

How to Study for Chapter 2: Increasing Marginal Cost; Rational Decision Making

Chapter 2 introduces two important concepts. The first is that opportunity costs rise as more of something is done. The second involves the manner by which rational decisions are made. Both will be used throughout the course.

1. Begin by looking over the Objectives listed below. This will tell you the main points you should be looking for as you read the chapter.
2. New words or definitions are highlighted in italics in the text and in red type. Other key points are highlighted in bold type and in blue type.
3. You have your first graph in this chapter. Be sure to go over every point so that you can say how they are derived. Be sure that you can **explain in your own words** why the curve has the shape that it does. Especially, **explain in your own words** why marginal costs increase.
4. You will be given an In Class Assignment and a Homework assignment to illustrate the two main concepts of this chapter. When you have finished the text and the assignments, go back to the Objectives. See if you can answer the questions without looking back at the text. If not, go back and re-read that part of the text. Be sure that you can **explain in your own words** how rational decisions are made, using the examples of the text and the assignments. When you are ready, take the practice quiz for Chapter 2 at the back of the text.

Objectives for Chapter 2: Increasing Marginal Cost; Rational Decision Making

At the end of Chapter 2, you will be able to answer the following:

1. Describe what is meant by **“increasing marginal opportunity cost”** and explain why it occurs. Define the term **“marginal”**?
2. Describe **"rational behavior"**? Explain the procedure by which rational decisions are made, giving some examples. Explain what **"marginal benefit"** and **“marginal opportunity cost”** mean.
3. Explain what is meant by the **optimal amount of pollution control**. Why is it not zero?
4. Use the case of global warming to explain the basic problems of economic decisions making.

Chapter 2 Increasing Marginal Opportunity Cost; Rational Decision Making

(Most recent revision June 2004)

(1) Increasing Marginal Opportunity Cost

In the last chapter, the concept of opportunity cost was introduced. Remember that opportunity cost was defined as the value of whatever is sacrificed when a decision is made. *We shall see over and over that, as we decide to choose more units of anything, the opportunity*

cost of each additional unit will rise. This means that the opportunity cost of the second unit will be greater than that of the first unit. The opportunity cost of the third unit will be greater than that of the second unit. And so forth. Economists use the word "***marginal***" instead of the word additional or change in. So we say that, as more units of anything are chosen, the marginal opportunity cost of an additional unit increases.

Let us illustrate increasing marginal opportunity cost with an example: your choice of the number of classes to take this term. Assume that your first choice is Principles of Microeconomics. What is the opportunity cost of your decision to take Principles of Microeconomics? The answer is that your opportunity cost includes the dollar value of the fees, books, and perhaps extra gasoline that you must pay because you chose to take the class. But it also includes the value of the time sacrificed. This sacrifice involves three hours per week of class time and an expected six additional hours per week for study. Which hours are you going to sacrifice? The answer is that you will presumably choose to sacrifice those hours that are worth the least to you. You take the class at the time that is most convenient for you. And you study at times when you would be doing activities that are not very important --- perhaps in the late afternoon. Having decided to take Principles of Microeconomics, let us now ask about your second choice --- History. The dollar cost of taking History will be the same as it was for Economics. But the value of the time will be greater. Why? The answer is that you have already sacrificed your least-valued time for Economics. You may take History at a time that is less convenient for you. And you must now study for History in the evenings, when you might otherwise be spending time with friends or family. So the opportunity cost of taking History is greater than for Economics. The same would be true for your third choice --- English. You have already sacrificed the late afternoon to study for Economics and the early evenings to study History. Now you must sacrifice later evenings to study English, reducing your sleep and eventually harming your health. And the third class may be scheduled at such a time that you are required to work fewer hours. Again, the opportunity cost of taking English will be greater than that of History. **We expect this principle of increasing marginal opportunity cost to hold as long as scarcity exists** (in this case, it is your time that is scarce).

The Production Possibilities Curve (This section may be skipped by the Instructor.)

