chapter 7

>> Making Decisions

Section 2: Making "How Much" Decisions: The Role of Marginal Analysis

As the story of the two wars at the beginning of this chapter demonstrated, there are two types of decisions: "either–or" decisions and "how much" decisions. To help you get a better sense of that distinction, Table 7-3 offers some examples of each kind of decision.

Although many decisions in economics are "either–or," many others are "how much." Not many people will stop driving if the price of gasoline goes up, but many people will drive less. How much less? A rise in wheat prices won't necessarily persuade a lot of people to take up farming for the first time, but it will persuade farmers who were already growing wheat to plant more. How much more?

To understand "how much" decisions, we use an approach known as *marginal analysis*. Marginal analysis involves comparing the benefit of doing a little bit more of some activity with the cost of doing a little bit more of that activity. The benefit of doing a little bit more of something is what economists call its *marginal benefit*, and the cost of doing a little bit more of something is what they call its *marginal cost*.

TABLE 7-3

"How Much" Versus "Either–Or" Decisions

"How much" decisions	"Either–or" decisions
How many days before you do your laundry?	Tide or Cheer?
How many miles do you go before an oil change in your car?	Buy a car or not?
How many jalapenos on your nachos?	An order of nachos or a sandwich?
How many workers should you hire in your company?	Run your own business or work for someone else?
How much should a patient take of a drug that generates side effects?	Prescribe drug A or drug B for your patients?
How many troops do you allocate to your invasion force?	Invade at Calais or at Normandy?

Why is this called "marginal" analysis? A margin is an edge; what you do in marginal analysis is push out the edge a bit and see whether that is a good move.

We will begin our study of marginal analysis by focusing on marginal cost, and we'll do that by considering a hypothetical company called Felix's Lawn-Mowing Service, operated by Felix himself with his tractor-mower.

Marginal Cost

Felix is a very hard-working individual; if he works continuously, he can mow 7 lawns in a day. It takes him an hour to mow each lawn. The opportunity cost of an hour of Felix's time is $10.00 because he could make that much at his next best job.

His one and only mower, however, presents a problem when Felix works this hard. Running his mower for longer and longer periods on a given day takes an increasing toll on the engine and ultimately necessitates more—and more costly—maintenance and repairs.

The second column of Table 7-4 shows how the total daily cost of Felix's business depends on the quantity of lawns he mows in a day. For simplicity, we assume that Felix's only costs are the opportunity cost of his time and the cost of upkeep for his mower.

At only 1 lawn per day, Felix's daily cost is $10.50: $10 for an hour of his time plus $0.50 for some oil. At 2 lawns per day, his daily cost is $21.75: $20 for 2 hours of his time and $1.75 for mower repair and maintenance. At 3 lawns per day, the daily cost

TABLE 7-4

Felix's Marginal Cost of Mowing Lawns

Quantity of lawns mowed	Felix's total cost	Felix's marginal cost of lawn mowed
0	$0	
		$10.50
1	10.50	
		11.25
2	21.75	
		13.25
3	35.00	
		15.50
4	50.50	
		18.00
5	68.50	
		20.75
6	89.25	
		23.75
7	$113.00	

PITFALLS

INCREASING TOTAL COST VERSUS INCREASING MARGINAL COST

The concept of *increasing marginal cost* plays an important role in economic analysis, but students sometimes get confused about what it means. That's because it is easy to wrongly conclude that whenever total cost is increasing, marginal cost must also be increasing. But the following example shows that this conclusion is misguided.

Suppose that we change the numbers of our example: the marginal cost of mowing the 6th lawn is now $20.00, and the marginal cost of mowing the 7th lawn is now $15.00. In both instances total cost increases as Felix does an additional lawn: it increases by $20.00 for the 6th lawn and by $15.00 for the 7th lawn. But in this example marginal cost is *decreasing:* the marginal cost of the 7th lawn is less than the marginal cost of the 6th lawn. So we have a case of increasing total cost and decreasing marginal cost. What this shows us is that, in fact, totals and marginals can sometimes move in opposite directions.

has risen to $35.00: $30 for 3 hours of his time and $5.00 for mower repair and maintenance.

The third column of Table 7-4 contains the cost incurred by Felix for each *additional* lawn he mows, calculated from information in the second column. The 1st lawn he mows costs him $10.50; this number appears in the third column between the lines representing 0 lawn and 1 lawn because $10.50 is Felix's cost of going from 0 to 1 lawn mowed. The next lawn, going from 1 to 2, costs him an additional $11.25. So $11.25 appears in the third column between the lines representing the 1st and 2nd lawn, and so on.

