chapter 10

# >>The Rational Consumer

## Section 2: Budgets and Optimal Consumption

The principle of diminishing marginal utility explains why most people eventually reach a limit, even at an all-you-can-eat buffet where the cost of another clam is measured only in future indigestion. Under ordinary circumstances, however, it costs some additional resources to consume more of a good, and consumers must take that cost into account when making choices.

What do we mean by cost? As always, the fundamental measure of cost is *opportunity cost*. Because the amount of money a consumer can spend is limited, a decision to consume more of one good is also a decision to consume less of some other good.

### Budget Constraints and Budget Lines

Consider Sammy, whose appetite is exclusively for clams and potatoes (there's no accounting for tastes). He has a weekly income of $20 and since, given his appetite, more of either good is better than less, he spends all of it on clams and potatoes. We will assume that clams cost $4 per pound and potatoes, $2 per pound. What are his possible choices?

Whatever Sammy chooses, we know that the cost of his consumption bundle cannot exceed the amount of money he has to spend. That is,

**(10-1)** Expenditure on clams + expenditure on potatoes $\leq$ total income

A **budget constraint** requires that the cost of a consumer's consumption bundle be no more than the consumer's total income.

A consumer's **consumption possibilities** is the set of all consumption bundles that can be consumed given the consumer's income and prevailing prices.

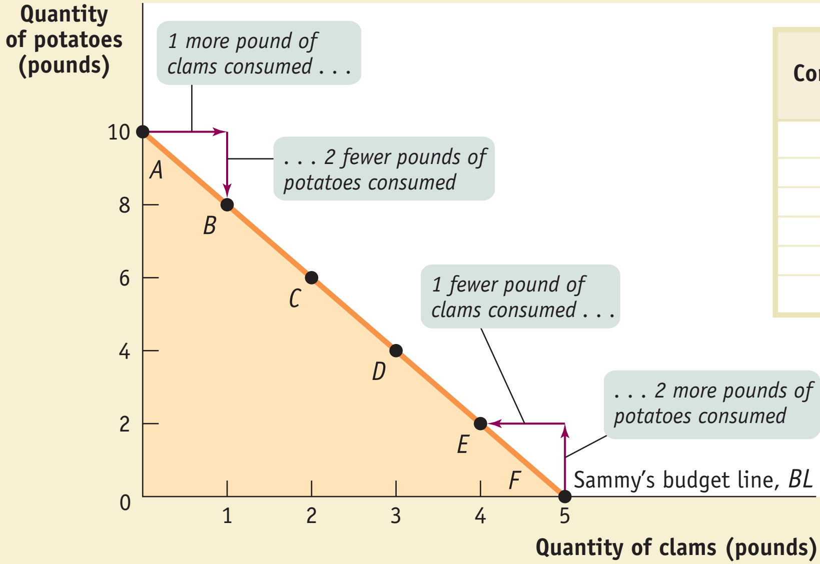
Consumers always have limited income, which constrains how much they can consume. So the requirement illustrated by Equation 10-1—that a consumer must choose a consumption bundle that costs no more than his or her total income—is known as the consumer's **budget constraint.** It's a simple way of saying that consumers can't spend more than the total amount of income available to them. In other words, consumption bundles are affordable when they obey the budget constraint. We call the set of all of Sammy's affordable consumption bundles his **consumption possibilities.** As we will see, which consumption bundles are in this set depends on the consumer's income and the prices of goods and services.

Figure 10-2 shows Sammy's consumption possibilities. The quantity of clams in his consumption bundle is measured on the horizontal axis and the quantity of potatoes on the vertical axis. The downward-sloping line connecting points *A* through *F* shows which consumption bundles are affordable and which are not. Every bundle on or inside this line (the shaded area) is affordable; every bundle outside this line is unaffordable. As an example of one of the points, let's look at point *C*, representing 2 pounds of clams and 6 pounds of potatoes, and check whether it satisfies Sammy's budget constraint. The cost of bundle *C* is 6 pounds of potatoes × \$2 per pound + 2 pounds of clams × \$4 per pound = \$12 + \$8 = \$20. So bundle *C* does indeed satisfy Sammy's budget constraint: it costs no more than his weekly income of \$20. In fact, bundle *C* costs exactly as much as Sammy's income. By doing the arithmetic, you can check that all the other points lying on the downward-sloping line are also bundles at which Sammy spends all of his income.