The principle of increasing marginal opportunity cost can be illustrated by the graph on the next page, known as ***the production possibilities curve***. In this case, assume that you have two exams tomorrow, one in Economics and one in History. You have ten hours available to study. Thus, your time is scarce. Point A shows that if you spend all ten hours studying Economics, you will score 100 on the Economics exam. However, you will score 0 on the History exam. Point F shows that if you spend all ten hours studying History, you will score 100 on the History exam. However, you will score 0 on the Economics exam. The rest of the points show the trade-off that you face. Point B shows that if you spend 8 hours studying Economics and 2 hours studying History, you will score 90 on the Economics exam and 30 on the History exam. The two hours of studying Economics that you gave up to study History had **an opportunity cost** --- 10 points on your Economics exam. Point C shows that if you spend 6 hours studying Economics and four hours studying History you will get a score of 75 on the Economics exam and 55 on the History exam. You have sacrificed an additional two hours of studying Economics in order to study History. Your **opportunity cost** is now 15 more points on your Economics exam (the score fell from 90 to 75). Point D shows that, if you spend 4 hours studying

Economics and 6 hours studying History, your scores will be 55 in Economics and 75 in History. Sacrificing two more hours of time to study Economics has lowered your Economics score by 20 points (from 75 to 55) but has raised your History score by 20 points (from 55 to 75). Finally, point E shows that sacrificing an additional two hours of study time in Economics will lower your score in Economics by 25 points (from 55 to 30). However, it will raise your History score by 15 points (from 75 to 90). *The bowed shape of the production possibilities curve reflects increasing marginal opportunity costs.* (See the graph on the next page)

Time Studying Economics Grade in Economics Marginal Opportunity Cost

10 Hours	100	
8 Hours	90	10
6 Hours	75	15
4 Hours	55	20
2 Hours	30	25
0 Hours	0	30

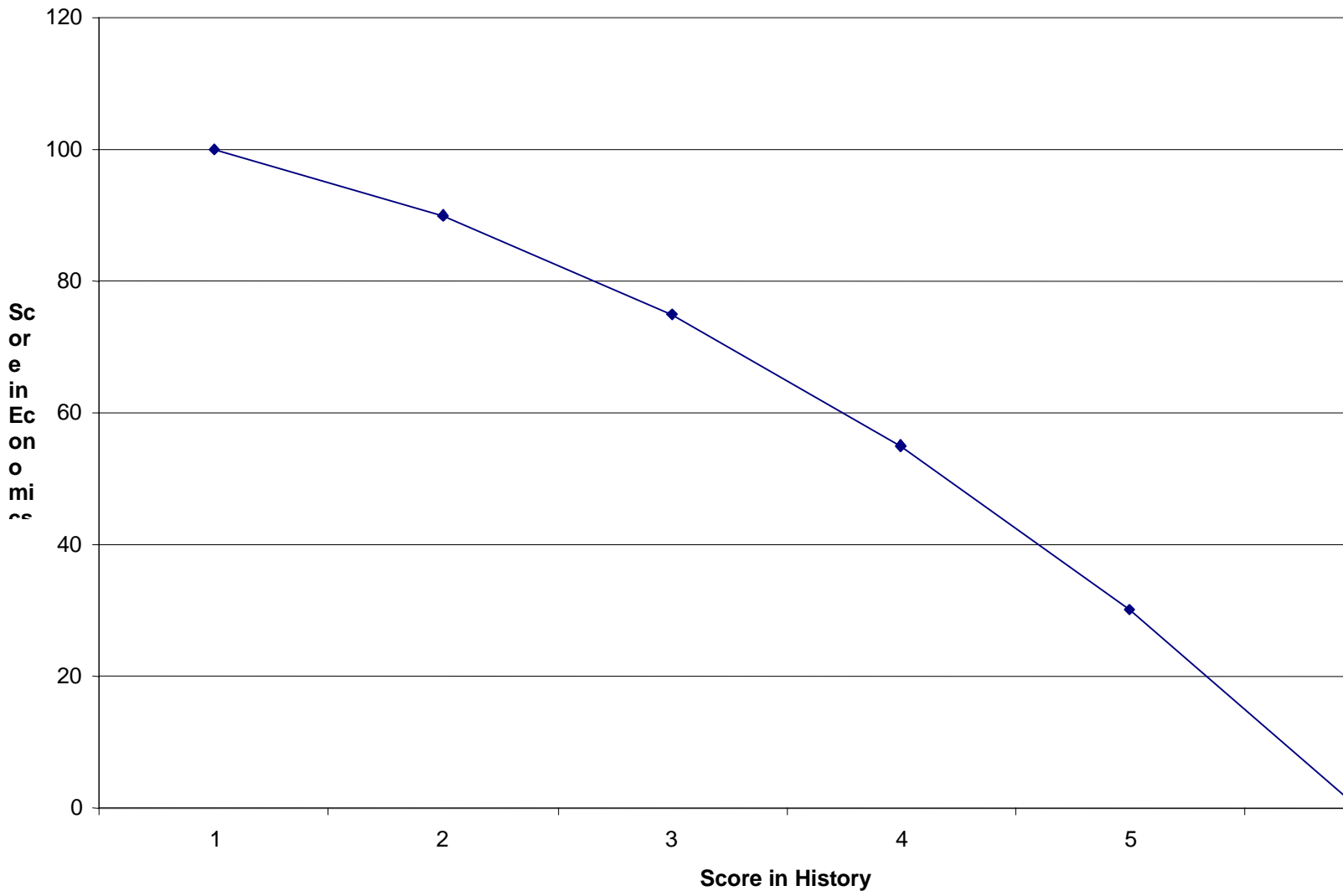
Notice that the marginal opportunity cost increases as more Economics study time is given up. This is a phenomenon you have possibly experienced while studying. As you start studying, you are focused and alert. As time goes on, you become tired. Your mind starts to wander. Also, you may learn that material which comes easiest to you at the beginning of the time, putting off the more difficult material for the end. It will require a longer time to learn a subject after you have been studying for several hours than it was when you first began to study.

