Consumers in the Marketplace

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For over a century, from 1888 until 1991, New Yorkers and Philadelphians by the tens of millions took their meals at Horn and Hardart—a chain of "automats," or cafeterias, where every wall is a giant vending machine dispensing everything from hot baked beans to cold egg salad sandwiches.[1]

One of Horn and Hardart's trademark offerings was the five-cent cup of coffee. So it was big news in 1950 when the price of coffee rose to ten cents. Sales immediately fell from 70 million cups a year to 45 million.

The automat appealed to the new breed of white collar workers who came to dominate city work forces in the early part of the twentieth century, when the number of typists and stenographers in the United States mushroomed from 5,000 to 300,000 over thirty years. They were clean, inexpensive, and fun. The playwright Neil Simon recalls that for a child, being given a handful of nickels and the chance to choose your own meal was a lesson in finance that "not even two years at the Wharton School could buy today."

By the 1990s, Horn and Hardart's day had passed. An increasingly prosperous workforce sought more exotic lunchtime choices. In 1991, the last of the 89 automats closed its doors for good.

The history of Horn and Hardart illustrates the way consumption decisions change as a function of price and income. Raise the price of coffee and people want less of it. Raise people's incomes and they'll opt for different kinds of food.

Of course, we already learned in Chapter 1 that when the price goes up the quantity demanded goes down. And we learned in Chapter 3 that when the price goes up, the budget line pivots in and consumers choose a new consumption point. Those are two different stories about what happens when a price goes up, and we have to reconcile them.

[1]The information that follows is from *The Automat: The History, Recipes and Allure of Horn and Hardart's Masterpiece* by L. Diehl and M. Hardart.

In this chapter, we will do just that by showing how the indifference curves and budget lines of Chapter 3 justify the law of demand that we assumed in Chapter 1—and thus explain the consumer response to a rise in the price of coffee at the automat.

It turns out that *income* changes are a little easier to analyze than *price* changes, so we'll begin by analyzing the effects of income changes in Section 4.1. We'll then turn to the effects of price changes in Sections 4.2 and 4.3. Finally, in Section 4.4, we'll talk about some numerical measures of these effects.

4.1 Changes in Income

In this section, we consider the effects of a change in income. In order to focus on a single good—call it X, which might stand for soft drinks or coffee or eggs—we will use the composite-good convention, lumping together everything except X into a single category called *all other goods.* This allows us to maintain the useful fiction that there are only two goods in the economy: There is X, and there is "all other goods," which we label Y.

Changes in Income and Changes in the Budget Line

Let's think about how your budget line moves when your income rises.

Suppose you start with the *Original* budget line in Exhibit 4.1. You can afford any basket on this budget line, including, for example, the illustrated basket G.

If your income rises by \$5, you can now afford to buy basket G *plus* \$5 worth of good Y. That is, you can afford point H. So point H is on your new budget line.

(If the price of Y is \$1 per unit, then the vertical arrow in Exhibit 4.1 has length 5; if the price of Y is \$2 per unit, then the vertical arrow has length 2½; if the price of Y is 1¢ per unit, then the vertical arrow has length 500.)

More generally, given *any* point on your old budget line, you can add \$5 worth of Y and get a point on your new budget line. So the vertical distance between the two budget lines is always the same "\$5 worth." Because this distance is always the same, it follows that the new budget line is parallel to the original.

A change in income causes a parallel shift of the budget line.

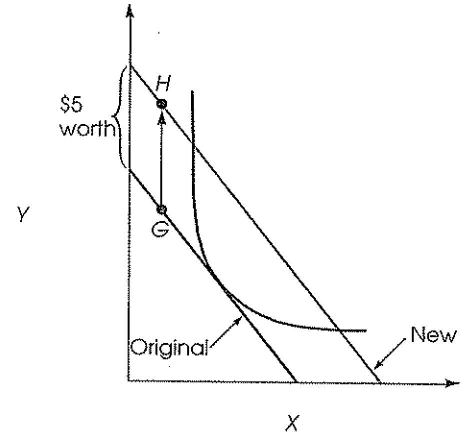
EXERCISE 4.1 Draw the new budget line that would result from a \$5 *fall* in income.

There is another way to see that a change in income causes a parallel shift of the budget line. Recall from Section 3.2 that the equation of the budget line can be written

$$y = -\frac{P_X}{P_Y} \cdot x + \frac{I}{P_Y}$$

so that a change in income (I) does not affect the slope ($-P_X/P_Y$). A change in income affects only the Y-intercept of the budget line, which is another way of saying that a change in income causes a parallel shift.

EXHIBIT 4.1 A Rise in Income



When your income increases by $5, the budget line shifts out parallel to itself. For each point on the original budget line (like G), there is a point on the new budget line (like H) which consists of basket G plus an additional $5 worth of Y.

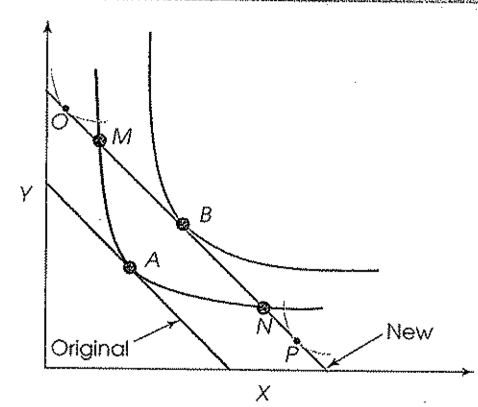
Changes in Income and Changes in the Optimum Point

When your income rises by $5, your budget line shifts out as in Exhibit 4.1. What happens to your optimum point?

In Exhibit 4.2, we suppose that your original optimum point is A, where the original budget line (in black) is tangent to the black indifference curve. Now your income rises by $5, causing your budget line to shift out; the new budget line is shown in color. Where can the new tangency be?

The tangency *cannot* be at point O. Here's why: If an indifference curve were tangent at O, it would be forced to cross the black indifference curve, which cannot happen. (The lightly colored curve shown tangent at O *cannot* be an indifference curve, because it crosses the black indifference curve that is tangent at A.) Likewise, the tangency cannot be at point P. Instead, the tangency must occur somewhere between points M and N on the new budget line, at a point like B.

EXHIBIT 4.2 A Rise in Income



An increase in income causes the budget line to shift outward. If the original tangency is at A, then the new tangency cannot be at O or P, as either possibility would require two indifference curves to cross. (The curves that are shown tangent at these points cannot be indifference curves because they must cross the original black indifference curve.) Instead, the new tangency is at a point like B.

Normal and Inferior Goods

If point B is located as in Exhibit 4.2, then a rise in income causes your consumption of X to rise. This is because point B is to the right of point A, and so corresponds to a basket with more X.

But alternative pictures are possible. Exhibit 4.3 shows two possibilities. Point B could be to the right of A, as in the first panel, or point B could be to the left of A, as in the second panel. In the first case, a rise in income leads you to consume more X, and we say that X is a **normal good**. In the second case, a rise in income leads you to consume *less* X, and we say that X is an **inferior good**.

Normal good A good that you consume more of when your income rises.

Inferior good A good that you consume less of when your income rises.

For example, it is entirely likely that if your income rises, you will consume less Hamburger Helper. That makes Hamburger Helper an inferior good.

> The word *inferior* is used differently here than in ordinary English. In ordinary English, *inferior* is a term of comparison; you can't call something inferior without saying what it is inferior to; as a student, you can be inferior to some of your classmates and superior to others. But in economics, a good either is or is not inferior, and inferiority does not have the negative connotations that it has in everyday speech.