A consumer's **budget line** shows the consumption bundles available to a consumer who spends all of his or her income.

The downward-sloping line has a special name, the **budget line.** It shows all the consumption bundles available to Sammy when he spends all of his income. Let's use

## Figure 10-2 The Budget Line




| Consumption bundle | Quantity of clams (pounds) | Quantity of potatoes (pounds) |
|---|---|---|
| *A* | 0 | 10 |
| *B* | 1 | 8 |
| *C* | 2 | 6 |
| *D* | 3 | 4 |
| *E* | 4 | 2 |
| *F* | 5 | 0 |

The *budget line* represents all the possible combinations of quantities of potatoes and clams that Sammy can purchase if he spends all of his income. Also, it is the boundary between the set of affordable consumption bundles (the *consumption possibilities*) and unaffordable ones. Given that clams cost $4 per pound and potatoes cost $2 per pound, if Sammy spends all of his income on clams (bundle *F*), he can purchase 5 pounds of clams; if he spends all of his income on potatoes (bundle *A*), he can purchase 10 pounds of potatoes. The slope of the budget line here is –2: 2 pounds of potatoes must be forgone for 1 more pound of clams, reflecting the opportunity cost of clams in terms of potatoes. So the location and slope of the budget line depend on the consumer's income and the prices of the goods.

Figure 10-2 to gain an intuitive understanding of Sammy's budget line. For brevity's sake, we will denote the quantity of clams (in pounds) by $Q_C$ and the quantity of potatoes (in pounds) by $Q_P$. We will also define $P_C$ to be the price of one pound of clams, $P_P$ to be the price of one pound of potatoes, and $N$ to be Sammy's income. So if we restate Sammy's budget constraint of Equation 10-1 in terms of this new notation, it becomes

**(10-2)** $(Q_C \times P_C) + (Q_P \times P_P) \leq N$

Whenever Sammy consumes a bundle on his *budget line,* he spends all of his income, so that his expenditure on clams and potatoes is exactly equal to his income. The equation for Sammy's budget line is therefore

**(10-3)** $(Q_C \times P_C) + (Q_P \times P_P) = N$

Now consider what happens when Sammy spends all \$20 of his income on clams (that is, $Q_P = 0$). In that case the greatest amount of clams he can consume is

$$Q_C = N/P_C = \$20/\$4 \text{ per pound of potatoes} = 5 \text{ pounds of clams}$$

So the horizontal intercept of the budget line—Sammy's clam consumption when he consumes zero potatoes—is at point *F*, where he consumes 5 pounds of clams.

Now consider the other extreme consumption choice given that Sammy spends all of his income: Sammy consumes all potatoes and no clams (that is, $Q_C = 0$). Then the greatest amount of potatoes he can consume would be

$$Q_P = N/P_P = \$20/\$2 \text{ per pound of potatoes} = 10 \text{ pounds of potatoes}$$

So the vertical intercept of the budget line—Sammy's potato consumption when he consumes zero clams—is at point A, where he consumes 10 pounds of potatoes.

The remaining four bundles indicated on the budget line—points *B*, *C*, *D*, and *E*—can be understood by considering the trade-offs Sammy faces when spending all of his income. Starting at bundle *A*, consider what happens if Sammy wants to consume 1 pound of clams while still consuming as many pounds of potatoes as possible. Consuming 1 pound of clams, which costs $4, requires that he give up 2 pounds of potatoes, which cost $2 per pound. In order to move 1 unit to the right (an increase of 1 pound of clams), Sammy must also move 2 units down (a decrease of 2 pounds of potatoes). This places him at bundle *B* on his budget line.

Similarly, if we start at bundle *F* and allow Sammy to give up 1 pound of clams (moving 1 unit to the left), how many pounds of potatoes will he receive in return? Giving up 1 pound of clams frees up $4 of Sammy's income, which goes to purchase 2 pounds of potatoes at $2 per pound. So by moving 1 unit to the left from bundle *F*, Sammy also moves up 2 units, putting him at bundle *E* on his budget line.