What about points G and H? *Point G, inside the production possibilities curve, is inefficient.* To score 30 on both exams means that you did not use your 10 hours efficiently. You were capable of higher scores on both exams. *Point H, outside the production possibilities curve, is not attainable.* You would like to score 100 on both exams, but it can't be done with only 10 hours of study time.

We can change the example. On the vertical axis, put "Economics Goods and Services" in place of Grade in Economics. And on the horizontal axis, put "Environment" in place of Grade in History. **The curve would now show that there is a trade-off between having more goods and services and having a better environment.** It turns out that this is true in certain situations and not in others. And the curve also shows that there is increasing marginal opportunity cost to having a better environment. When the environment has been seriously damaged, it can often be improved in ways that require relatively little sacrifice of goods and services. As the environment becomes cleaner, it becomes harder (and therefore more costly) to improve it even more. We shall discuss this phenomenon again later in this chapter.

Production Possibilities Curve

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We can change the example yet again. On the horizontal axis, put "consumption today". On the vertical axis, we can put "consumption in the future". Remember the definition of "**capital**" --- **goods that are produced by people for the purpose of increasing production** (and therefore consumption) in the future. So, on the vertical axis, we can put "capital goods". **The curve would now show that there is a trade-off between consuming today and producing capital so that we can have even greater consumption in the future.**

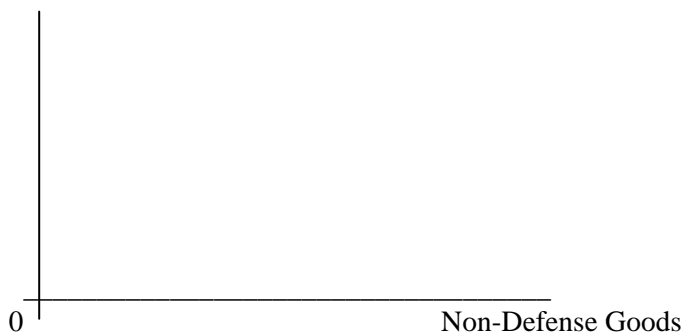
***Test Your Understanding*.**

In recent years, there has been a large reduction in spending on defense. As defense is reduced, production of other (non-defense) goods should rise. Assume the following table:

Production for Defense	Production of Non-Defense
\$300 billion	\$6,000 billion
275 billion	6,800 billion
250 billion	7,400 billion
225 billion	7,700 billion
200 billion	7,800 billion

1. Draw the **production possibilities curve** in the space below:

Defense Goods



2. Fill-in the following table:

Defense Goods	Marginal Opportunity Cost
\$200 billion	-----
\$225 billion	
\$250 billion	
\$275 billion	
\$300 billion	

3. Briefly explain why it is likely that we would observe increasing marginal opportunity cost between defense and non-defense goods.