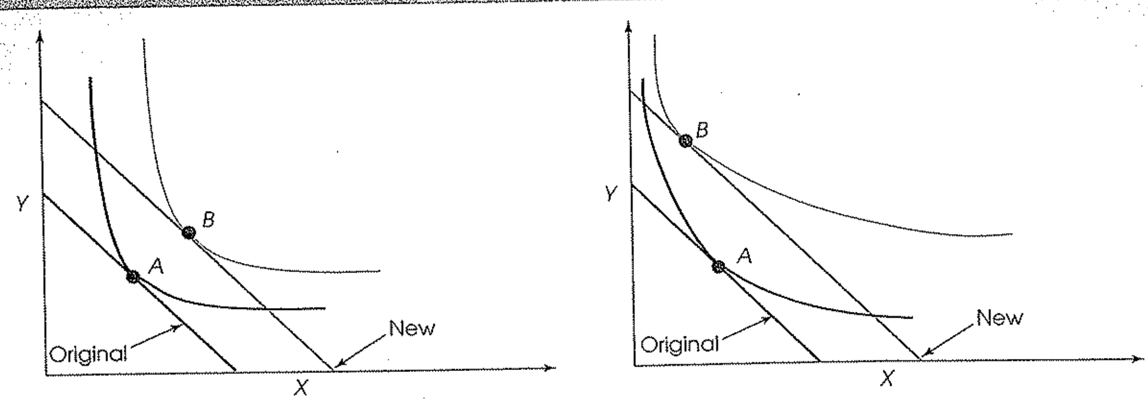
EXERCISE 4.2 In the first panel of Exhibit 4.3, is Y an inferior good? What about in the second panel? Where must the tangency B be located if Y is an inferior good?

The Engel Curve

Engel curve A curve showing, for fixed prices, the relationship between income and the quantity of a good consumed.

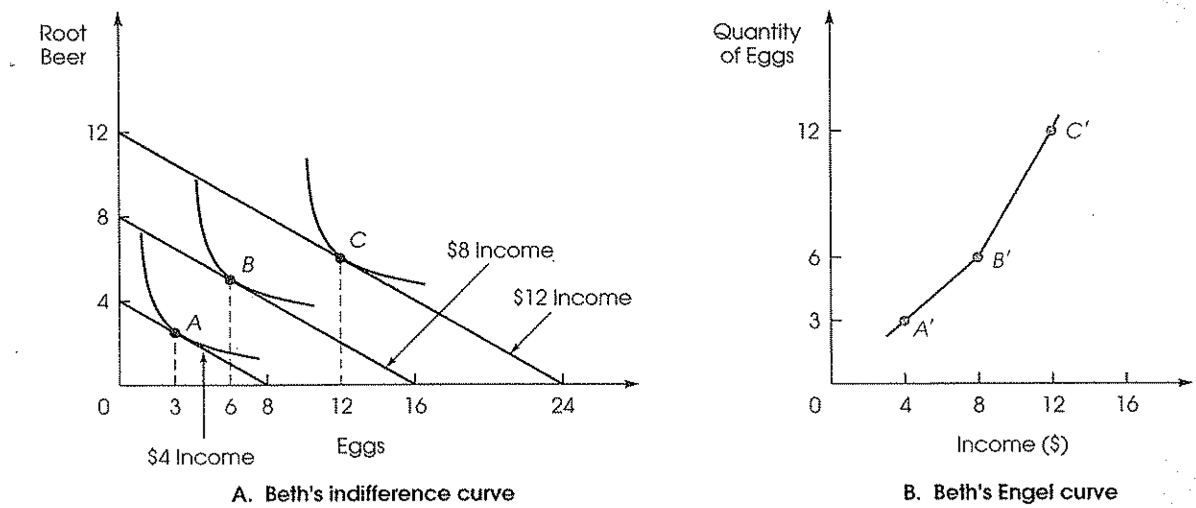
Beth is a consumer who buys eggs and root beer. Her **Engel curve** for eggs is a graph that shows how many eggs she'll consume at each level of income. You can see her Engel curve in the second panel of Exhibit 4.4.

EXHIBIT 4.3 Normal and Inferior Goods



Suppose your original tangency is at A and your income increases. Then your new tangency B could be either to the right of A (as in the first panel) or to the left of A (as in the second panel). In the first case, a rise in income leads you to consume more X and we call X a normal good. In the second case, a rise in income leads you to consume less X and we call X an inferior good.

EXHIBIT 4.4 Constructing the Engel Curve



Points *A*, *B*, and *C* in the first panel show Beth's optima at a variety of incomes. (The prices of eggs and root beer are held fixed at 50¢ and $1, respectively). Points *A′*, *B′*, and *C′* in the second panel record the quantity of eggs that Beth consumes for each of three incomes; these quantities are the horizontal coordinates of points *A*, *B*, and *C*. The curve through *A′*, *B′*, and *C′* is Beth's Engel curve for eggs.

When her income is $4, she consumes 3 eggs; when her income is $8, she consumes 6 eggs, and so on.

It turns out that if we know the prices of eggs and root beer, and if we know Beth's indifference curves, then we can *figure out* the coordinates of the points on her Engel curve. For example, suppose we know that the price of an egg is 50¢, the price of a root beer is $1, and Beth's indifference curves are the curves shown in Exhibit 4.4A.

To construct a point on Beth's Engel curve, we follow a five-step process:

1. Imagine an income for Beth—say, $4.
2. Draw the corresponding budget line. In this case, given our assumptions about the prices of eggs and root beer, Beth can afford up to 8 eggs (with no root beer) or 4 root beers (with no eggs). Therefore, her budget line is the one labeled "$4 income" in Exhibit 4.4A.
3. Find the tangency between this budget line and an indifference curve. (We can do this because we've assumed that we *know* Beth's indifference curves.) In this case, the tangency occurs at point A.
4. Read off the corresponding quantity of eggs—in this case, 3.
5. Plot the point on the Engel curve, relating the income in step 1 to the quantity in step 4. In this case, we get the point A′ = ($4, 3), illustrated in Exhibit 4.4B.

To get *another* point on Beth's Engel curve, repeat the entire five-step process, beginning with a different income. If you imagine the income $8 in step 1, you'll be led to the quantity 6 in step 4, and you'll plot the point *B′* in step 5.

EXERCISE 4.3

Explain how to derive the coordinates of point *C′* in Exhibit 4.4B.

The moral of this story is that *the Engel curve contains no information that is not already encoded in the indifference curve diagram.* Once we know the indifference curves, we can generate the Engel curve by a purely mechanical process.

The Shape of the Engel Curve

The Engel curve in Exhibit 4.4B is upward sloping. In other words, when Beth's income rises, she consumes more eggs. Thus, eggs are a normal good for Beth.

In general, the Engel curve will slope upward for a normal good and downward for an inferior good. If eggs were an inferior good for Beth, then the tangency B in Exhibit 4.4A would occur somewhere to the *left* of the tangency A—say, with a horizontal coordinate of 2. This would yield the point $B' = (\$8, 2)$ in Exhibit 4.4B, and the curve through A' and B' would slope downward.

4.2 Changes in Price

We now shift our attention from changes in income to changes in the price of X.

Changes in Price and Changes in the Budget Line

To focus attention on changes in the price of X, we assume that your income and the price of Y remain fixed. For example, suppose the price of Y remains fixed at \$3 per unit and your income remains fixed at \$24. Exhibit 4.5 shows the budget lines that result when the price of X is \$2, \$3, and \$6.

EXERCISE 4.4 Verify that the budget lines have been drawn correctly.

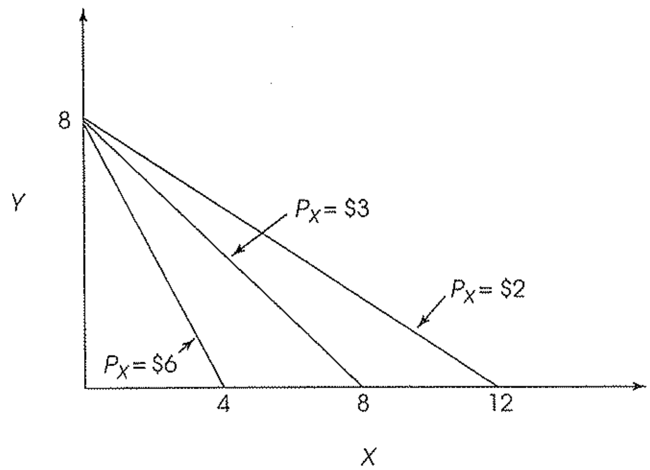
There are two important things to notice in Exhibit 4.5. First, a change in the price of X has no effect on the Y-intercept of the budget line. When you buy zero Xs, you can always afford exactly 8 Ys, regardless of what happens to the price of X. Thus:

A change in the price of X causes the budget line to pivot around its Y-intercept.