This exercise shows that when Sammy spends all of his income, he trades off more clams for fewer potatoes, or vice versa, by "sliding" along his budget line. In particular, if we assume that Sammy can consume fractions of pounds of clams and potatoes as well as whole pounds, his budget line is indeed the line connecting the points *A* through *F* in Figure 10-2.

Do we need to consider the other bundles in Sammy's consumption possibilities, the ones that lie *within* the shaded region in Figure 10-2 bounded by the budget line? The answer is, for all practical situations, no: as long as Sammy doesn't get satiated—that is, his marginal utility from consuming either good is always positive—and he doesn't get any utility from saving income rather than spending it, then he will always choose to consume a bundle that lies on his budget line.

Because changing a consumption bundle involves sliding up or down the budget line, the *slope* of the budget line tells us the opportunity cost of each good in terms of the other. Recall from Chapter 2 that we used the slope of the production possibility frontier to illustrate the opportunity cost to the economy of an additional unit of one good in terms of how much of the other good must be forgone, a cost that arose from the economy's limited productive resources. In this case, the slope of the budget line illustrates the opportunity cost to an individual of consuming one more unit of one good in terms of how much of the other good in his or her consumption bundle must be forgone. The scarce "resource" here is money—the consumer has a limited budget.

The slope of Sammy's budget line—the rise over run—is –2; 2 pounds of potatoes must be forgone to obtain another pound of clams. Economists call the number of pounds of potatoes that must be forgone in order to obtain one more pound of clams the *relative price* of one pound of clams in terms of potatoes. The relative price of the good on the horizontal axis in terms of the good on the vertical axis is equal to minus the slope of the budget line.

One important point about the budget line may be obvious but nonetheless needs emphasizing: the position of a consumer's budget line—how far *out* it is from the origin—depends on that consumer's income. Suppose that Sammy's income were to rise to $32 per week. Then he could afford to buy 8 pounds of clams, or 16 pounds of potatoes, or any consumption bundle in between; as shown in Figure 10-3, his budget line would move *outward*. However, if his income were to shrink to $12 per week, his budget line would shift *inward:* he would be able to consume at most 3 pounds of clams or 6 pounds of potatoes. In all these cases, the slope of the budget line would not change because the relative price of clams in terms of potatoes does not change: for 1 more pound of clams, Sammy still has to give up 2 pounds of potatoes.

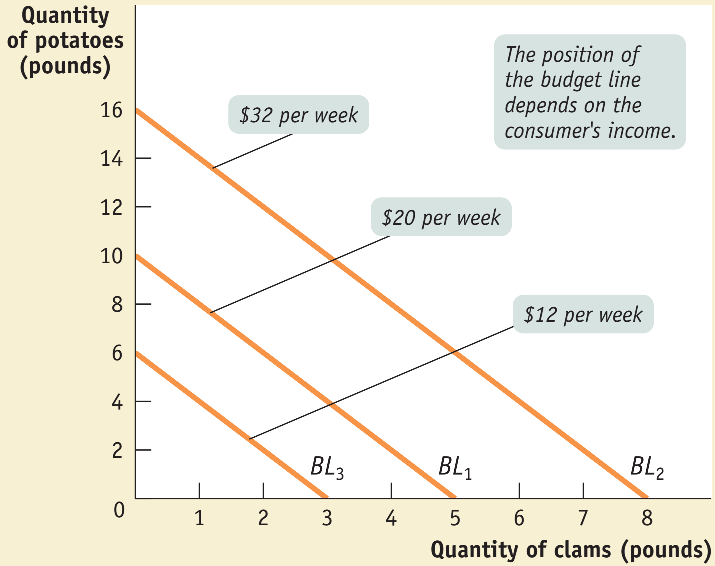
Clearly, a larger income would increase Sammy's consumption possibilities; and utility analysis can tell us how he would take advantage of those possibilities to increase his total utility by consuming more of one or both goods. Conversely, a smaller income would reduce Sammy's consumption possibilities. He would be forced to consume less, and his utility would be lower. But for now let's continue to assume that Sammy's income is fixed at $20 per week.

