods that human beings produce in order to use them to produce other goods. They include *private capital* owned by private citizens, such as trucks, tractors, and manufacturing plants, as well as *public capital* owned collectively by the public, such as roads, bridges, or national parks. Another capital category is the *human capital*. By this term economists mean all the knowledge, skills, and expertise *acquired and possessed* by an individual. This fits the definition of capital because an individual acquires it through education or learning by doing.

Scarcity means that with the available resources we cannot satisfy the collective wants of all the members of the society. In other words, if we asked all members of society how much of each good and service they would like to have if money was no object, we would realize that we do not have enough resources to produces all those things. We will analyze the question of scarcity more fully in the next chapter.

Scarcity implies that every society has to answer three questions. These are called the "what," "how," and "for whom" questions.

1. What goods and services should the society produce? Should we produce more consumer goods such as food and clothing, or more capital goods such as trucks, tractors, and computers? Should we produce more civilian goods or more military goods?

2. How to produce those goods and services? There are generally different ways of producing the same good. We can produce cars either using a lot of labor and not much capital equipment, or a lot of robotics and not much labor. We can produce agricultural products using a lot of land but without any fertilizers and pesticides, or with less land and a lot of fertilizers and pesticides. We can produce electricity using fossil fuel such as oil and natural gas, or using renewable sources such as wind, water, or solar energy.

3. For whom should we produce these goods and services? This question is about the distribution of income in the society. Should the distribution be nearly equal so that all members of the society can buy the same amounts of the goods and services produced, or should we allow some inequality in the distribution of income? How much inequality is tolerable?

Every society, whether small or large, primitive or modern, capitalistic or socialistic, has to answer these questions. In a small traditional village the elderly might decide on these questions. In a free market capitalist system these questions are answered mostly by the private sector of the economy, but governments heavily influence the choices made by the public. In socialist economies a central planning bureau generally makes all the decisions.

Microeconomics

Economics is broadly divided into two fields: microeconomics and macroeconomics.

> *Microeconomics studies the decisions made by one individual decision making unit and economic conditions prevailing in one particular market or industry.*

A **decision-making unit**, or a decision maker for short, can be an individual or a firm. A **market** is any institution that brings buyers and sellers of a good or service together. The market could be small, like the garage sale market in a small town, or big, like the currency markets in which world currencies are traded. It could be in a physical location, like weekend farmers markets, or it could be the interconnection of computers, such as some financial markets. An **industry** is a collection of firms that produce identical or nearly identical products. Examples are the textile industry and the automobile industry.

Economists assume that a decision maker makes an economic decision or takes an action to *maximize satisfaction*. Generally, that action or decision is either to *buy* something or to *sell* something. Satisfaction could be either in monetary or subjective terms. The managers of business firms would measure satisfaction in terms of their profits. The higher their profits, the more satisfied they are. A consumer's satisfaction, on the other hand, could be subjective—"happiness" he or she would derive from consuming goods and services. Meet a few decision makers that you will encounter frequently in this book.

A **consumer** decides how much of a particular good to buy on the basis of the price of that good, the prices of related goods, and the level of your income. Her objective is to maximize her satisfaction. For example, in buying a car the consumer will consider its price, will compare it to the prices of other cars, will have one eye on the price of gasoline, and will be mindful of her budget.

A **worker** decides how much labor service to supply to business firms on the basis of the wage she will receive and the prices of goods and services she will consume. She will be mindful of prices because ultimately she is working in order to make money to be able to buy goods and services. Therefore, it is always the relationship between the wages she is paid and the prices of the goods she buys that is important for her decision. For example, in a city with a relatively low cost of living she may accept a job that is paying only $30,000 per year. However, she cannot maintain the same quality of life with that kind of money in New York or Chicago. Therefore, she might accept that money for a job located in a small city with low prices, but not in New York.

An **employer** decides how much labor to hire given the price of the product it is producing and the wage it has to pay for the labor. The employer hires labor to produce some products and sell them in the market at some market prices. The revenue that the additional unit of labor would bring into the company is the benefit of hiring that person, while the wage that the employer would have to pay for that unit constitutes its cost. The employer will be inclined to hire more labor if the price of the product it is selling increases or the wage that it is paying decreases.

A **producer** decides how much of a good to produce and sell given the market price of its product and the cost of producing that product. The cost of production involves the wage the producer has to pay to hire labor, the rent to use the land and office buildings, and the interest for the money borrowed, among other things. Obviously, the producer would be willing to produce and sell more if the price of the good he is selling increases or the cost of producing it decreases.

A lot of times one person or entity makes more than one decision. In the above examples, the consumer and the worker are generally the same person. They make consumption decisions on the basis of the money they earn from working. Occasionally we combine these two decision makers into one unit and call it the **household**. Similarly, the employer and the producer are the same person. An employer hires workers to produce things. Sometimes we combine employers and producers into one decision-making unit called the **firm**.

These are, of course, not the only decisions faced by households and firms in a society. People also decide on how much of their money to invest in stocks, bonds, and real estate and how much to keep in the banks. They also decide how much to lend and borrow. Moreover, the same person sometimes makes all these decisions. For example, the owner of a restaurant employs people to produce and sell meals. He also works in his own restaurant. Finally, with the money he makes from his business, he decides how much to consume, and how much to invest in stocks and bonds.

Microeconomics takes a typical consumer and studies her decision to buy a particular good, such as car. Then it takes a typical producer and analyzes his decision to produce and sell cars. It finally assumes that there are many such consumers and producers who come together in the **market** for cars. The collection of all the producers of cars constitutes the car **industry**. Similarly, microeconomics studies the market for labor by considering the workers who are willing to supply their labor services and the employers who are willing to hire them.

Macroeconomics

Macroeconomics, on the other hand, analyzes broad economic aggregates. What this means is that macroeconomics studies economy-wide variables. Macroeconomics is not concerned with one particular product such as bread. It instead looks at the sum total of all the goods and services produced in a country. This is called the *aggregate level of output*. Instead of studying the price of one particular product, macroeconomics analyzes the behavior of the prices of *all* the goods and services produced in the country. It studies some average of all these prices. This average is called the *general price level*. Finally, instead of studying just one worker, one employer, or one labor market, macroeconomics studies the *overall employment* in the economy. Overall employment means, of all the people who are willing to work, the number who have jobs.