The second important thing to notice is the direction in which the budget line pivots. When the price of X is low (like \$2), the budget line extends out to a high quantity of X (in this case, 12); when the price of X is high (like \$6), the budget line extends out only to a low quantity of X (in this case, 4). Thus:

A rise in the price of X causes the budget line to pivot inward. A fall in the price of X causes the budget line to pivot outward.

EXHIBIT 4.5 Changes in the Price of X



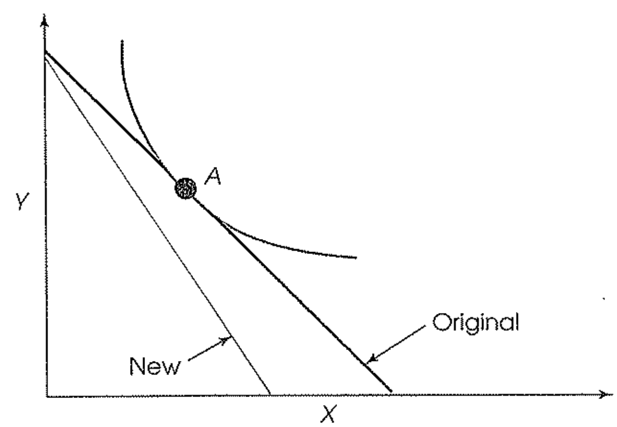
The price of Y is fixed at \$3 and income is fixed at \$24. A rise in the price of X causes the budget line to pivot inward around its Y-intercept, and a fall in price causes the budget line to pivot outward around its Y-intercept.

Changes in Price and Changes in the Optimum Point

When the price of X rises, your budget line pivots inward, as shown in Exhibit 4.6.

The geometry of Exhibit 4.6 places no restrictions on the location of the new optimum point; it could be anywhere at all on the new budget line. Now we're going to think a little more deeply about the location of that new optimum.

EXHIBIT 4.6 A Price Increase



A rise in price causes the budget line to pivot inward. The original optimum is at A, and the new optimum could be anywhere at all on the new (brown) budget line.

Giffen good A good that violates the law of demand, so that when the price goes up, the quantity demanded goes up.

Non-Giffen good A good that obeys the law of demand: When the price goes up, the quantity demanded goes down.

Giffen and Non-Giffen Goods

Exhibit 4.7 illustrates two possibilities. In both cases, a rise in the price of X causes the optimum point to shift from A to B. In the first panel, B lies to the left of A; in the second panel, B lies to the right of A.

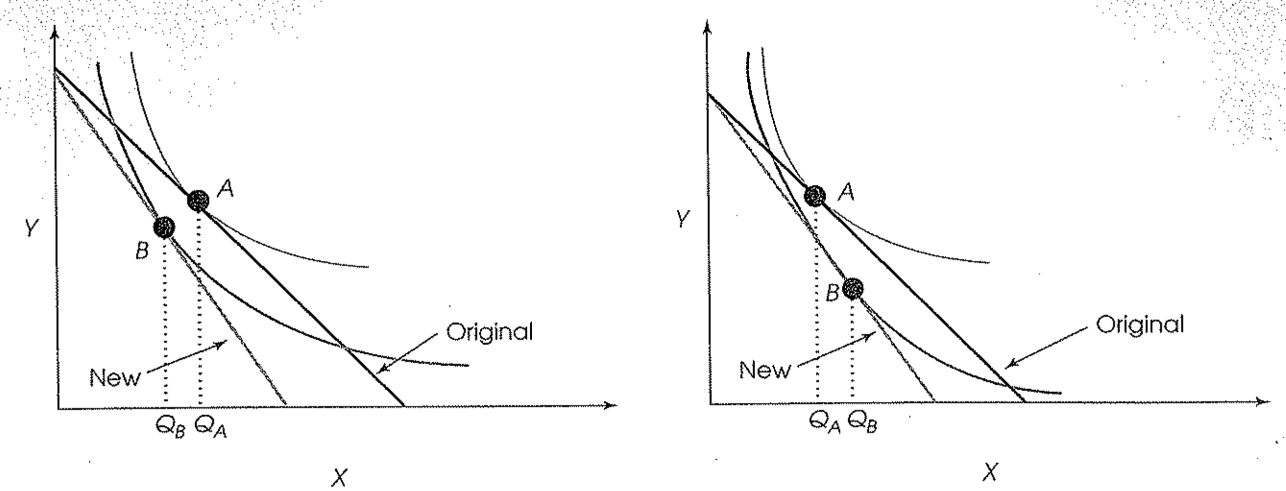
In the first panel, you can see that when the price of X goes up, the quantity demanded goes down (from Q_A to Q_B). That statement should sound familiar; it is the same law of demand that we met in Chapter 1.

In the second panel, you can see that when the price of X goes up, the quantity demanded goes *up*! In this case, X violates the law of demand.

Goods that violate the law of demand (like good X in the second panel of Exhibit 4.7) are called **Giffen goods**. Goods that obey the law of demand (like good X in the first panel of Exhibit 4.7) are called **non-Giffen goods**.

> Do not confuse the question "Is X Giffen?" with the question "Is X inferior?" To determine whether X is inferior, you must ask what happens when *income* changes, so that the budget line undergoes a parallel shift (as in the two panels of Exhibit 4.3). To determine whether X is Giffen, you must ask what happens when the price of X changes, so that the budget line pivots around its Y-intercept, as in the two panels of Exhibit 4.7.

EXHIBIT 4.7 Non-Giffen Goods and Giffen Goods



When the price of X goes up, the budget line pivots inward. The optimum moves from point A to point B and the quantity of X that you demand changes from Q_A to Q_B. In the first panel, Q_B is less than Q_A; in other words "when the price goes up the quantity demanded goes down," as required by the law of demand. In the second panel, Q_B is greater than Q_A, so that "when the price goes up the quantity demanded goes *up*," in violation of the law of demand. When the law of demand is violated, X is called a Giffen good.

In the panels of Exhibit 4.7, it is not possible to tell by inspection whether Y is a Giffen good. To determine whether Y is Giffen, we have to ask what happens to the consumption of Y when there is a change in the price of Y. But the graphs in Exhibit 4.7 illustrate a change in the price of X, not a change in the price of Y.

EXERCISE 4.5

Draw a graph illustrating how the budget line shifts when the price of *Y* rises. Draw the original optimum. Where is the new optimum located if *Y* is not a Giffen good? Where is the new optimum located if *Y* is a Giffen good?

A Puzzle: Why Are Giffen Goods So Rare?

Giffen goods are extremely uncommon; in fact, they are so uncommon that the author of your textbook does not know of a single actual instance. That's why the law of demand is called a *law*—it is virtually always obeyed.

The theory of indifference curves tells us that there *can* be exceptions to the law of demand—in other words, it is possible to draw a picture like the second panel of Exhibit 4.7. But experience tells us that although such exceptions are possible, they are either extremely rare or completely nonexistent. And therein lies a puzzle. If the theory allows Giffen goods to exist, why don't they?

We will return to this puzzle—and solve it—near the end of Section 4.3.