Given that $20 per week budget, what point on his budget line will Sammy choose?

**Figure 10-3**

### Changes in Income Shift the Budget Line

If Sammy's income increases from \$20 to \$32 per week, he is clearly better off: his consumption possibilities have increased, and his budget line shifts, from $BL_1$, outward to its new position at $BL_2$. If Sammy's income decreases from \$20 to \$12, he is clearly worse off: his consumption possibilities have decreased and his budget line shifts inward toward the origin, from $BL_1$ to $BL_3$. >web...




## Optimal Consumption Choice

The **optimal consumption bundle** is the consumption bundle that maximizes a consumer's total utility given his or her bud-get constraint.

Because Sammy has a budget constraint, which means that he will consume a consumption bundle on the budget line, a choice to consume a given quantity of clams also determines his potato consumption, and vice versa. We want to find the consumption bundle—the point on the budget line—that maximizes Sammy's total utility. This bundle is Sammy's **optimal consumption bundle,** the consumption bundle that maximizes total utility given the budget constraint.

Table 10-1 shows how much utility Sammy gets from different levels of consumption of clams and potatoes, respectively. According to the table, Sammy has a healthy appetite; the more of either good he consumes, the higher his utility.

But because he has a limited budget, he must make a trade-off: the more pounds of clams he consumes, the fewer pounds of potatoes, and vice versa. That is, he must choose a point on his budget line.

Table 10-2 shows how his total utility varies as he slides down his budget line. Each of six possible consumption bundles, *A* through *F* from Figure 10-2, is given in the first col-

**TABLE 10-1**

**Sammy's Utility from Clam and Potato Consumption**

| Utility from clam consumption | | Utility from potato consumption | |
|---|---|---|---|
| **Quantity of clams (pounds)** | **Utility from clams (utils)** | **Quantity of potatoes (pounds)** | **Utility from potatoes (utils)** |
| 0 | 0 | 0 | 0 |
| 1 | 15 | 1 | 11.5 |
| 2 | 25 | 2 | 21.4 |
| 3 | 31 | 3 | 29.8 |
| 4 | 34 | 4 | 36.8 |
| 5 | 36 | 5 | 42.5 |
| | | 6 | 47.0 |
| | | 7 | 50.5 |
| | | 8 | 53.2 |
| | | 9 | 55.2 |
| | | 10 | 56.7 |

**TABLE 10-2**

**Sammy's Budget and Total Utility**

| Consumption Bundle | Quantity of clams (pounds) | Utility from clams (utils) | Quantity of potatoes (pounds) | Utility from potatoes (utils) | Total utility (utils) |
|---|---|---|---|---|---|
| *A* | 0 | 0 | 10 | 56.7 | 56.7 |
| *B* | 1 | 15 | 8 | 53.2 | 68.2 |
| *C* | 2 | 25 | 6 | 47.0 | 72.0 |
| *D* | 3 | 31 | 4 | 36.8 | 67.8 |
| *E* | 4 | 34 | 2 | 21.4 | 55.4 |
| *F* | 5 | 36 | 0 | 0 | 36.0 |

umn. The second column shows the level of clam consumption corresponding to each choice. The third column shows the utility Sammy gets from consuming those clams. The fourth column shows the quantity of potatoes Sammy can afford *given* the level of clam consumption; this quantity goes down as his clam consumption goes up, because he is sliding down the budget line. The fifth column shows the utility he gets from consuming those potatoes. And the final column shows his *total utility*. In this example, Sammy's total utility is the sum of the utility he gets from clams and the utility he gets from potatoes.

Figure 10-4 illustrates the result graphically. Panel (a) shows Sammy's budget line, to remind us that when he decides to consume more clams he is also deciding to consume fewer potatoes. Panel (b) then shows how his total utility depends on that choice. The horizontal axis in panel (b) has two sets of labels: it shows both the quantity of clams, increasing from left to right, and the quantity of potatoes, increasing from right to left. The reason we can use the same axis to represent consumption of both goods is, of course, the budget line: the more pounds of clams Sammy consumes, the fewer pounds of potatoes he can afford, and vice versa.