Of course, these are not the only variables we study in macroeconomics. We also analyze the behavior of some other variables such as aggregate or national consumption, national saving, interest rates, and wage rates. But, ultimately, we are interested in these other variables because of their effects on the aggregate level of output, the overall price level, and overall employment.

> *Macroeconomics studies the behavior of aggregate economic variables such as the aggregate level of output, the general price level, and overall employment.*

Why do we need two different fields? Macroeconomics and microeconomics are *related* but *different*. They are related because the total production in the economy of all the goods and services must be just the sum of the products produced by individual producers. Similarly, if the price of every good and service increases by 5%, then the general price level must increase by 5%. The same is true for consumption. We expect that if the consumers' incomes in the society increase with the overall prices remaining the same, each individual consumer will consume more of everything and so the aggregate level of consumption will increase. Or, if the wage rate drops in the society relative to goods prices, then the cost of production for every producer will go down, resulting in more employment and more production.

However, the two fields are also different. A lot of times microeconomic relationships do not carry over to aggregate relationships. There are problems that are aggregate in nature and cannot be analyzed by microeconomic tools. A couple of examples will clarify this.

Example 1:
Microeconomics: Suppose you go shopping in the morning to find that the price of corn flakes has gone down by 5%, *everything else the same*. You will buy more corn flakes for two reasons. First, you will substitute the corn flakes for the other kinds of cereals because their price is now relatively lower. This is called the *substitution effect* of a price reduction. Second, since the price of corn flakes has decreased, if you buy the same amount of corn flakes, you will have more money left in your pocket that you can spend on every good, including corn flakes. It is as if your income has increased. This is called the *income effect* of the price reduction.

Macroeconomics: What if the price of every good goes down by 5%? Then, unlike the above example, the relative prices will remain the same and there will be no substitution effect. But will the nation buy more of all the goods because of the income effect? We cannot even answer this question without further information. As you will see in a later chapter, if the prices of every good and service go down by 5%, the total income earned by everyone in the economy will also go down by 5%. This is because, if you pay $100 to buy a textbook, it is expenditure for you but is income for the recipients of that $100. Suppose the bookstore pays $70 of that $100 to buy the textbook from the publisher. This $70 constitutes part of the incomes of the people in the publishing company. The bookstore pays $20 out of that $100 as wages to the workers, rent for the shop, and interest to the bank. These constitute the incomes of the recipients of this $20. Finally, the bookstore owner pockets the remaining $10 as profit. This $10 becomes the owner's income.

You see that if all the prices fall by 5%, the total income will also fall by 5% and there will be no income effect from this general fall in prices. The aggregate purchasing power of all the people in the economy will remain the same. It seems that people overall will not increase their purchases of goods and services. However, *this conclusion* may not be correct either. We will address this question later in the book. The intent of this example was merely to show that we cannot always analyze questions involving overall or aggregate magnitudes using microeconomic tools.

The above example demonstrates what is called the *fallacy of composition*. This is the notion that what is true for one individual may not be true for the sum of all the individuals. If an individual fan at a football game stands up, he will see the game better, but if everyone stands up, no one will see the game better. If one bidder at an auction shouts loudly, she will succeed in attracting the attention of the auctioneer, but if every bidder does the same, none will succeed. The following example applies this concept to further demonstrate the distinction between microeconomics and macroeconomics.

Example 2:
If a single wheat farmer produces more wheat in a year, he will make more money. This is because the additional output from one farmer will be too small relative to the whole market to have any effect on the price of wheat. Therefore, the farmer will sell more wheat at the same price, enjoying a greater amount of profit. However, if all the wheat farmers produce more wheat due to, say, better-than-normal weather, then the price of wheat will fall in the market and they may all suffer a loss.

Positive and Normative Statements

Economists distinguish between two types of statements. Some statements are about how things are, or how we think they are. These statements don't make any value judgment about whether any particular state or outcome is good or bad. Here are some examples:

- The average price of gasoline in the U.S. is $4 per gallon.
- We are entering a recession and therefore unemployment could increase.
- OPEC raised the price of oil, so we expect goods prices to rise in the U.S.
- If the Fed increases the interest rate, the U.S. inflation rate could go down.
- More that fifty million people in the U.S. do not have health insurance.

Such statements are called *positive statements*.

Positive does not mean "true". You can affirm or refute a positive statement. In fact, you can use this as a criterion to tell whether a statement is a positive statement. You can say, "Yes that is true", or "No, that is not true", or "No, I don't think that is true". For example, the fifth statement probably is not true (in 2007). At the time of writing this book an estimated 47 million Americans did not have health insurance. Nevertheless, the statement is a positive statement.

Normative statements involve norms or judgments. The person making the statement considers the present state of things or the outcome of a decision to be good or bad. Here are some examples:

- The gasoline price is too high. (The present state is bad.)
- The government should pursue a pro-growth policy in order to increase the rate of growth of output to 3%. (The outcome is good.)
- We are entering a recession and therefore the government should try to keep unemployment from rising. (The outcome is good.)
- The current rate of inflation is too high; it is hurting people. (The present state is bad.)
- We should try to reduce the inflation rate. (The outcome is good.)
- We should not pursue active stabilization policies (The outcome is bad.)

Note that you cannot affirm or refute the above statements. When someone says, "gasoline prices are too high", you won't be able to affirm or refute that statement since you don't know how high is too high. If you say, "Yes, I also think the gasoline prices are too high", you are not affirming the statement. You are just making another normative statement. In economics we mostly concentrate on positive questions. For example, we tell the world that if you try to lower the unemployment rate, you may end up increasing the inflation rate. You cannot lower both in the short run. Then we leave it to others (e.g., politicians and voters) to decide whether they want to reduce inflation or unemployment.

A positive statement by an economist: In the short run you can either reduce inflation or unemployment, but not both.