The Demand Curve

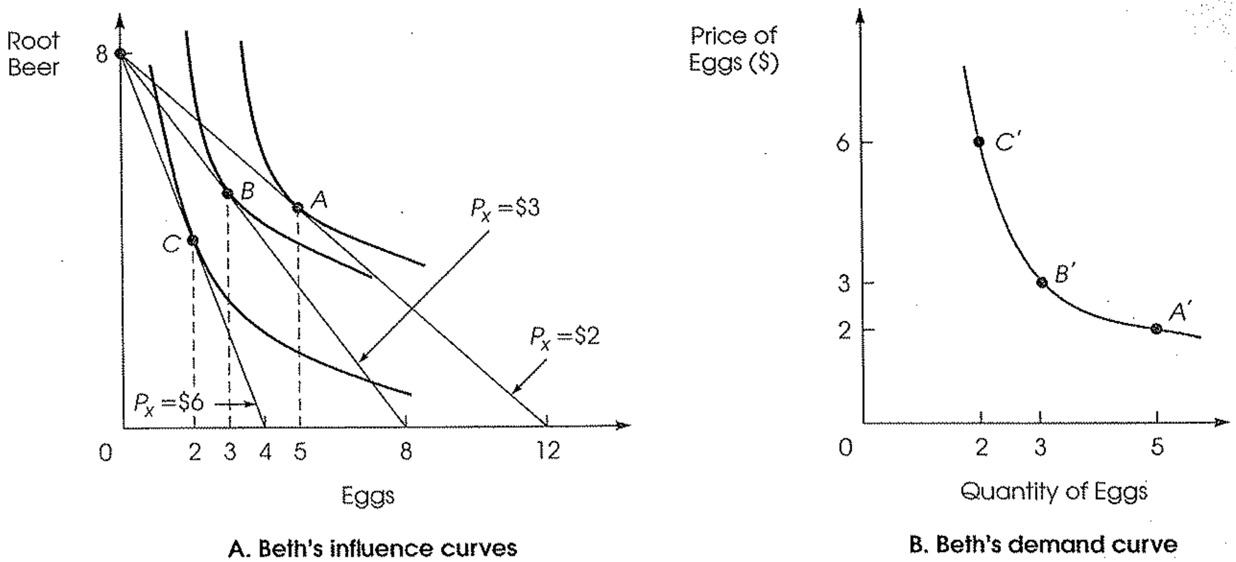
Let us return our attention to Beth, who buys eggs and root beer. Just as Beth's Engel curve shows the relation between her income and her egg consumption, so her demand curve shows the relation between the price of eggs and her egg consumption.

The Engel curve plots income on the horizontal axis versus egg consumption on the vertical; the demand curve plots the price of eggs on the vertical axis versus egg consumption on the horizontal.

Like the Engel curve, the demand curve can be derived from the indifference curve diagram. If we know Beth's income, the price of root beer, and her indifference curves, then we can construct her demand curve for eggs.

The process is illustrated in Exhibit 4.8, where we assume that the price of root beer is \$3 and Beth's income is \$24; thus, the vertical intercept of her budget line is at 8 root beers.

EXHIBIT 4.8 Constructing the Demand Curve



When the price of eggs is \$2 apiece, Beth chooses basket A, with 5 eggs. This information is recorded by point A' in the second panel. Points B', and C' are derived similarly. The curve through A', B', and C' is Beth's demand curve for eggs.

To construct a point on Beth's demand curve, we follow a five-step process:

1. Imagine a price for eggs—say, \$2.
2. Draw the corresponding budget line. Given our assumption that Beth's income is \$24, she can afford up to 12 eggs (with no root beer). Thus, her budget line has horizontal intercept 12, as illustrated in Exhibit 4.8A.
3. Find the tangency between this budget line and an indifference curve. In this case, the tangency occurs at point A.
4. Read off the corresponding quantity of eggs—in this case, 5.
5. Plot a point on the demand curve relating the price in step 1 to the quantity in step 4. In this case we get the point A' in Exhibit 4.8B.

To get *another* point on Beth's demand curve, repeat the entire five-step process, beginning with a different price for eggs. If you imagine the price \$3 in step 1, you'll be led to the quantity 3 in step 4, and you'll plot the point B' in step 5.

EXERCISE 4.6 Explain how to derive the coordinates of point C' in Exhibit 4.8B.

As with the Engel curve, we now know that *the demand curve contains no information that is not already encoded in the indifference curve diagram.* Once we know the indifference curves, we can generate the demand curve by a purely mechanical process.

The Shape of the Demand Curve

In Exhibit 4.8, eggs obey the law of demand; therefore, the demand curve for eggs slopes down. If eggs were a Giffen good, then the tangency B would be to the *right* of A, say, at a quantity of 7. Then the point B' on the demand curve would have horizontal coordinate 7 and the demand curve would slope upward.

> Students sometimes attempt to draw the demand curve and the indifference curves on the same graph. This cannot be done correctly because the two diagrams require different axes (quantities of goods X and Y for the indifference curves; quantity and price of good X for the demand curve).
>
> Other students sometimes think that the labeled points in Exhibit 4.8A illustrate the shape of the demand curve. This is also incorrect. It *is* true that each point on the demand curve arises from a point in the indifference curve diagram, but translating from one diagram to the other is not simply a matter of copying points. The only way to go from one diagram to the other is via the five-step process just described.

4.3 Income and Substitution Effects

We have a puzzle to solve: Why, in the real world, do there seem to be essentially no Giffen goods? It would be very satisfying to answer this question by saying that the geometry of indifference curves makes Giffen goods impossible. Unfortunately, that's not the case. Exhibit 4.7 showed that there is no geometric obstruction to the existence of a Giffen good.

So the solution to our puzzle will require an argument that goes beyond geometry. We will start with a purely verbal discussion of two distinct reasons why the law of demand "ought" to hold. After we've understood these effects in words, we will translate our words into geometry and then tie the two approaches together.

Two Effects of a Price Increase

When the price of a good goes up, we typically expect the quantity demanded to fall. There are two separate, good reasons for this expectation, called the *substitution effect* and the *income effect*.

The Substitution Effect

Suppose you're in the habit of buying 5 hamburgers a day at $2 apiece. If the price goes up to $3 apiece, you might decide that fifth hamburger is simply not worth the money, and therefore cut back to 4 hamburgers a day. That's the **substitution effect of a price increase.**

Substitution effect of a price increase A change in consumption due to the fact that you won't buy goods whose marginal value is below the new price.

To put this a little more precisely: We know that each of your five hamburgers must have a marginal value (to you) of at least $2; otherwise you wouldn't have been buying them all along. But their marginal values are not all identical; the second hamburger is worth less than the first, and the third is worth less than the second. So it's entirely possible that the first four hamburgers are worth more than $3 each (to you) and the fifth hamburger is worth less than $3. That's why you still eat some hamburgers, but not as many as before.

So the substitution effect comes down to this: When the price of a good rises, you adjust your consumption downward so as to avoid buying goods whose price is now above their marginal value.

When the price of a good goes up, the substitution effect leads you to consume less of it.

The Income Effect

Now we will describe the income effect of a price increase.

Suppose the price of hamburgers rises. Then, because you can't spend more than your entire income, you'll have to consume less of *something.* (Another way to say this is that your old basket is outside your new budget line, so you'll have to choose a new basket.) It's then quite likely—though not certain—that hamburgers themselves will be among the goods you cut back on.

We can be more precise about this: The fact that you can no longer afford your original basket is tantamount to a change in *income;* in a very real sense, a price increase makes you *poorer.* When you become poorer, you reduce your consumption of all normal goods, though you increase your consumption of inferior goods.

Income effect of a price increase A change in consumption due to the fact that you can no longer afford your original basket and are therefore effectively poorer.

That's the **income effect of a price increase**: When the price of hamburgers rises, you are effectively poorer and therefore consume either fewer hamburgers (if hamburgers are a normal good) or more hamburgers (if hamburgers are an inferior good).

When the price of a good goes up, the income effect leads you to consume either less of it (this happens if the good is normal) or more of it (this happens if the good is inferior).

Isolating the Substitution Effect: A Hypothetical Scenario

The first panel of Exhibit 4.9 illustrates a rise in the price of candy bars. When the price goes up, Albert's budget line pivots inward (from the *Original* line to the *New* line) and his consumption falls from 8 candy bars a day to 3 candy bars a day—the quantity demanded falls by 5. The demand curve in the bottom panel shows the same thing: When the price rises from its original level to its new level, Albert's consumption falls from 8 to 3. Our immediate goal is to determine how much of that change is due to the substitution effect and how much is due to the income effect.

To accomplish that goal, let's imagine a hypothetical scenario. Suppose Albert walks down to the vending machine and discovers that the price of candy bars has risen. This makes him less happy than he was a moment ago. But now suppose Albert discovers a $5 bill lying on the ground. This makes him *more* happy. And suppose that—just by coincidence—the combination of these two surprises leaves Albert exactly as happy as he was when he woke up this morning.