Clearly, the consumption bundle that makes the best of the trade-off between clam consumption and potato consumption, the optimal consumption bundle, is the one that maximizes Sammy's total utility. That is, Sammy's optimal consumption bundle puts him at the top of the total utility curve.

As always, we can find the top of the curve by direct observation. We can see from Figure 10-4 that Sammy's total utility is maximized at point C—that his optimal con-

**Figure 10-4**

## Optimal Consumption Bundle

Panel (a) shows Sammy's budget line and his six possible consumption bundles. Panel (b) shows how his total utility is affected by his consumption bundle, which must lie on his budget line. The quantity of clams is measured from left to right on the horizontal axis, and the quantity of potatoes is measured from right to left. His total utility is maximized at bundle *C*, where he consumes 2 pounds of clams and 6 pounds of potatoes. This is Sammy's *optimal consumption bundle*. >web...

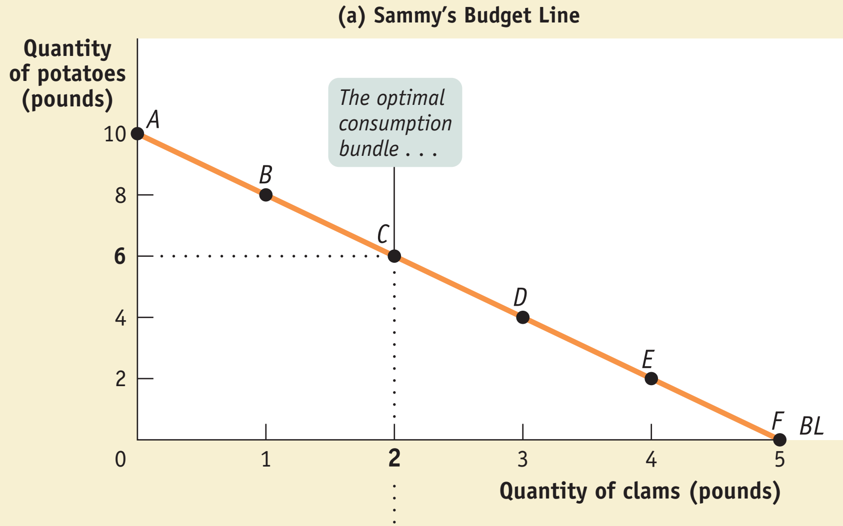
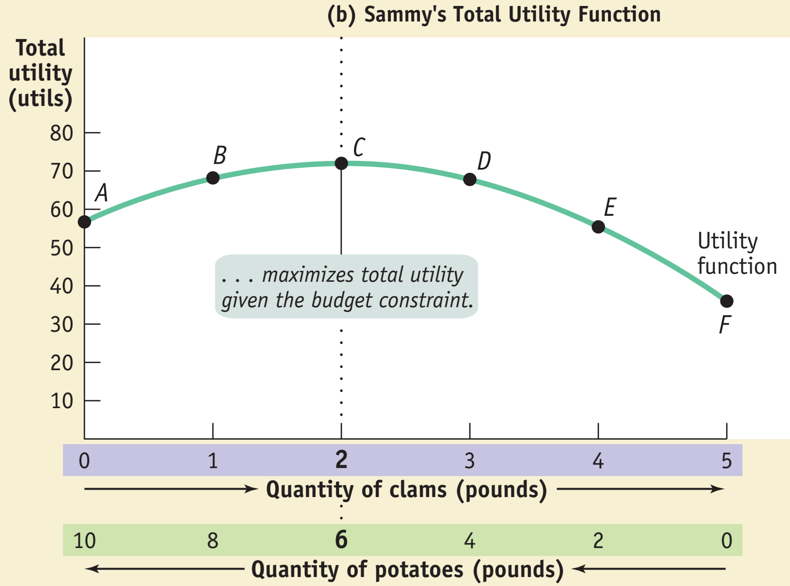


**Figure 10-4** **(continued)**




sumption bundle contains 2 pounds of clams and 6 pounds of potatoes. But we know that we usually gain more insight into "how-much" problems when we use marginal analysis. So in the next section we turn to representing and solving the optimal consumption choice problem with marginal analysis. ■