(2) Rational Decision Making

Economic thinking makes a specific assumption about the nature of people: **people are rational, self-interested, maximizers**. Such a being is often called **homo economicus** (economic man). As noted in the last chapter, "**rational**" means that each person knows what is best for himself or herself. "**Self-interested**" does not mean that people only act for themselves and never care about others. But it does mean that people do act in their self-interest as they perceive it. A "**maximizer**" acts to get the most possible. We assume that consumers act to maximize the

satisfaction they receive from the goods and services they buy. We assume that businesses attempt to maximize the profits they earn and that workers attempt to maximize the wages (or other benefits) they earn. (A recent study concluded that people who study Economics tend to be more selfish than others. It therefore needs to be stressed that **no economist argues that people should or do care only about themselves**. People obviously have strong spiritual needs. People are also commonly observed engaging in altruistic and loving behaviors that do not seem to be related to narrow self-interest. We do need to consider these behaviors, and will do so in later chapters. However, people do act in their own self-interest much of the time. It is this aspect of their behavior that we will be focusing on. Assuming that people act in their own self-interest allows economists to learn much, but not everything, about their behaviors.) Our focus for the rest of this early chapter is the question: **how do people make rational decisions?** We can look at the procedures from the point of view of individuals and also from the point of view of governments.

Let us look at the procedure for making rational decisions. Read this paragraph first. Then, the examples below should clarify it.

First, one does not ask the question "how many units should be chosen?" Instead, **treat the units of the decision one at a time**. The question then is: should we choose one unit? If yes, should we choose a second unit? And so on. For unit #1, we need to ask two questions to determine if we should choose it. *First, what is the additional benefit we get from unit #1?* (Benefit is a general term. There are many kinds of benefits: satisfaction if we are consuming products, revenues if we are selling products, wages if we are working, and so forth.) *Second, what is the additional opportunity cost* (that is, what is the additional sacrifice that must be made to choose unit #1)? As you know, in place of the word additional, we use the word *"marginal"*. So we are asking about the marginal benefits and marginal opportunity cost of unit #1. If the marginal benefit is greater than the marginal opportunity cost, we are better-off choosing unit #1. That being so, go on to unit #2. What is the marginal benefit of unit #2 given that we have already chosen unit #1? What is the marginal opportunity cost of unit #2 given that we have already chosen unit #1? If this marginal benefit is still greater than the marginal opportunity cost, choose to do unit #2. Go on to unit #3. In the examples we shall use, *you will see that the marginal benefit will either remain unchanged or will fall as we move from unit #1 to unit #2 to unit #3. The marginal opportunity cost will always rise*, a principle you learned earlier in this chapter. At some point, the marginal benefit will be less than the marginal opportunity cost. That unit should not be chosen. When this point is reached, you may stop the process. *The maximum is reached where the marginal benefit and marginal opportunity cost are equal*. This reasoning is complicated. So, to illustrate it, let us take some examples.

Example 1: Courses Taken This Term

Let us consider again your decision about the number of courses to take this semester. The course is the unit of our decision. We do not ask: "how many courses do you take this term?" Rational decision-making requires that you consider the choices one at a time. Course #1 is, of course, Principles of Microeconomics. Should you take this course? First, what is the marginal benefit? The answer is that you get three units of credit toward a degree or certificate. Also, you gain some valuable knowledge. There may be other benefits. What is the marginal opportunity cost? The answer, as discussed earlier, is the fees, books, extra gasoline etc. and the value of the

hours you will sacrifice (assumed to be 3 hours per week for class meeting and 6 hours per week for study). As noted earlier, if you work, we can measure the value of the sacrificed hours --- you have given up the wages you would have earned. If you would not work these hours, there is still a value to the time sacrificed. Obviously, the marginal benefit you expect is greater than the marginal opportunity cost you expect. I know this because you have chosen to take this course! Now, go on to course #2 --- History. What is the marginal benefit? Another three units of credit or some more valuable knowledge. What is the marginal opportunity cost? More fees and books and more hours sacrificed. However, when you chose to take Economics, you already chose to sacrifice the hours that were least valuable to you. When these already used for Economics, you must sacrifice more valuable hours to study History. If you expect the marginal benefits of History to be greater than the marginal opportunity cost, you will take that course too. This process will go on and on. **Notice that, as we consider each course, the marginal benefit stays the same (3 units) while the marginal opportunity cost rises.** Eventually, the marginal benefit will be less than the marginal opportunity cost. You will choose to not take that course.