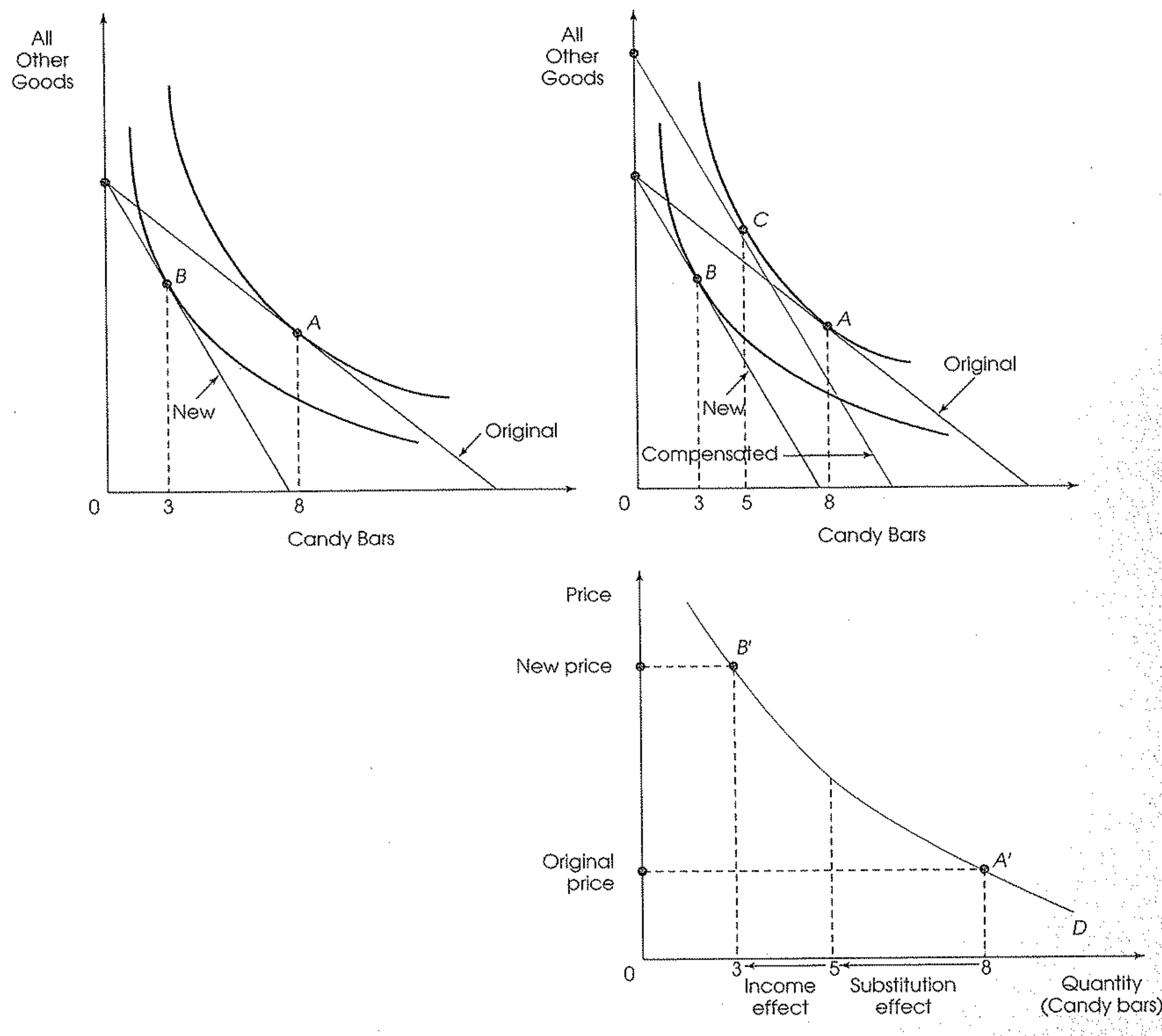
In that hypothetical scenario, Albert feels no income effect. The income effect is the result of "feeling poorer," but Albert—thanks to the

EXHIBIT 4.9 Income and Substitution Effects

When the price of candy bars rises, Albert moves from point A on his *original* budget line to point B on his new budget line. His consumption falls from 8 candy bars to 3. Part of this fall is due to the substitution effect and part is due to the income effect.

In the second panel, we imagine that the price increase is accompanied by an increase in Albert's income, just large enough to make him exactly as happy as he was originally. This gives Albert the *Compensated* budget line, which is parallel to the *New* line (to reflect the new prices) and tangent to the original indifference curve (to reflect Albert's level of happiness). In this case, the income effect is eliminated (leaving only the substitution effect) and Albert moves to point C. Therefore, when the price goes up and Albert moves from A to B, we can imagine the move taking place in two steps: A pure substitution effect (from A to C) followed by a pure income effect (from C to B).

The demand curve in the lower panel illustrates the same conclusions: When the price rises from its original level to its new level, Albert's consumption falls from 8 to 3, partly because of the substitution effect and partly because of the income effect.



$5 he's just found—does not feel poorer at all. Thus the income effect has been eliminated so we can now observe the substitution effect in isolation. Now we will incorporate this idea into our graph.

The second panel of Exhibit 4.9 illustrates the hypothetical scenario. First, Albert discovers that the price of candy bars has risen; this causes his budget line to pivot inward (from the *Original* to the *New*) just as in the first panel. Then, he discovers the $5 bill on the floor. This is a pure increase in income, so it causes his *New* budget line to shift out parallel to itself.

The final position of the budget line is labeled *Compensated* in Exhibit 4.9. Notice that the compensated line is tangent to the original (black) indifference curve. That's because we assumed that the combined changes leave Albert exactly as happy as he was at the beginning, which means he ends up on the same indifference curve he started out on.

> In drawing graphs like the second panel of Exhibit 4.9, students sometimes attempt to make the compensated budget line tangent to the indifference curve at point *A*. This can't be correct because the original budget line is already tangent there. Two different lines cannot be tangent to the same curve at the same point.

Albert ends up at point *C* on the compensated indifference curve. Because we have eliminated the income effect, the move from *A* to *C* is a pure substitution effect. Thus, we can see from the graph that the substitution effect causes Albert to reduce his consumption of candy bars from 8 to 5.

Combining the Effects

Now let's reconsider what happens when the price of candy bars goes up. We know that Albert moves from point *A* to point *B* in each panel of Exhibit 4.9. (We have now discarded the hypothetical scenario and are no longer supposing that Albert gets lucky and finds money on the floor.) The move from *A* to *B* is due partly to the substitution effect and partly to the income effect.

We have already figured out (by imagining the hypothetical scenario) that the substitution effect moves Albert from *A* to *C*. Thus, the remainder of the move—from *C* to *B*—must be due to the income effect. So in this case, our experiment has revealed that when the price of candy bars rises as in the first panel of Exhibit 4.9, Albert cuts out 3 candy bars because of the substitution effect (moving from 8 to 5) and 2 candy bars because of the income effect (moving from 5 to 3), for a total cutback of 5 candy bars.

An Imaginary Experiment

In real life, we rarely get to observe income and substitution effects separately. A rise in price causes both effects to happen simultaneously, and it's generally impossible for an observer to disentangle them. Thus, when Albert discovers the price increase and cuts back from 8 candy bars to 3, it's not at all obvious how much of that cutback we should attribute to each of the effects.

However, in principle, an experimenter can always disentangle the effects by first giving Albert extra income and then taking it away. If you wanted to observe a pure substitution effect, you could leave a $5 bill under the machine for Albert to find, and then watch to see how many candy bars he wants to buy. According to Exhibit 4.9, you'll see him choose 5 (at point *C*). Then, just as he's about to make his selections, you can whisk by him and grab the $5 out of his hand. Now he's returned to his *new* budget line, and he chooses 3 candy bars (at point *B*).

To do this experiment properly, you can't just give Albert a random amount of additional income; you have to give him just enough to compensate him for the price change—that is, just enough to allow him to achieve his original indifference curve.

Notice that the income effect is well named; it occurs because you take away some of Albert's income.

In real life, Albert never gets the extra income. But whenever the price of candy bars goes up, you can *imagine* that Albert first finds, and then loses, some extra income. This lets you imagine that the move from *A* to *B* takes place in two steps, with a stop at *C* along the way. In that way, you can separate the substitution effect from the income effect.