The **marginal cost** of an activity is the additional cost incurred by doing one more unit of that activity.

The increase in Felix's cost when he mows one more lawn is his **marginal cost** of lawn-mowing. In general, the marginal cost of any activity is the additional cost incurred by doing one more unit of that activity.

There is **increasing marginal cost** from an activity when each additional unit of the activity costs more than the previous unit.

The marginal costs shown in Table 7-4 have a clear pattern: Felix's marginal cost is greater the more lawns he has already mowed. That is, each time he mows a lawn, the additional cost of doing yet another lawn goes up. Felix's lawn-mowing business has what economists call **increasing marginal cost:** each additional lawn costs more to mow than the previous one. Or, to put it slightly differently; with increasing marginal cost, the marginal cost of an activity rises as the quantity already done rises.

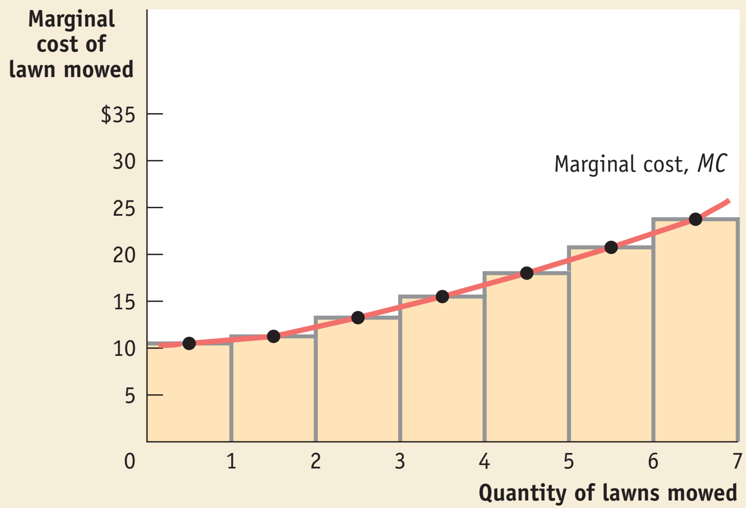
The **marginal cost curve** shows how the cost of undertaking one more unit of an activity depends on the quantity of that activity that has already been done.

Figure 7-1 is a graphical representation of the third column in Table 7-4. The horizontal axis measures the quantity of lawns mowed, and the vertical axis measures the marginal cost of a mowed lawn. The height of each shaded bar indicates the marginal cost incurred by mowing a given lawn. For example, the bar stretching from 4 to 5 lawns is at a height of $18.00, equal to the cost of mowing the 5th lawn. Notice that the bars form a series of ascending steps, a reflection of the increasing marginal cost of lawn-mowing. The **marginal cost curve,** the red curve in Figure 7-1, shows the relationship between marginal cost and the quantity of the activity already done. We draw it by plotting a point in the center at the top of each bar and connecting the points.

Figure 7-1

The Marginal Cost Curve

The height of each bar is equal to the marginal cost of mowing the corresponding lawn. For example, the 1st lawn mowed has a marginal cost of $10.50, equal to the height of the bar extending from 0 to 1 lawn. The bars ascend in height, reflecting increasing marginal cost: each additional lawn is more costly to mow than the previous one. As a result, the marginal cost curve (drawn by plotting points in the top center of each bar) is upward sloping.



The marginal cost curve is upward sloping, due to increasing marginal cost. Not all activities have increasing marginal cost; for example, it is possible for marginal cost to be the same regardless of the number of lawns already mowed. Economists call this case *constant* marginal cost. It is also possible for some activities to have a marginal cost that initially falls as we do more of the activity and then eventually rises. These sorts of activities involve gains from specialization: as more output is produced, more workers are hired, allowing each one to specialize in the task that he or she performs best. The gains from specialization yield a lower marginal cost of production.

Now that we have established the concept of marginal cost, we move to the parallel concept of marginal benefit.

Marginal Benefit

Felix's business is in a town where some of the residents are very busy but others are not so busy. For people who are very busy, the opportunity cost of an hour of their time spent mowing the lawn is very high. So they are willing to pay Felix a fairly high sum to do it for them. People with lots of free time, however, have a lower opportunity cost of an hour of their time spent mowing the lawn. So they are willing to pay Felix only a relatively small sum. And between these two extremes lie other residents who are moderately busy and so are willing to pay a moderate price to have their lawns mowed.