A normative statement by a policymaker: The current unemployment is a more serious problem. We should reduce unemployment and forget about inflation.

This is not to say that economists do not make *any* normative statements. The very fact that economists propose policies to change the course of some events indicates that they regard the status quo as undesirable. For example, they mostly advocate free trade policies among different countries since they generally believe that trade restrictions such as tariffs or quotas between nations have economically undesirable effects, and that easing of these restrictions will produce better outcomes. However, even then they specify what they mean by "good" or "desirable"—in this case increased social welfare, somehow defined.

Economic Models

Economists conduct analyses using economic models. It is fair to say that almost anything you will study in economics is in terms of some type of a model. Economic models are simplified versions of reality that economists develop to analyze and understand the complex economic relationships that exist in the real world. As such, they are approximations to the real world. Decades ago a famous Cambridge economist named Joan Robinson likened economic models to area or road maps. In the same way that road maps help us organize our *trips*, economic models help us organize our *thoughts*. Suppose, for example, that you are to attend a conference in a large city like Los Angeles. You arrive in the city Sunday evening and the next day you decide to find the place where the conference is held. Imagine leaving your hotel without any maps and without asking anyone for directions, and instead trying to find the place just by trial and error. Chances are you will never reach your destination.

Area maps would be useful in these circumstances for one reason. They do not include any unnecessary details such as all the buildings or the kinds and names of the shops in the streets. All you need is a few lines representing the streets connecting your hotel to the conference place, and this is exactly what the map would show you. A map is a simplified version of the reality that is only used to organize a particular kind of a trip. If instead you were going fishing or camping, you would need another kind of map with other kinds of information on it. The city map would not be helpful in *this* trip. In either case a one-to-one map—a map the size of the area itself with all the details included—would be as useless as not having the map at all.

Economic models are similar. To understand a particular problem, economists construct a model that *assumes away* (ignores) all the unnecessary details in order to concentrate on the problem at hand. Since the reality is too complex, a very realistic model with a lot of details would be as useless as a one-to-one map. In this sense, all models are unrealistic. However, they are useful because they only include the details we care about and these details are based on reality. Moreover, like the area maps, we develop and use different models to answer different questions. A model that is useful to answer one question may be totally useless in answering another question.

In fact, people use models in their day-to-day lives to make decisions. Suppose a friend of yours is thinking of renting an apartment in your neighborhood. He therefore comes to you and asks, "What is your average speed on a typical winter day driving home from the school?" Your typical answer would be, "It depends. Under the average rain and traffic conditions I can drive 30 miles per hour". These are the only important factors affecting your driving speed. You ignore other irrelevant details such as the kind of music you listen to or whether someone else is in the car with you. You also explain that if either the rain or the traffic condition turned out better than the average, you could drive faster. However, you explain, you cannot exceed the legal speed limit of 45 miles per hour. You just answered your friend's question using a model.

Economic models contain two types of magnitudes: *constants* and *variables*. Constants are those magnitudes whose values do not change. In the above example, the speed limit of 45 miles per hour is a constant. We know you will never drive faster than that.[1] Variables are those magnitudes that can take different values. For example, your speed, the amount of rainfall, and the number of cars on the street can change from day to day. In any model, there are two types of variables. *Endogenous variables* are those variables whose values are determined *inside the model* on the basis of the values of the other variables. In other words, these are the variables whose values we don't know but are interested in knowing. Simply put, these are the unknowns of the problem. In the above example, your friend was interested in knowing your daily average speed. So this was the endogenous variable of the model.

The other variables are called *exogenous variables*. The values of the exogenous variables are determined *outside the model* by factors other than the endogenous variables, and are therefore known to the analyst. Exogenous variables are the cause and the endogenous variables are the effect. Endogenous means *inside* and exogenous means *outside*. In mathematics these are called depended and independent variables, respectively. In the above example, the amount of rainfall and the number of cars on the street are exogenous variables. Their values are determined outside your model by other factors like climate or the number of residents in the city. They will not depend on your driving speed. Your friend was not interested in the values of these variables *per se*.

[1] We hope!

However, their values would affect your driving speed, something your friend was interested in knowing.

A lot of times we are interested in analyzing the effect of a change in an exogenous variable on the value of the endogenous variable, *keeping all the other exogenous variables unchanged*. For example, we ask, *all else the same*, what would happen to your driving speed on a particular winter day if the rainfall was heavier than normal? In this example, "all else the same" means keeping the other exogenous variable, the traffic condition, unchanged at its average level. A lot of times, economists use the Latin phrase *ceteris paribus* instead of its English equivalent *all else the same*.[2]

Suppose that now your friend asks a second question, "How long does it take you to get home from school on a typical winter day?" Now we have a second endogenous variable—a variable whose value we are interested in. Your friend's second question cannot be answered with the existing set of exogenous variables and relationships. We need new pieces of information to answer this new question. You remember from high school algebra that to solve for two unknowns, we need two independent equations. We are talking about the same thing here.
You would answer, "*The distance from the school to my house is about 10 miles. Therefore, it takes about 20 minutes to get home*." So you would add the relationship between speed and travel time to your model to answer both questions. Note that the second relation comes with another constant: the fixed distance between your home and the school, which is 10 miles.

In general, the number of relationships must be equal to the number of endogenous variables for us to be able to determine the values of the endogenous variables. The appendix to this chapter reviews most of the math, including an algebraic description of economic models that you will need to know in order to follow the arguments in this book.

[2] Like in medieval times, this is mainly to make us sound sophisticated!

Mathematical Appendix

The math prerequisite for this book is minimal. All you need to know is how to manipulate simple algebraic equations and how to work with graphs. This appendix will review most of the math you need know to be able to follow the material in the book. We start with the definition of a function. A function is a *rule* that assigns one and only one value to a *dependent variable* for each value of an *independent variable*. The independent variable is the cause and the dependent variable the effect. For example, the profit earned by a company depends on the amount of output it produces, so profit is the dependent variable and the amount of output is the independent variable. You could spend more if you had more money in your pocket, so the level of your spending is the dependent variable and the amount of cash in your pocket is the independent variable.