EXERCISE 4.7

Suppose the price of candy bars were to fall. Draw a diagram analogous to Exhibit 4.9 showing how Albert's consumption changes and separating the change into a substitution effect and an income effect. (*Hint:* When the price of candy bars falls, Albert feels happier than before. To eliminate the income effect, you have to "compensate" him negatively, by taking income away until he is no happier than before.)

Why Demand Curves Slope Downward

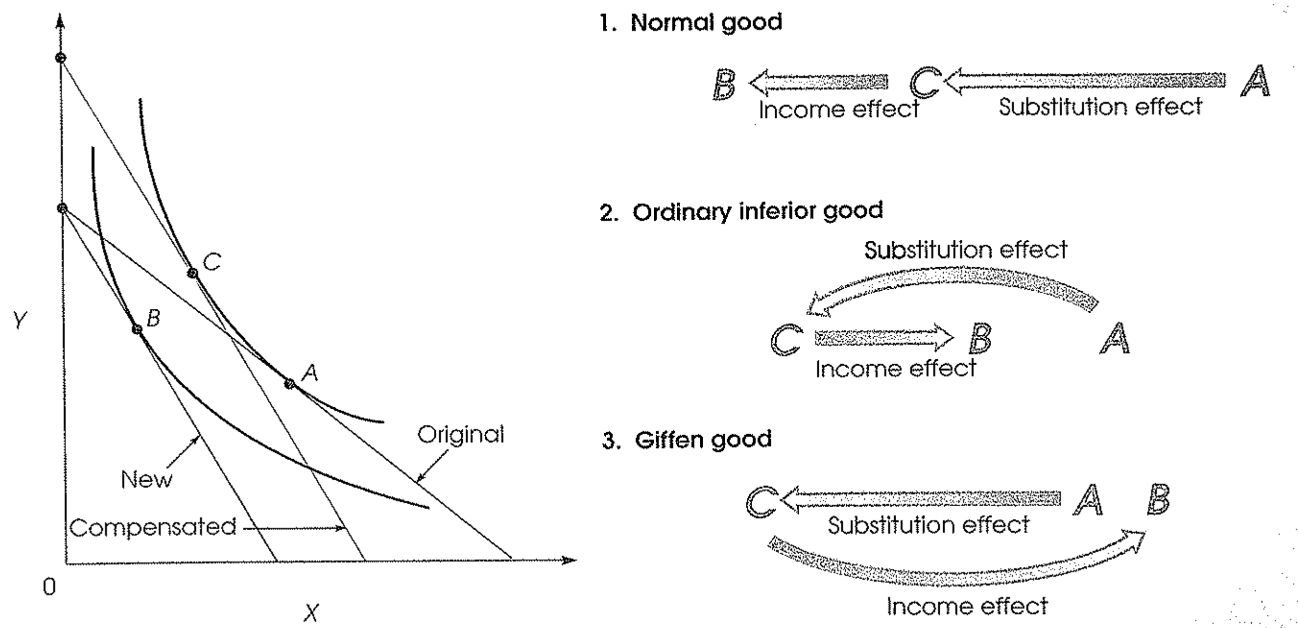
The first panel of Exhibit 4.10 illustrates the income and substitution effects of a rise in the price of *X*. The substitution effect is the move from *A* to *C*, and the income effect is the move from *C* to *B*.

Some Geometric Observations

Here are three key observations about the points in Exhibit 4.10:

1. *C* is always to the left of *A*. Here's why: *C* and *A* are on the same indifference curve, but *C* is the tangency with a steeper line, so *C* must be on a steeper part of the curve. Steeper parts of the curve are always to the left. (Notice that this purely geometric observation is equivalent to something we observed earlier: When the price of a good goes up, the substitution effect always leads you to consume less of it.)
2. If *X* is a normal good, then *B* is to the left of *C*. Here's why: The move from *C* to *B* represents a pure change in income (*C* and *B* are tangencies with parallel budget lines). When you move from the *Compensated* line to the *New* line, income falls, so you consume less *X*; that is, you move to the left.
3. If *X* is an inferior good, then *B* is to the right of *C*. In other words, when income falls, you consume *more* of the inferior good *X*.

EXHIBIT 4.10 Income and Substitution Effects



When the price of X rises, the consumer moves from A to B. This move can be broken down into a substitution effect (from A to C) followed by an income effect (from C to B). The move from A to C is always leftward. If X is normal, the move from C to B is also leftward, so the move from A to B is leftward; therefore, X is not Giffen. If X is inferior, the move from C to B is rightward. This allows two possibilities: Either B is to the left of A (this happens when the income effect is small), so that X is not Giffen, or B is to the right of A (this happens when the income effect is large), so that X is Giffen.

(In Exhibit 4.10, B is drawn to the left of C, so in this case X is a normal good.)

The Demand Curve for a Normal Good

Suppose that X is a normal good. When the price of X goes up, the consumer in Exhibit 4.10 moves from A to B. What is the direction of that move?

We know from the first of our geometric observations that C is to the left of A. Because we've assumed that X is normal, we know from the second observation that B is to the left of C. Using your best IQ-test skills, what can you conclude about the relative positions of A and B?

The answer is revealed in the top row of the right-hand panel in Exhibit 4.10, where you can see that B must be to the left of A. In other words, when the price of X goes up, the quantity demanded goes down. In still other words, X is not a Giffen good. Because this argument applies whenever X is normal, we can summarize our conclusion as follows:

A normal good cannot be Giffen.

We've just discovered something truly remarkable. To say that a good is normal is to say something about the response to an *income* change. To say that a good is Giffen is to say something about the response to a *price* change. There is no obvious reason why these conditions should have anything to do with one another. But our analysis reveals that they are closely related nevertheless: No normal good can ever be Giffen. The demand curve for a normal good is sure to slope downward.

Although we've phrased the argument in terms of geometry, we can translate it into economics. When the price of *X* goes up, the substitution effect (from *A* to *C*) must cause the quantity demanded to fall. At the same time, the income effect (from *C* to *B*) *also* causes the quantity demanded to fall. These effects reinforce each other, and the quantity demanded certainly falls.

The Demand Curve for an Inferior Good

Now suppose that *X* is an inferior good. When the price of *X* goes up, the consumer in Exhibit 4.10 moves from *A* to *B*. What is the direction of that move?

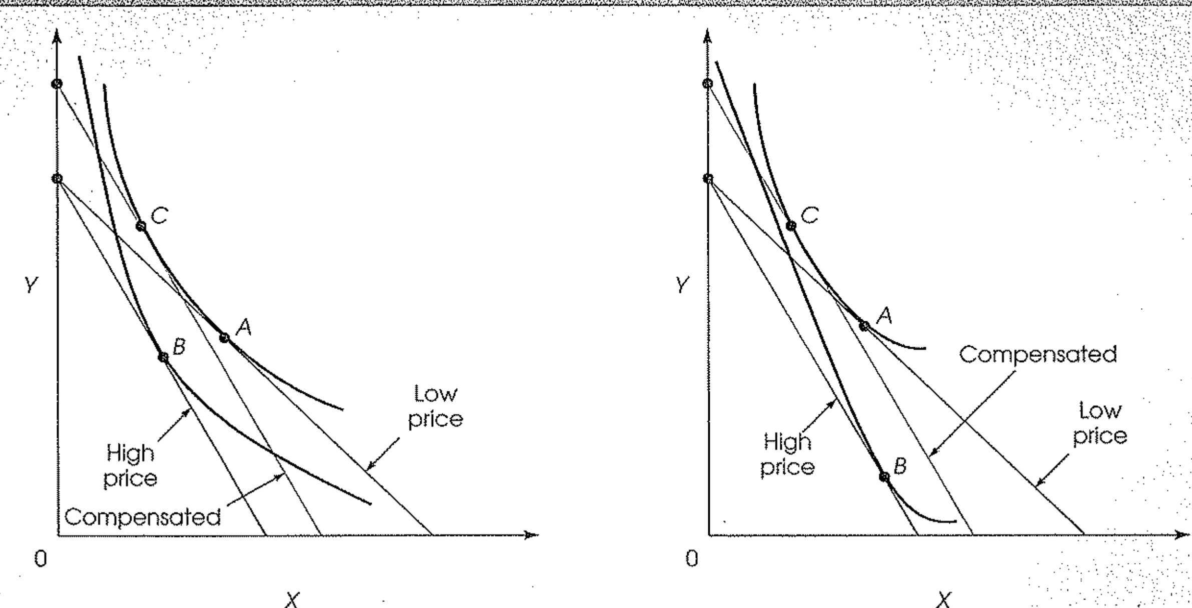
We know from the first geometric observation that *C* is to the left of *A*. Because we've assumed that *X* is inferior, we know from the second observation that *B* is to the right of *C*.