You are probably saying that you did not go through a thinking process like this one. But, without consciously figuring the marginal benefits and the marginal opportunity costs, you did. You are taking a certain number of courses. You are allowed to take one more if you so choose. If you were asked why you do not take one more course, you would probably answer something like "it isn't worth it!". "It isn't worth it" translates as "the marginal opportunity cost (no sleep for the next four months) is greater than the marginal benefit (three more units).

Of course, you don't know what the marginal benefits and the marginal opportunity costs will be. You have certain expectations of them based on the information available to you at this time. But this information is limited. And if we have an enormous amount of information, we have only a limited ability and a limited time to process this information. So we are rational, as described, but only within the limits of the information available and our ability to process it. This has been called "***bounded rationality***".

Example 2: Air Pollution Control

The Environmental Protection Agency (EPA) has estimated that between 1970 and 1990, air quality regulations created \$523 billion of costs but conferred \$22.2 trillion worth of benefits. So they clearly have been worthwhile. But this is not the way that we need to consider the question of air quality regulations. Remember that in making rational decisions, we analyze the units of the decision one-at-a-time. So, the question is NOT "should air pollution be reduced?" Instead, we must treat the units of the decision one at a time. Let us assume that the unit to consider is a 5% reduction in pollutants. Should we undertake policies to reduce pollutants by 5%? To answer this, we must answer our two questions. **First, what is the marginal benefit of reducing air pollutants by 5%?** The most obvious is the improvement in people's health. The Environmental Protection Agency (EPA) estimated in 1997 that air pollutants in total cause 64,000 premature deaths in the United States each year. Another would be the reduction in property destruction, since pollutants destroy plants as well as paints on buildings and cars. Yet a third would be the aesthetic gain from being able to see the beautiful scenery. **Second, what is the marginal opportunity cost of reducing air pollutants by 5%?** The answer depends on the manner in which pollution is to be reduced. If this is to be accomplished by forcing all drivers to

have a pollution control device on their cars, the marginal opportunity cost is the value of whatever would have been produced if the pollution control devices had not been required. In a similar way, assume that pollution reduction is to be accomplished by forcing electricity-producing companies to install equipment to reduce the pollutants they put into the air. In this case, the marginal opportunity cost is the value given-up to produce the equipment plus the effects the equipment might have on the cost of producing electricity. (Question: What is the marginal opportunity cost if pollution reduction is accomplished by forcing drivers to car pool to work?)

If the marginal benefit from a 5% reduction in pollutants is greater than the marginal opportunity cost, society is better off to do so. Then, we should consider the next 5%. And so on. **As the air becomes cleaner, the marginal benefit declines.** When the air is very polluted, a 5% reduction in pollutants may have great beneficial effects. But when the air is only 5% polluted, the reduction to zero pollution may have little benefit (a small amount of pollution may cause little harm). **On the other hand, to make the air cleaner and cleaner, the marginal opportunity cost rises.** Indeed, a certain amount of pollutants can be removed at zero cost as part of the natural assimilative capacity of the environment. (For example, the smoke from one cigarette is completely broken down by the environment.) Beyond this, removing a small amount of pollutants from the air may be relatively easy. But since the easy choices are done first, removing more and more pollutants from the air becomes progressively more difficult. At some point, the marginal opportunity cost is greater than the marginal benefit, and removing any more pollution "is not worth it". **The point where the marginal benefit and the marginal opportunity cost are equal is the optimum amount of pollution reduction.** Notice that this is NOT zero. Beyond this point, we would have to sacrifice more than we would gain to remove additional pollutants.

Economists make studies of the desired amount of pollution control in this manner. Consider, for example, a recent study of one region (Baltimore). The authors estimated the marginal benefits and costs of various total suspended particulates. Total suspended particulates are small particles of ash or soot emitted as a result of burning oil or coal. They cause health problems, damage property and clothing, and reduce visibility. They found that the marginal cost of pollution reduction rises; reducing the pollutants from 110 to 109 parts per million would cost \$3 million while reducing them from 95 to 94 parts per million would cost an additional \$16 million. They also found that the marginal benefits decreased approximately \$10 million for each one unit decrease in particulates. In this study, the optimum amount of pollution reduction came at about 99 parts per million. The marginal benefits of reducing the particulates in the air are greater than the marginal opportunity costs up to this amount. Beyond it, the marginal opportunity cost is greater than the marginal benefits.