A function can be represented in three forms:

1. Tabular form
2. Graphical form
3. Algebraic form

We will mostly use tabular and graphical forms, although occasionally an algebraic form will sneak in. We will generally be interested in three aspects of a function:

1. Slope
2. Curvature
3. Shifts

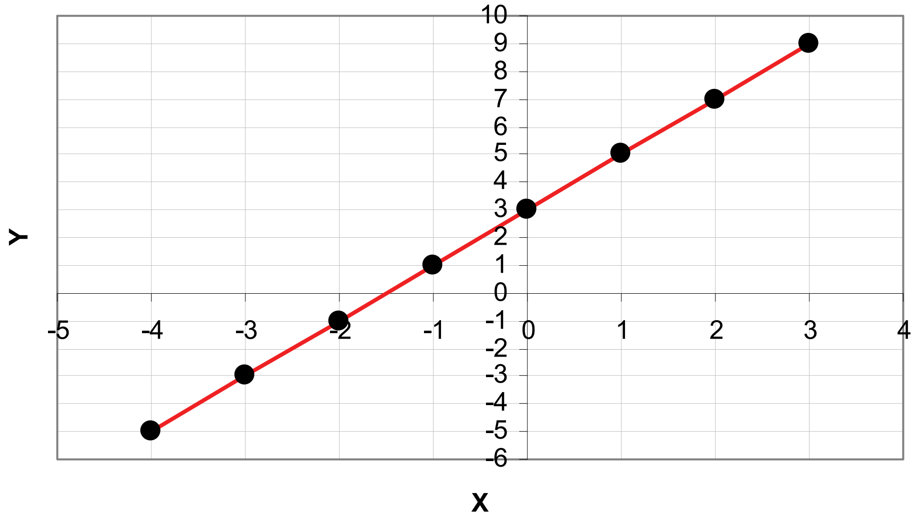
Let's start with the slope.

The Slope

The following table shows the *tabular form* of a function. In this function Y is the dependent variable and X is the independent variable—variations in X are the cause of the variations in Y. First, note that there is only one Y value corresponding to each X value, so this fits the definition of a function. You can see that an increase in X results in an increase in Y. We say that the relationship between X and Y is *positive*.

X	-4	-3	-2	-1	0	1	2	3
Y	-5	-3	-1	1	3	5	7	9

The following figure shows the *graphical form* of the above function. The graphical form of this function is a straight line. This is called a *linear function*.



A few features of a linear function should be noted. First, the point where the line crosses the Y-axis is called the *Y-intercept*. In the function above, the Y-intercept is 3. Second, the above table and graph show that when X increases by one unit, Y increases by 2 units. Then we say that the *slope* of the function is 2.

The equation for the slope is:

$$\text{Slope} = \frac{\Delta Y}{\Delta X}$$

Where ΔY means the change in Y and ΔX means the change in X. In the above function, when X = 1, then Y = 5. If X increases by one unit to X = 2, then Y increases by 2 units to Y = 7. Therefore,

$$\Delta X = 2 - 1 = 1$$
$$\Delta Y = 7 - 5 = 2$$

And

$$\text{Slope} = \frac{7-5}{2-1} = \frac{2}{1} = 2$$

A very important feature of a linear function is that its *slope is constant*. This means two things. First, no matter how much we increase X, the change in Y per unit increase in X will be the same. For example, suppose we increased X by two units from X = 1 to X = 3. We would still get

$$\text{Slope} = \frac{9-5}{3-1} = \frac{4}{2} = 2$$

Therefore, if we increase X by 2 units, Y will increase by 4 units so that for each one-unit increase in X, Y will increase by 2 units.

The second meaning of the constancy of the slope is that no matter where we start to increase X, the change in Y per unit increase in X will be the same. This is evident from the above table. Suppose, for example, that we increase X from X = 2 to X = 3. Then

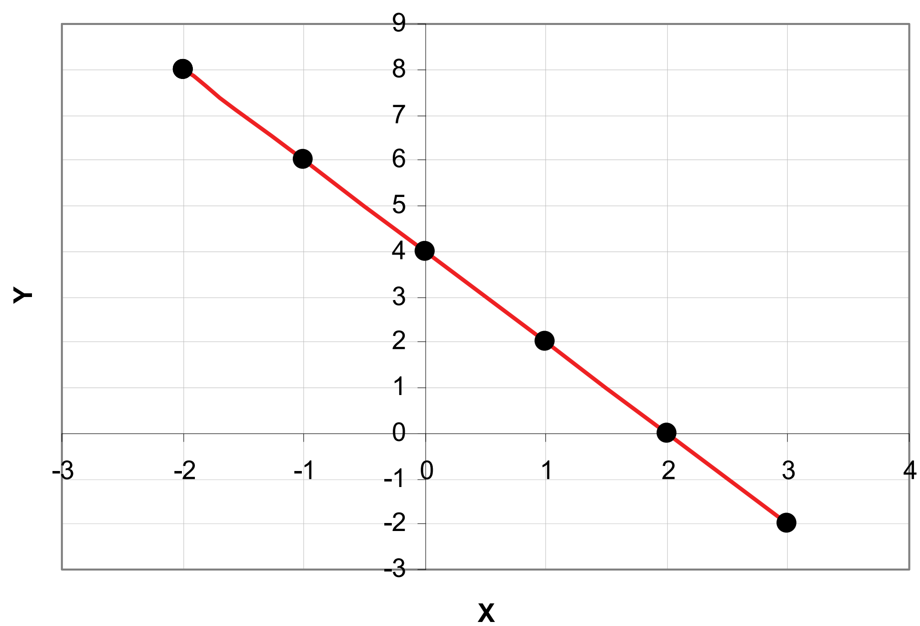
$$\text{Slope} = \frac{9-7}{3-2} = \frac{2}{1} = 2$$

So the slope is the same, 2 units.

Now consider the function presented in the following table.

X	-4	-3	-2	-1	0	1	2	3
Y	12	10	8	6	4	2	0	-2

In this case an increase in X results in a decrease in Y. We say that the relationship between X and Y is *indirect* or *negative*. The following is a graph of this function.