Bringing your IQ-test skills to bear on this problem, you'll quickly discover that you can draw no certain conclusion about the relative locations of points *A* and *B*. There are two possibilities, illustrated in the second and third rows of the right-hand panel in Exhibit 4.10. When the substitution effect is larger than the income effect, *B* is to the left of *A* (so that *X* is not Giffen) but when the income effect is larger than the substitution effect, *B* is to the right of *A* (so that *X* is Giffen).

The two panels of Exhibit 4.11 show that each of these possibilities can occur. Therefore:

An inferior good is non-Giffen if the substitution effect exceeds the income effect, but Giffen if the income effect exceeds the substitution effect.

EXHIBIT 4.11 Income and Substitution Effects for an Inferior Good



In both panels, *X* is an inferior good; that is, *B* is to the right of *C*. In the first panel, *X* is not Giffen; that is, *B* is to the left of *A*. In the second panel, *X* is Giffen; that is, *B* is to the right of *A*.

The economic interpretation is straightforward: When the price of X goes up, the substitution effect (from A to C) causes the quantity demanded to fall. At the same time, the income effect (from C to B) causes the quantity demanded to *rise* (because X is an inferior good). These effects work in opposite directions, so the quantity demanded of X can fall or rise, depending on which effect is bigger.

The Size of the Income Effect

Suppose the price of bubble gum rises. Will you feel slightly poorer or a lot poorer? Unless you are a very unusual person—that is, unless you spend a very substantial portion of your income on bubble gum—you will feel only slightly poorer. Therefore, the income effect, which is caused by that sense of being poorer, is likely to be small.

On the other hand, suppose the price of college tuition rises. Depending on who's paying for your education, there's a good chance you'll now feel quite substantially poorer. If tuition expenses account for a substantial fraction of your income, the income effect might be considerable.

In general, the income effect of a price change is large only for goods that account for a large fraction of your expenditure. The laws of arithmetic dictate that there can't be very many such goods (for example, there can be no more than 3 goods that account for at least $\frac{1}{3}$ of your expenditure). So large income effects are relatively rare.

Giffen Goods Revisited

A Giffen good must satisfy two conditions. First, it must be inferior (because a normal good cannot be Giffen). Second, it must account for a substantial fraction of your expenditure (because an inferior good is Giffen only when the income effect exceeds the substitution effect).

Each of these conditions is unusual. Many goods are inferior, but most are not. And only very few goods can account for substantial fractions of your expenditure. Thus, in order to be Giffen, a good must satisfy *two* unusual conditions at once. This explains why Giffen goods are rare.

> In fact, one can make an even stronger argument. We've said that a randomly chosen good is likely to be normal. But we can also say that if the randomly chosen good accounts for a large fraction of your expenditure, then it's *particularly* likely to be normal. Here's why: When your income increases, you have to spend the excess on something, and the goods on which you spend relatively little are unlikely to soak up much of that excess. For example, if your income rises by \$100 per week, it is unlikely that you'll devote the entire \$100 to bubble gum—to do so would require an implausibly large percentage increase in your bubble gum expenditures. Instead, some of the \$100 will probably go toward the goods that account for the bulk of your expenditure—which means that those goods are probably normal. So not only do Giffen goods have to satisfy two improbable conditions but one of those improbable conditions causes the other to become even *more* improbable.

Here's a hypothetical example. Suppose you eat hamburger six days a week and steak on Sunday; suppose also that hamburger is an inferior good. One day the price of hamburger rises. Because you eat so much hamburger, this makes you feel a lot poorer. Because you are now so much poorer, you decide to cut out steak entirely and eat hamburgers seven days a week. When the price of hamburgers goes up, the quantity demanded goes *up*. In this case, hamburgers are a Giffen good.

For this story to work, hamburgers must be inferior *and* you must spend so much on hamburger that the price increase has a major impact on your lifestyle. The moral of Exhibit 4.10 is that this story about hamburgers is essentially the *only* story that could ever produce a Giffen good.

The Compensated Demand Curve

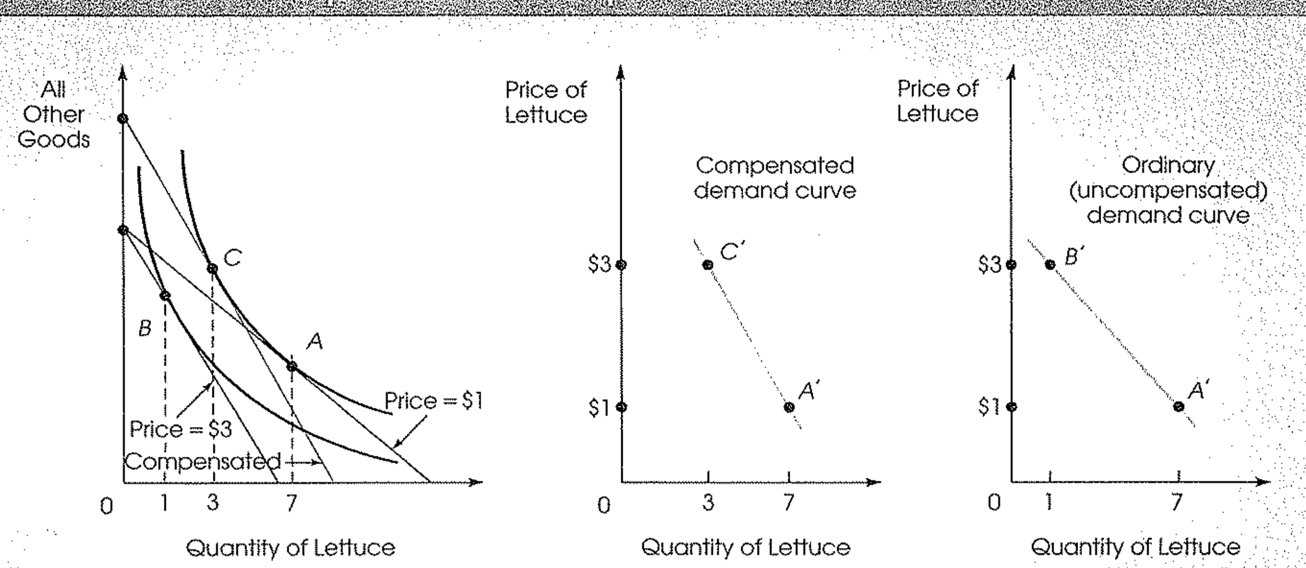
When the price of lettuce rises from $1 to $3, Bugs reduces his consumption from 7 heads of lettuce per day to 1 head of lettuce per day. You can see in the first panel of Exhibit 4.12 that his consumption is reduced from 7 to 3 by the substitution effect and from 3 to 1 by the income effect. Bugs's demand curve, shown in the third panel, records the combined effect by showing that his consumption falls from 7 to 1.

But for some applications, it is useful to keep track of the substitution effect independent of the income effect. (We will meet some of these applications in Chapter 8.) In order to do that, we can draw Bugs's **compensated demand curve**, which shows that at a price of $3, he would consume 3 heads of lettuce—in the hypothetical circumstance where he feels no income effect.

Compensated demand curve A curve showing, for each price, what the quantity demanded would be if the consumer were income-compensated for all price changes.