We'll assume that on any given day, Felix has one potential customer who will pay him $35 to mow her lawn, another who will pay $30, a third who will pay $26, a fourth who will pay $23, and so on. Table 7-5 lists what he can receive from each of his seven potential customers per day, in descending order according to price. So if Felix goes from 0 to 1 lawn mowed, he can earn $35; if he goes from 1 to 2 lawns mowed, he can earn an additional $30; and so on. The third column of Table 7-5 shows the **marginal benefit** to Felix of each additional lawn mowed. In general, marginal benefit is the additional benefit derived from undertaking one more unit of an activity. Because it arises from doing one more lawn, each marginal benefit value appears between the lines associated with successive quantities of lawns.

The **marginal benefit** from an activity is the additional benefit derived from undertaking one more unit of that activity.

There is **decreasing marginal benefit** from an activity when each additional unit of the activity produces less benefit than the previous unit.

The **marginal benefit curve** shows how the benefit from undertaking one more unit of an activity depends on the quantity of that activity that has already been done.

It's clear from Table 7-5 that the more lawns Felix has already mowed, the smaller his marginal benefit from mowing one more. So Felix's lawn-mowing business has what economists call **decreasing marginal benefit:** each additional lawn mowed produces less benefit than the previous lawn. Or, to put it slightly differently, with decreasing marginal benefit, each additional unit produces less benefit than the unit before.

Just as marginal cost could be represented with a marginal cost curve, marginal benefit can be represented with a **marginal benefit curve,** shown in blue in Figure 7-2.

TABLE 7-5

Felix's Marginal Benefit of Mowing Lawns

Quantity of lawns mowed	Felix's total benefit	Felix's marginal benefit of lawn mowed
0	$0	
		$35.00
1	35.00	
		30.00
2	65.00	
		26.00
3	91.00	
		23.00
4	114.00	
		21.00
5	135.00	
		19.00
6	154.00	
		18.00
7	$172.00	

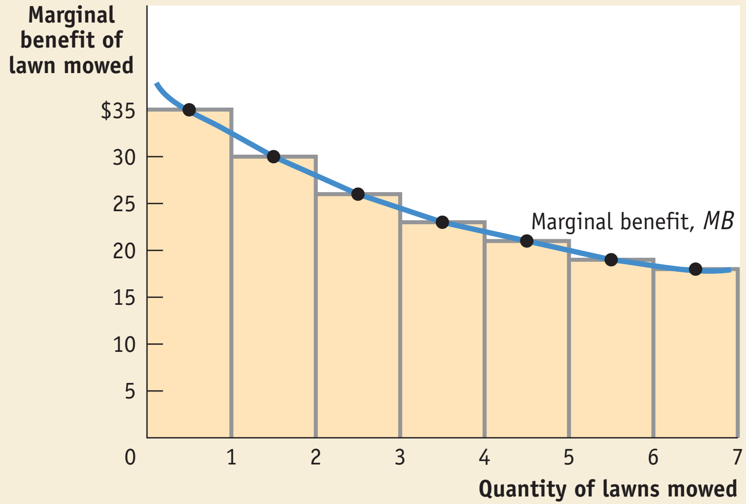
The height of each bar shows the marginal benefit of each additional lawn mowed; the curve through the middle of each bar's top shows how the benefit of each additional unit of the activity depends on the number of units that have already been undertaken.

Felix's marginal benefit curve is downward sloping because he faces decreasing marginal benefit from lawn-mowing. Not all activities have decreasing marginal benefit; in fact, there are many activities for which marginal benefit is constant—that is, it is the same regardless of the number of units already undertaken. In later chapters where we study firms, we will see that the shape of a firm's marginal benefit curve from producing output has important implications for how it behaves within its industry. We'll also see in Chapters 10 and 11 why economists assume that declining marginal benefit is

Figure 7-2

The Marginal Benefit Curve

The height of each bar is equal to the marginal benefit of mowing the corresponding lawn. For example, the 1st lawn mowed has a marginal benefit of $35, equal to the height of the bar extending from 0 to 1 lawn. The bars descend in height, reflecting decreasing marginal cost: each additional lawn produces a smaller benefit than the previous one. As a result, the marginal benefit curve (drawn by plotting points in the top center of each bar) is downward sloping. >web...



the norm when considering choices made by consumers. Like increasing marginal cost, decreasing marginal benefit is so common that for now we can take it as the norm.

Now we are ready to see how the concepts of marginal benefit and marginal cost can be brought together to answer the question of "how much" of an activity an individual should undertake.

Marginal Analysis

Table 7-6 shows the marginal cost and marginal benefit numbers from Tables 7-4 and 7-5. It also adds an additional column: the net gain to Felix from one more lawn mowed, equal to the difference between the marginal benefit and the marginal cost.