For this function, the slope is constant at −2. For example, if X increases from X = 0 to X =1, then Y will decrease from Y = 4 to Y = 2 so that

$$\text{Slope} = \frac{2-4}{1-0} = \frac{-2}{+1} = -2$$

So when the relationship between X and Y is negative, the slope will be a negative number.

To repeat, what makes a function linear is the constancy of the slope. If the relationship is positive, the line will be upward sloping (you will go up if you draw the line from left to right). If the relationship is negative, the line will be downward sloping (you will go down if you draw the line from left to right). It is important to remember the meaning of slope: Slope answers the following question, "*If we increase X by one unit, by how much will Y change?*"

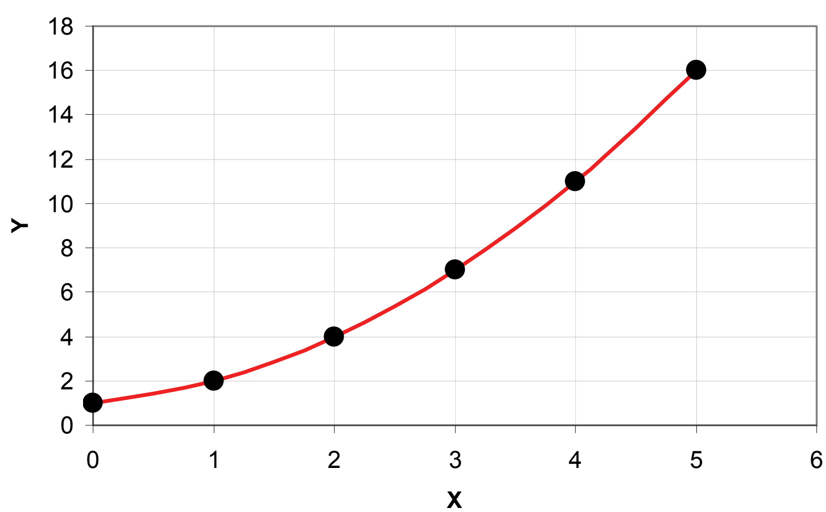
Slopes are important in economics and finance because they measure the response by a dependent variable to changes in an independent variable. For example, it provides answers to such questions as: By how much our company's profit will change if we increase production by one unit? What will happen to the government tax revenue if we increase the tax rate by one percent? What will happen to national consumption if we increase national income by one unit?

The Curvature

If the slope of a function is not constant, then the graph of the function will not be a line. Consider the following table. Since most economic and financial variables never take negative values, from now on we will concentrate on positive X and Y values. The table below shows that the relationship between X and Y is positive. The slope however is not constant. The slope increases with X (as an exercise, calculate the slope at two or three points).

X	0	1	2	3	4	5
Y	1	2	4	7	11	16

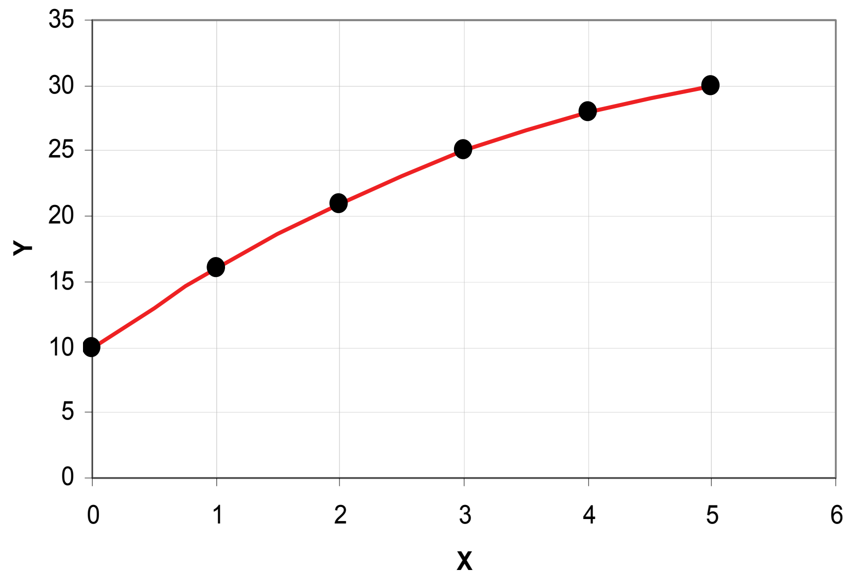
The following is a graph of this function. This function is *concave from above*.



Now consider the function in the following table. Again, the relationship between X and Y is positive, but the slope decreases as X increases (verify this by calculating the slope at a few points).

X	0	1	2	3	4	5
Y	10	16	21	25	28	30

The following is the graph of this function. This function is *concave from below*.



So you see that if a function is upward sloping, its slope is positive. If the slope is constant, the function is a linear. If it is not, it can take one of the above two non-linear forms.

Now consider the following function:

X	0	1	2	3	4	5
Y	50	49	46	40	30	15

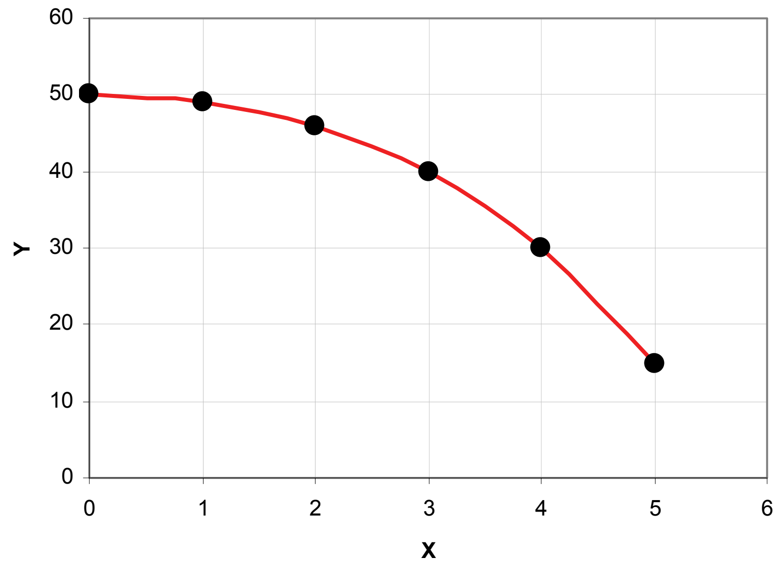
Now the relationship between X and Y is negative and the slope is not constant. If X increases from zero to 1, then Y goes down by one unit. So the slope is