There are two issues raised by this analysis. **The first is the issue of measurement.** Since the main benefit of pollution control is improved health, we need some measure of this. Not only do we need to know how much health is improved, we also need to know what the value of this improvement is. If reducing pollutants by 5% reduces the probability of lung cancer by 2%, what is this 2% reduction worth? Can the worth even be measured? (The study on Baltimore mentioned above values each life saved at \$2 million and each lost workday at \$100, and each restricted activity day at \$25.) The same is true for the increased aesthetic enjoyment. How do

we measure the value of an improved view? Can it even be measured? We shall consider some of these issues in Chapter 12. **The second is the issue of distribution.** The people who benefit from pollution control may be very different from the people who will absorb the cost. This has great effects on the political process, which we shall consider in Chapter 11.

Test Your Understanding

Consider how you would use the procedure for rational decision making in each of the following situations. Then write briefly what you have concluded.

1. A family must decide how many children to have.
2. You have taken a quiz and received a grade of 3 out of a possible 10 points (F). You are allowed to take a second version of the quiz. If you do so, you can raise your grade to a maximum of 7 out of 10 (C) as long as your score on the second quiz is at least 7. Since you scored poorly on the first version, you will need to study carefully. There are 570 maximum possible points in the course. Will you take the second version of the quiz? Why?
3. You are driving home from Phoenix. You stop at a Dennys in a small town for dinner. You have never been in this small town before and are not likely to ever be there again. Your dinner is fine and so is the service. Your bill is \$10. Use the procedures for rational decision-making to determine whether or not you will leave a tip for the person who waited on your table.

Example 3: The Case of Global Warming

Global warming is caused by various greenhouse gases that act to trap heat as it is reflected from the earth. Some of these greenhouse gases include carbon dioxide, nitrogen oxide (from fertilizers), methane gas (from oil and gasoline production, from rice production, and from the digestive system of cows and sheep), and CFCs (from air conditioning and refrigeration). It has been estimated that these gases trapping the reflected heat will raise average world temperatures by at least three degrees Fahrenheit by 2050, a greater increase than has been seen in the past 10,000 years. This could change rain patterns, affecting food production. It could act to kill off forests and cause species extinction. And it could cause the sea levels to rise. So global warming is an extremely important issue facing the entire world. Let us use global warming to illustrate how economists think about such important issues. And let us focus only on reducing carbon dioxide levels to the levels of 1990. Carbon dioxide is responsible for 60% of this greenhouse gas effect. Burning fossil fuel and deforestation are the main reasons for the increase in carbon dioxide in the atmosphere. (The amount of carbon dioxide in the atmosphere, at 368 parts per million by volume, is the highest in at least the past 420,000 years.)

The first issue is to calculate the costs of reducing carbon dioxide levels. Companies required to reduce emissions of carbon dioxide will face an increase in their costs of production. They will respond by producing fewer goods. This reduction in goods available is the opportunity cost. **There is considerable uncertainty in the measurement of this cost.** One group of studies estimates the lost production (the opportunity cost) from holding carbon dioxide to 1990 levels at between \$8 billion and \$36 billion per year (in 1990 dollars). However, there is another argument that if new technologies are developed to get more energy from the same resources, there might be more goods and services available, not less. For example, one study estimates that spending \$2.7 trillion on these new technologies between 1990 and 2030 could reduce emissions of carbon dioxide by 50%. The study estimates that these new technologies would save consumers and companies \$5 trillion on energy bills.

A second issue is to calculate benefits. Here, the uncertainty of measurement is even greater. As you can guess, it is very hard to measure the effects on food production because

people adapt to changing environmental conditions so that they can maintain their ability to produce. Measuring the benefits of preserving forests, preserving species, and preventing a rising sea level is even harder. A warmer world will see more heat waves, causing hundreds of thousands of additional deaths. In a warmer world, pests and germs will thrive, causing greater disease. The rise in the sea level will affect coastal areas and will also cause storms to extend further inland and become more intense. As climates change and species become extinct, perhaps millions of people will be forced to migrate (called “environmental refugees”). Most studies by economists estimate that preventing global warming would increase production in the United States and in the entire world by a bit less than 2%. But these estimates omit many factors and are therefore low.