We can use Table 7-6 to determine how many lawns Felix should mow. To see this, imagine for a moment that Felix planned to mow only 3 lawns today. We can immediately see that this is too small a quantity. If Felix mows an additional lawn, increasing the quantity from 3 to 4, he realizes a marginal benefit of $23 and incurs a marginal cost of only $15.50—so his net gain would be $23.00 – $15.50 = $7.50. But even 4 lawns is still too few: if Felix increases the quantity from 4 to 5, his marginal

TABLE 7-6

Felix's Net Gain from Mowing Lawns

Quantity of lawns mowed	Felix's marginal benefit of lawn mowed	Felix's marginal cost of lawn mowed	Felix's net gain of lawn mowed
0			
	$35.00	$10.50	$24.50
1			
	30.00	11.25	18.75
2			
	26.00	13.25	12.75
3			
	23.00	15.50	7.50
4			
	21.00	18.00	3.00
5			
	19.00	20.75	−1.75
6			
	18.00	23.75	−5.75
7			

benefit is $21.00 and his marginal cost is only $18.00, for a net gain of $21.00 – $18.00 = $3.00 (as indicated by the highlighting in the table).

But if Felix goes ahead and mows 7 lawns, that is too many. We can see this by looking at the net gain from mowing that 7th lawn: Felix's marginal benefit is $18.00, but his marginal cost is $23.75. So mowing that 7th lawn would produce a net gain of $18.00 – $23.75 = –$5.75; that is, a net *loss* for his business. Even 6 lawns is too many: by increasing the quantity of lawns mowed from 5 to 6, Felix incurs a marginal cost of $20.75 compared with a marginal benefit of only $19.00. He is best off at mowing 5 lawns, the largest quantity of lawns for which marginal benefit is at least as great as marginal cost.

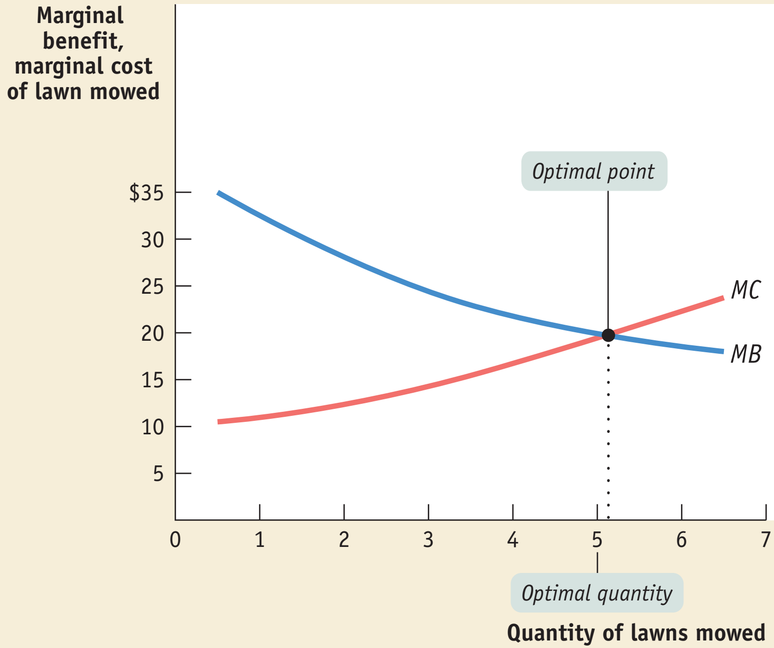
The upshot is that Felix should mow 5 lawns—no more and no less. If he mows fewer than 5 lawns, his marginal benefit from one more is greater than his marginal cost; he would be passing up a net gain by not mowing more lawns. If he mows more than 5 lawns, his marginal benefit from the last lawn mowed is less than his marginal cost, resulting in a loss for that lawn. So 5 lawns is the quantity that generates Felix's maximum possible total net gain; it is what economists call the **optimal quantity** of lawns mowed.

The **optimal quantity** of an activity is the level that generates the maximum possible total net gain.

Figure 7-3 shows graphically how the optimal quantity can be determined. Felix's marginal benefit and marginal cost curves are both shown. If Felix mows fewer than 5 lawns, the marginal benefit curve is *above* the marginal cost curve, so he can make himself better off by mowing more lawns; if he mows more than 5 lawns, the marginal benefit curve is *below* the marginal cost curve, so he would be better off mowing fewer lawns.