$$\text{Slope} = \frac{49-50}{1-0} = -1$$

But if X increases from 4 to 5, then Y goes down from 30 to 15 and the slope is

$$\text{Slope} = \frac{15-30}{5-4} = -15$$

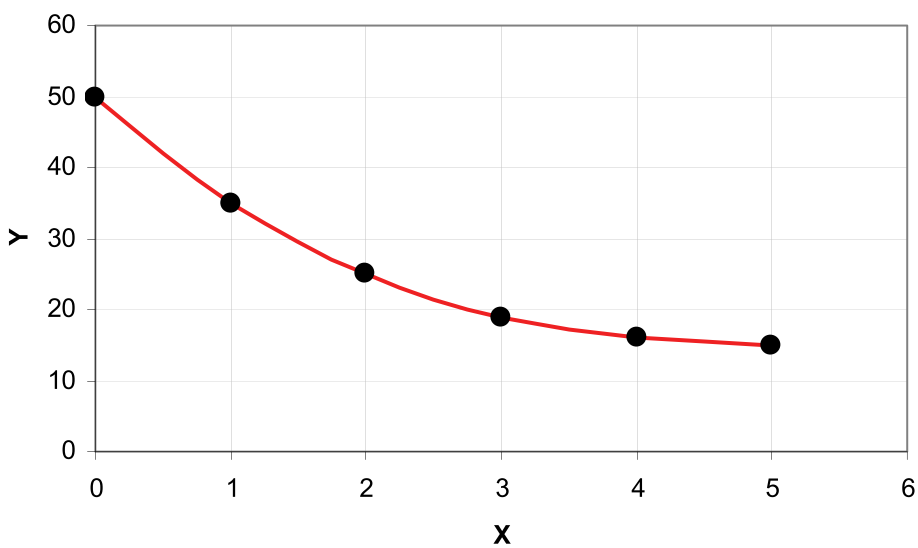
The following is the graph of this function. This function is *concave from the origin*.



Finally, consider the following function.

X	0	1	2	3	4	5
Y	50	35	25	19	16	15

This function is also downward sloping but the size of the slope decreases as X increases. The following is the graph of this function. The function is *convex from the origin*.



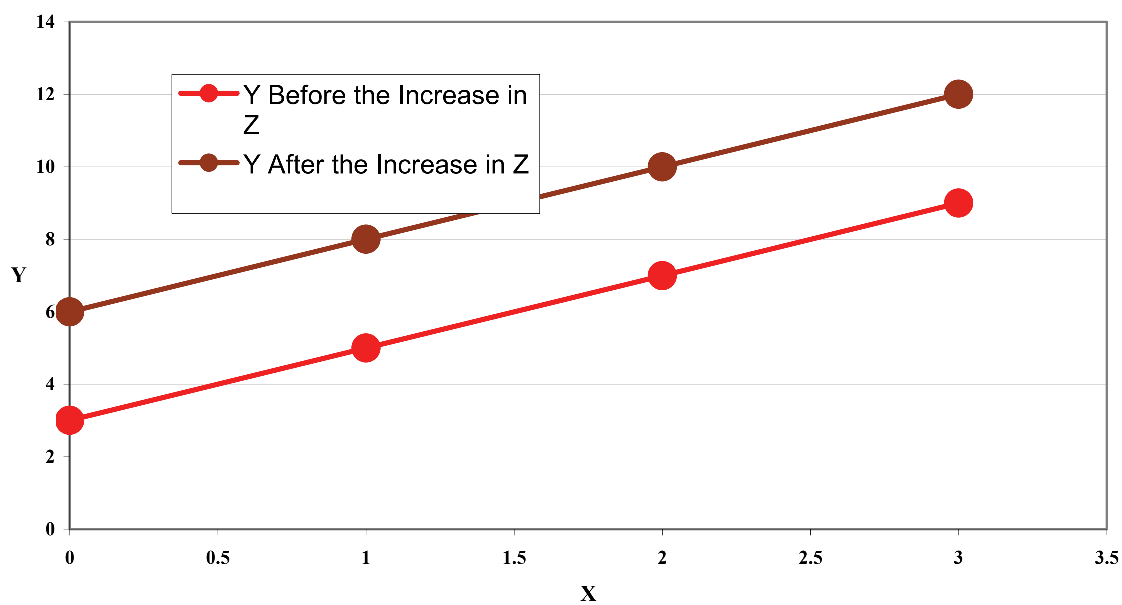
Shifts in the Functions

A lot of times a dependent variable is a function of more than one independent variable. For example, the amount of crop production in a region depends on the amount of fertilizer used as well as inches of rainfall. A household's expenditure on bread depends on the price of bread as well as household income. Your speed on a highway depends on the weather conditions as well as the numbers of other cars on the road.

Suppose Y depends on two independent variables, X and Z, in such a way that for any value of Z, an increase in X will lead to an increase in Y. Similarly, for any value of X, an increase in Z will lead to an increase in Y. For example, assume that for any one-unit increase in Z, Y will increase by 3 units regardless of what X equals to. See the following table.

X	0	1	2	3
Y Before the Increase in Z	3	5	7	9
Y After the Increase in Z	6	8	10	12

What this table says is that if we keep Z unchanged and increase X, then for each unit increase in X the value of Y will increase by 2 units. Now if we increase Z and keep it at the new higher level, then the value of Y will be higher than before by 3 units at every level of X. Nevertheless, still Y increases by 2 units with each one-unit increase in X. The following graph shows the function before and after the change in Z. The change in Z causes the function to shift up.