A third issue involves **intergenerational equity**. If we do not undertake policies to reduce emissions of carbon dioxide, the generations living now may have more goods and services available. But the generations living in the second half of the 21st century may be much worse off. How do we evaluate the concerns of the different generations? Do people today care about future generations? On the same line of thinking, failing to undertake policies to reduce emissions of carbon dioxide will help certain countries more than others. In particular, the richer countries will be helped more today. But the problems of global warming may hurt the poorer countries more in the future. Several economists have used the procedure for rational decision making described in this chapter. **If we value the present as much more important than the future, the optimal reduction in greenhouse gases is estimated at only between 10% and 15%. But if we value the future as equal to the present, the optimal reduction of greenhouse gases is 80% by the middle of the 21st century (and 97% by 2200).**

While economists focus on questions such as the ones mentioned in the last three paragraphs, others focus on **ethical questions**. Is it unethical and immoral to allow the massive environmental damage that could result from global warming?

If we have decided to reduce emissions of carbon dioxide, we will need governments to carry this out. Can governments as currently constituted carry out the required policies? We will consider this question in Chapter 11 when we look at the political influences on governments.

If we have decided to reduce emissions of carbon dioxide and are going to use governments to do so, we must then decide what policies to choose. **One choice is called technology-based regulation (also called “command and control regulation”).** This involves the government forcing companies to use certain technologies in their production (analogous to you having to have a smog control device on your car). **Another choice is called incentive-based regulation.** In this case, the government changes the prices faced by private individuals and businesses in order to persuade them to undertake activities to reduce emissions of carbon dioxide. An example might be a tax on the amount of pollutants emitted. **A third choice is for government to promote energy efficiency.** This would involve government subsidies to research and development of clean energy technologies, such as solar, wind, and hydro-thermal. It would also involve what is called “smart growth” – encouraging more density in residential living and greater use of mass transit. A fourth option is to plant many new trees. New trees absorb carbon dioxide from the atmosphere. We will consider these choices in later chapters.

The purpose of this section has not been to describe the problem of global warming in detail. I hope it does illustrate some of the problems people face in dealing with very serious social problems and the ways that economists might go about thinking about these problems.

Practice Quiz on Chapters 1 and 2

1. The **fundamental economic problem** faced by all societies is:
 - a. unemployment
 - b. poverty
 - c. inequality
 - d. scarcity
2. The computer in this class room is an example of which of the **factors of production**?
 - a. natural resources
 - b. labor
 - c. capital
 - d. entrepreneurship
3. You are presently working and earning an annual income of \$10,000. You are considering quitting your job and going to college to complete a degree. You estimate that the annual cost of tuition and books will be \$20,000. The **opportunity cost** of completing your education is:
 - a. \$10,000
 - b. \$20,000
 - c. \$30,000
 - d. \$0
4. You have taken this quiz and received a grade of 3 out of a possible 10 points (F). You are allowed to take a second version of this quiz. If, after you study, you score 7 or more, you can raise your score to a 7 (C). In making a **rational decision** as to whether or not to retake the test, you should
 - a. always retake the quiz
 - b. consider only the marginal benefits from of retaking the quiz (possible four extra points)
 - c. consider only the marginal opportunity costs from taking the quiz (the time spent)
 - d. decide if the marginal benefits are greater than the marginal opportunity costs
5. **Distributing goods and services in a manner seen a “fair”** is called:
 - a. allocative efficiency
 - b. productive efficiency
 - c. equity
6. An economic system in which the capital goods are owned by private individuals is called
 - a. capitalism
 - b. socialism
 - c. communism
7. Every society must answer which of the following questions?
 - a. What is to be produced?
 - b. How are goods and services to be produced?
 - c. Who gets the goods and services produced?
 - d. All of the above
8. A statement that can clearly be demonstrated as true or false is called
 - a. positive
 - b. normative
9. In making decisions, as we go from unit #1 to unit #2 to unit #3, the **marginal opportunity cost** will
 - a. increase
 - b. decrease
 - c. stay the same
10. The **optimal amount of pollution control** is the amount of control so that
 - a. there is zero pollution
 - b. the marginal benefit is at its greatest
 - c. the marginal cost is at its lowest
 - d. the marginal benefit equals the marginal cost

Answers: 1. D 2. C 3. C 4. D 5. C 6. A 7. D 8. A 9. A 10. D