The table in Figure 7-3 confirms our result. The second column repeats information from Table 7-6, showing marginal benefit minus marginal cost—or the net gain—for each lawn. The third column shows total net gain according to the quantity of lawns mowed. The total net gain after doing a given lawn is simply the sum of numbers in the second column up to and including that lawn. For example, the net gain is $24.50

Figure 7-3 The Optimal Quantity



Quantity of lawns mowed	Felix's net gain of lawn mowed	Felix's total net gain
0		$0
	$24.50	
1		24.50
	18.75	
2		43.25
	12.75	
3		56.00
	7.50	
4		63.50
	3.00	
5		66.50
	−1.75	
6		64.75
	−5.75	
7		59.00

The optimal quantity of an activity is the quantity that generates the highest possible total net gain. It is the quantity at which marginal benefit is equal to marginal cost. Equivalently, it is the quantity at which the marginal benefit curve and the marginal cost curve intersect. Here they intersect at approximately 5 lawns. The table beside the graph confirms that 5 is indeed the optimal quantity: the total net gain is maximized at 5 lawns, generating $66.50 in net gain for Felix.

PITFALLS

MUDDLED AT THE MARGIN

The idea of setting marginal benefit *equal* to marginal cost sometimes confuses people. Aren't we trying to maximize the *difference* between benefits and costs? And don't we wipe out our gains by setting benefits and costs equal to each other? But what we are doing is setting *marginal*, not *total*, benefit and cost equal to each other.

Once again, the point is to maximize the total net gain from an activity. If the marginal benefit from the activity is greater than the marginal cost, doing a bit more will increase that gain. If the marginal benefit is less than the marginal cost, doing a bit less will increase the total net gain. So only when the *marginal* benefit and cost are equal is the difference between *total* benefit and cost at a maximum.

The **principle of marginal analysis** says that the optimal quantity of an activity is the quantity at which marginal benefit is equal to marginal cost.

for the first lawn and $18.75 for the second. So the total net gain after doing the first lawn is $24.50, and the total net gain after doing the second lawn is $24.50 + $18.75 = $43.25. Our conclusion that 5 is the optimal quantity is confirmed by the fact that the greatest total net gain, $66.50, occurs when the 5th lawn is mowed.

The example of Felix's lawn-mowing business shows how you go about finding the optimal quantity: increase the quantity as long as the marginal benefit from one more unit is greater than the marginal cost, but stop before the marginal benefit becomes less than the marginal cost.

In many cases, however, it is possible to state this rule more simply. When a "how much" decision involves relatively large quantities, the rule simplifies to this: the optimal quantity is the quantity at which marginal benefit is equal to marginal cost.

To see why this is so, consider the example of a farmer who finds that her optimal quantity of wheat produced is 5,000 bushels. Typically, she will find that in going from 4,999 to 5,000 bushels, her marginal benefit is only very slightly greater than her marginal cost—that is, the difference between marginal benefit and marginal cost is close to zero. Similarly, in going from 5,000 to 5,001 bushels, her marginal cost is only very slightly greater than her marginal benefit—again, the difference between marginal cost and marginal benefit is very close to zero. So a simple rule for her in choosing the optimal quantity of wheat is to produce the quantity at which the difference between marginal benefit and marginal cost is approximately zero—that is, the quantity at which marginal benefit equals marginal cost.

Economists call this rule the **principle of marginal analysis.** It says that the optimal quantity of an activity is the level at which marginal benefit equals marginal cost. Graphically, the optimal quantity is the level of an activity at which the marginal benefit curve *intersects* the marginal cost curve. In fact, this graphical method works quite well even when the numbers involved aren't that large. For example, in Figure 7-3 the marginal benefit and marginal cost curves cross each other at about 5 lawns mowed—that is, marginal benefit equals marginal cost at about 5 lawns mowed, which we have already seen is Felix's optimal quantity.

A Principle with Many Uses

The principle of marginal analysis can be applied to just about any "how much" decision—including those decisions where the benefits and costs are not necessarily expressed in dollars and cents. Here are a few examples:

- The number of traffic deaths can be reduced by spending more on highways, requiring better protection in cars, and so on. But these measures are expensive. So we can talk about the marginal cost to society of eliminating one more traffic fatality. And we can then ask whether the marginal benefit of that life saved is large enough to warrant doing this.
- Many useful drugs have side effects that depend on the dosage. So we can talk about the marginal cost, in terms of these side effects, of increasing the dosage of a drug. The drug also has a marginal benefit in helping fight the disease. So the optimal quantity of the drug is the quantity that makes the best of this trade-off.
- Studying for an exam has costs because you could have done something else with the time, such as studying for another exam or sleeping. So we can talk about the marginal cost of devoting another hour to studying for your chemistry final. The optimal quantity of studying is the level at which the marginal benefit in terms of a higher grade is just equal to the marginal cost. ■