Algebraic Form of a Linear Function

Recall that a function is a rule. In the above examples, we did not explicitly describe the rules. The rules can best be described using algebraic forms. The following is a general *algebraic form* for linear functions:

$$Y = a + bX$$

As usual Y is the dependent variable and X is the independent variable. The letters "a" and "b" are the constants of the function.

For example, our first linear function had the following algebraic form:

$$Y = 3 + 2X$$

To see what the *rule* is, you should read this function from right to left. This function says: whatever X value you have multiply it by 2 and add the result to 3 in order to get the value for Y. For example, if the value of X is 3, then multiply t by 2 to get 6 and add the result to 3 three to get Y = 9. This number agrees with the first table above.

A few features of a linear function should be noted. First, the stand-alone number a = 3 is called the Y-intercept. It is the value of Y when X is zero. It is the point where the line crosses the Y-axis. Second, the number that multiplies the independent variable X is the slope. In the above case, the slope equals 2. This number also agrees with the first table, which shows that as X increases by one unit, Y increases by 2 units.

As another example, the algebraic form of the second linear function above is

$$Y = 4 - 2X$$

In this case the intercept equals 4 and the slope equals −2, as we already know.

We can also show the shifts in the linear function. Recall that for a function to shift, the dependent variable should be a function of more than one independent variable. For example, suppose that we have the following function:

$$Y = 2X + 3Z$$

We cannot graph this function in the two-dimensional coordinate system. The only way to graph this is to fix the value of one of the variables. For example, suppose we want to analyze the behavior of Y when Z is fixed at Z = 1. Substituting this into the function, we get:

$$Y = 2X + 3(1)$$
$$Y = 2X + 3$$

This becomes our first linear function. We already have the graph of this function above. We learn something from this simple exercise. The number that multiplies X is still the slope of the function. However, since there is also a Z in the function, the slope takes a slightly different meaning. It says: if we increase X by one unit, Y will increase by 2 units, *provided we keep Z unchanged*. Similarly, if we keep X unchanged and increase Z by one unit, then Y will increase by 3 units.

Now suppose the value of Z increases to Z = 2. Substituting this new value we get:

$$Y = 2X + 6$$

Note that the slope remains the same but the intercept increases to 6. The function shifts up by 3 units. We have seen the graph of this function above.

Let's consider another example and learn some new material. As I said, a lot of times, a dependent variable could be a function of more than one independent variable. For example, your driving speed (S) would be a function of the inches of rainfall (R) and the traffic condition (T), measured as the number cars on the street. Suppose the function takes the following form:

$$S = 45 - 10R - 0.10T$$

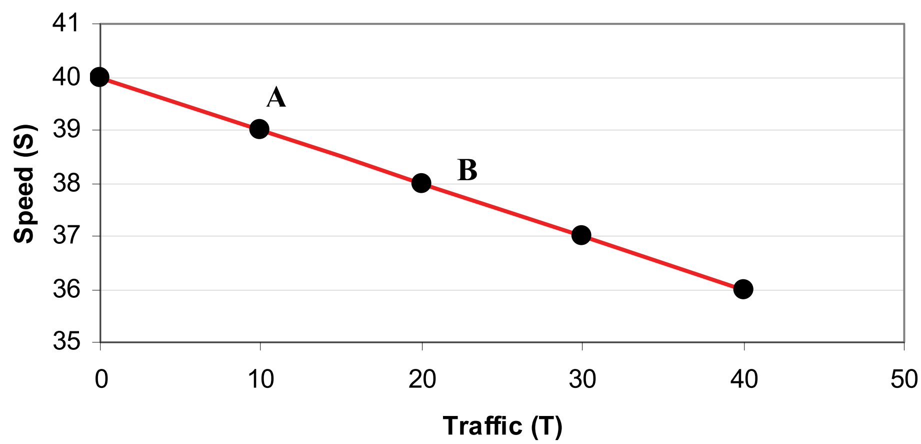
Suppose that, on average, the amount of rainfall in the city is 0.50 inches and there are 100 cars on the street when you are driving home from the school. Then your average speed can be calculated simply as

$$S = 45 - 10(0.50) - 0.10(100)$$
$$S = 30 \qquad \text{miles per hour (mph)}$$

Note also that if there is no rain (R = 0) and no traffic (T = 0), your speed will be 45 mph. Since we are interested in the behavior of the dependent variable, we choose it to go on one of the axes. Suppose that the Highway Patrol is interested in the relationship between traffic and speed. Then we can set the rainfall to a value, say its average value, and graph S against T. Our linear function becomes:

$$S = 45 - 10(0.50) - 0.10T$$
$$S = 40 - 0.10T$$

Therefore, keeping the rainfall fixed, if the number of cars on the street increases by one, your speed will go down by 0.10 mph. This is the number attached to T and is the slope of the function. See the following graph.



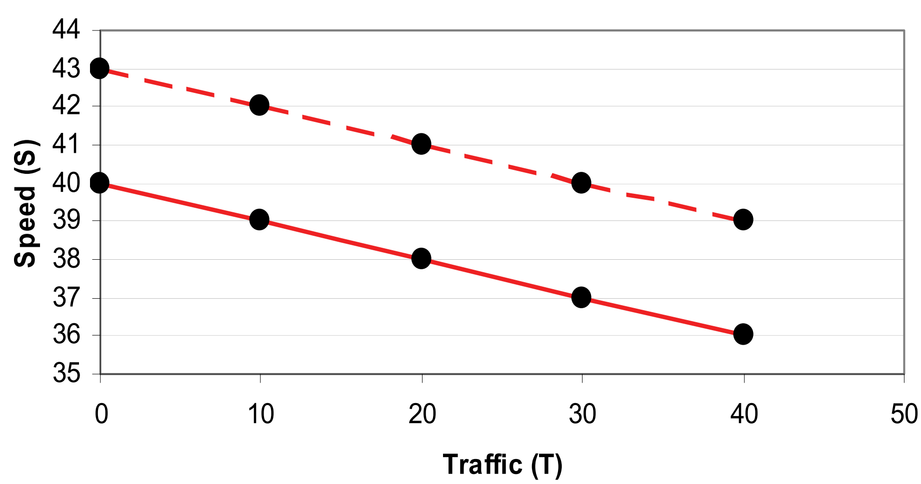
If the number of cars on the street on a day increases to from 10 to 20, while the rainfall remains at 0.50 inches, your speed will go down from 39 mph to 38 mph. Graphically, the intercept remains at 40, but you move from point A to point B. This is called a *movement along the curve*. So let's learn the general rule:

> *All else the same, if a variable that is measured along one of the two axes changes, there will be a movement along the curve.*

What would happen if, on a particular day, the amount of rainfall turned out to be different than the average? Suppose R = 0.20 inches, then:

$$S = 45 - 10(0.20) - 0.10T$$
$$S = 43 - .10T$$

So that the intercept would increase and the whole curve shifts up for any value of T. See the following graph.



This gives us the rule to shift the functions:

> *If a variable that is NOT measured along one of the two axes changes, there will be a shift in the curve.*

The direction of the shift in the curve would depend on the effect of the variable that is *not* measured on the axes on those that are. This is easy to remember and apply in practice. In the above example, the effect of rainfall on speed is negative: an increase in rainfall would reduce speed and a decrease in rainfall would increase speed. Therefore, in the above graph, since S is measured on the vertical axis, a decrease in rainfall shifted the curve up (vertically) so that at any level of traffic, you would drive faster. For example, before when there were 20 cars in the street you could drive at 38 mph. Now, with a lower amount of rain, if there are 20 cars in the street, you will be able to drive at 41 mph.

Now suppose your friend asks "How long does it take you to get home from school on a typical winter day?" We now have two dependent variables to analyze: the first one is your speed and the second one is the length of time it will take you to get home. We cannot answer this question without further information.

We need one more equation to answer both questions. Assume the distance from your home to your school is 10 miles. We know that the number of miles per hour traveled (or speed) times the number of hours (H) equals distance. Therefore:

$$S \times H = 10$$

Or

$$H = 10/S$$

Since S = 30 on a typical day,

$$H = 10/30 = 1/3 \text{ hours or just 20 minutes.}$$

We have learned that we need two equations to analyze behavior of two dependent variables.

To Summarize:

1. Scarcity means that human wants are unlimited in relation to the available resources in the economy.
2. Resources are those things societies use to produce goods and services. They are also called production inputs or factors of production. They include:
    a. Land (natural resources)
    b. Labor (human resources)
    c. Capital (produced means of production)
3. All societies need to answer three economic questions:
    a. What goods and services should the society produce?
    b. How to produce those goods and services?
    c. For whom should we produce these goods and services?
4. Microeconomics studies the decisions made by one individual decision making unit and economic conditions prevailing in one particular market or industry.
5. Economists assume that decision makers act in their own self interest to maximize their satisfaction. Satisfaction could be in monetary units or could be subjective.
6. Examples of decision making units are consumers, workers, employers, and producers.
7. Macroeconomics studies the behavior of aggregate economic variables such as the aggregate level of output, the overall price level, and overall employment.
8. The substitution effect of a price change indicates that when the price of a good goes down people buy more of it because it becomes cheaper relative to its substitutes. Similarly for an increase in price.
9. The income effect of a price change indicates that when the price of a good goes down, people will have more money left over if they buy the same amounts of the good. This is like an increase in their incomes. They use this money to buy more of every good and service including the good in question. Similarly for an increase in price.
10. Fallacy of composition is the notion that what is true for one individual may not be true for the sum of all the individuals.
11. Positive statements are about how things are, or how we think they are.
12. Normative statements involve norms or judgments. They are statements as to how things are ought to be.

Exercises

Question 1: The dollar value of all the goods produced by the Chrysler Corporation in a year might well exceed the dollar value of all the goods produced by a small country such as Jordan or Nepal. Still, the analysis of Chrysler Corporation falls in the realm of microeconomics, while we should use macroeconomic tools to study the economies of Jordan or Nepal. Why?

Question 2: Which of the following statements are positive and which ones are normative?

a. An increase in oil prices could cause a recession.
b. Western economies should coordinate their economic policies.
c. The government should pay more attention to the needs of the low-income people.
d. The September 11 terrorist attack did not have much of an impact on the U.S. economy.
e. The government should regulate the stock market.
f. We are growing too slowly; we should speed up to catch up with the rest of the world.
g. I think unemployment is a worse problem than inflation.

Exercises for Mathematical Appendix

Question 1
Determine whether the following functions are linear and graph them.

Function 1

X	0	1	2	3	4	5
Y	8	7	6	5	4	3

Function 2

X	0	1	2	3	4	5
Y	8	9	11	14	18	23

Question 2
Graph the following functions and identify their slopes and intercepts.

a. $Y = 5 + 4X$
b. $Y = 6 - 3X$
c. $Y = -2 - X$
d. $Y = X$
e. $Y = 4$

Question 3

Graph the following functions, assuming that Z = 2. Then graph them again, now assuming that Z = 3. Explain how the graphs shift as the result of the increase in Z.

a. $Y = 5 + 3X + 2Z$
b. $Y = 5 + 3X - 2Z$

Question 4

Using the functions from question 3, graph Y against Z twice, assuming first that X = 1 and then that X = 2. Comment on the shifts in the graphs as a result of the increase in X.

Question 5

Consider the speed example in the text. If there are 20 cars on the road and the amount of rain is 0.50 inches, how long will it take you to get home? What if the amount of rain was 0.20 inches?

Question 6

The quantity of wheat produced by a farm (Q) depends on the amount of fertilizer used (F) and the amount of rainfall (R) according to the following function.

$$Q = 10{,}000 + 20F + 5000R$$

Graph the function, assuming that the amount of rainfall equals R = 1 inch. What will happen to the graph if the amount of rainfall increases to R = 2 inches?

Question 7

The amount of bread purchased by a household (Q) in a year can be described by the following function, where P is the price of bread and I is the household's income.

$$Q = 100 - 5P + 0.002I$$

Graph Q against P, assuming that the household's income is I = \$20,000. What is the interpretation of the number multiplying the price? What will happen to this function if the household's income increases to I = \$25,000?