You can imagine Bugs as the subject of an imaginary experiment, where every time the price of lettuce changes, experimenters adjust his income to keep him on his original indifference curve; we summarize this

EXHIBIT 4.12 Compensated and Uncompensated Demand Curve



When the price of lettuce rises from $1 to $3, Bugs reduces his consumption from 7 heads to 1; this is recorded by the ordinary demand curve in the rightmost panel. If he were income-compensated for the price change, he would reduce his consumption from 7 heads to 3; this is recorded by the compensated demand curve in the center panel.

condition by saying that Bugs is income-compensated for all price changes. The compensated demand curve shows how much lettuce Bugs would consume if he were the subject of that experiment.

Because the substitution effect of a price increase always reduces the quantity demanded, it follows that the compensated demand curve must slope down. In terms of Exhibit 4.12, point C in the first panel is always to the left of point A; therefore, point C' in the second panel is always to the left of point A'. Again, the conclusion is that the compensated demand curve slopes downward. This is in contrast to the ordinary (uncompensated) demand curve, which slopes upward in the case of a Giffen good.

> The ordinary (uncompensated) demand curve describes the behavior of actual consumers in actual markets. *Whenever we use the unqualified phrase "demand curve," we always mean the ordinary (uncompensated) demand curve.*

4.4 Elasticities

If you owned a clothing store, you'd want to be able to anticipate changes in your customers' buying habits. From the material we have developed so far, you'd be able to draw two general conclusions. First, if their income increases, your customers will probably buy more clothes. Second, if the price of clothing falls, your customers will almost surely buy more clothes.

As the owner of a business who is trying to foresee market conditions, you might find these revelations unsatisfying. Although they predict the *directions* of change, they say nothing about the *magnitude* of change. What you really want to know is: If my customers' incomes increase by a certain amount, by *how much* will they increase their expenditures on clothing? If the price falls by a certain amount, by *how much* will the quantity demanded increase?

Elasticities are numbers that answer these questions. In this section, we will learn what elasticities are and see some sample estimates.

Income Elasticity of Demand

First we will consider the response to a change in income. This response is depicted by the Engel curve, and one way to measure it is by the *slope* of that curve. We ask: If your income increased by $1, by how many units would you increase your consumption of X? That number is the slope of your Engel curve.

Unfortunately, this slope is arbitrary. For one thing, it depends on the units in which X is measured. When your income goes up by $1, your yearly coffee consumption might go up by 6 cups, which is the same as 1 pot. If coffee is measured in cups, your Engel curve has slope 6; if coffee is measured in pots, it has slope 1. For another thing, the slope depends on the units in which your income is measured. Your coffee consumption will respond differently if your income increases by one Italian lira instead of one U.S. dollar.

Therefore, we adopt a different measure, one that does not depend on the choice of units. Instead of asking, "If your income increased by *one dollar*, by how many *units* would you increase your consumption of X?" we ask, "If your income increased by 1%, by what *percent* would you increase your consumption of X?" The answer to this question is a number that does not depend on the choice of units. That number is called the elasticity of your Engel curve, or your **income elasticity of demand.**

Income elasticity of demand The percent change in consumption that results from a 1% increase in income.

If your income I changes by an amount ΔI, then the percent change in your income is given by $100 \times \Delta I/I$. If the quantity of X that you consume, Q, changes by an amount ΔQ, then the percent change in consumption is $100 \times \Delta Q/Q$. The formula for income elasticity is

$$\text{Income elasticity} = \frac{\text{Percent change in quantity}}{\text{Percent change in income}}$$

$$= \frac{100 \cdot \Delta Q/Q}{100 \cdot \Delta I/I}$$

$$= \frac{I \cdot \Delta Q}{Q \cdot \Delta I}$$

Suppose, for example, that your Engel curve for X is the one depicted in panel B of Exhibit 4.4. When your income increases from \$8 to \$12 (a 50% increase), your consumption of X increases from 6 to 12 (a 100% increase). In this region, your income elasticity of demand is 100%/50% = 2.

On the other hand, when your income increases from \$4 to \$8, your consumption of X increases from 3 to 6; a 100% increase in income yields a 100% increase in quantity, so your income elasticity of demand in this region is 1.

EXERCISE 4.8

What would it mean for your income elasticity of demand for X to be negative?

EXAMPLE

Let us suppose again that you own a clothing store, you foresee an increase in your customers' incomes, and you want to anticipate the change in their clothing expenditures. The critical bit of information is the income elasticity of demand for clothing. In fact, that elasticity has been estimated at about .95.[2] If your customers' incomes increase by 10%, you may expect them to increase their expenditures on clothing by about 9.5%.

Following an increase in income, it usually takes time for people to fully adjust their spending patterns. Thus, we can estimate both a short-run and a long-run income elasticity, reflecting an initial partial response

[2]H. Houthakker and L. Taylor, *Consumer Demand in the United States*, Cambridge: Harvard University Press, 1970. All further elasticity estimates in this chapter are taken from this source.

to an income increase and the ultimate full response. We expect the long-run elasticity to exceed the short-run elasticity, and for clothing this is indeed the case. Although the short-run elasticity is .95, the long-run elasticity is 1.17. Following a 10% increase in income, people initially increase expenditures on clothing by 9.5%, but ultimately increase expenditures by 11.7%.

Income elasticities take a wide range of values. The income elasticity of demand for an inferior good is negative. The income elasticity of demand for alcoholic beverages is only about .29. (A 10% increase in income leads to a 2.9% increase in expenditure on alcohol.) The income elasticity of demand for jewelry is about 1, so that expenditure on jewelry increases roughly in proportion with income. The income elasticity of demand for household appliances is 2.72. When income increases 10%, expenditure on appliances increases 27.2%. (The estimates in this paragraph are all short-run elasticities.)

The Demand for Quality

When people get wealthier, they not only buy *more* goods, they also buy *better* goods. If your income goes up by 10 percent, you might replace your microwave or your stereo with a better microwave or a better stereo.

When economists estimate income elasticities, they usually count a $2,000 stereo system as the equivalent of two $1,000 stereo systems. So when we say that a 10% increase in income yields a 27.2% increase in expenditure on appliances, that might mean a 27.2% increase in the *number* of appliances, or a 27.2% increase in the *quality* of the appliances, or both. (Here we are using price to measure quality, so that by definition a stereo that costs 27.2% more is 27.2% better.)

On average over all goods, economists Mark Bils and Pete Klenow estimate that as people become wealthier, quality grows a little more rapidly than quantity. But the ratio of quality changes to quantity changes is very different for different goods. If you're rich enough to own two microwaves instead of one, they'll cost, on average, about 25% more than your poorer neighbor's single unit. The poor family pays (say) $200 for one microwave; the rich family pays $250 apiece for two (presumably better) microwaves. But if you're rich enough to own two living room tables instead of one, the 25% rule no longer holds; now you'll pay, on average, about 100% more per table. The poor family pays $500 for one living room table while the rich family pays $1,000 apiece for two. A family with twice as many vacuums pays (on average) about 22% more per vacuum; a family with twice as many trucks pays about 140% more per truck.[3]

These numbers suggest that over time, as families on average become richer, the average quality of living room tables should rise faster than the average quality of microwaves, and the average quality of trucks should rise faster than the average quality of vacuums. Of course, it's possible that technological consideration will undercut some of these predictions—we could, in principle, reach a point where it's very hard to make better trucks but still very easy to make better vacuums.

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[3]The numbers in this paragraph, and the idea of estimating elasticities for "quality Engel curves," come from M. Bils and P. Klenow, "Quantifying Quality Growth", *American Economic Review*, September 2001.

Price Elasticity of Demand

When the price of salt goes up, people buy less salt. When the price of fresh tomatoes goes up, people buy fewer tomatoes. But the responses are of very different magnitudes. A 10% increase in the price of salt typically leads to about a 1% decrease in the quantity bought. A 10% increase in the price of fresh tomatoes typically leads to about a 46% decrease in the quantity bought.

We express this contrast by saying that the **price elasticity of demand** for tomatoes is 46 times as great as the price elasticity of demand for salt.

Price elasticity of demand The percent change in consumption that results from a 1% increase in price.

More formally, your price elasticity of demand for a good X (also called the elasticity of your demand curve for X) is defined by the formula:

$$\text{Price elasticity} = \frac{\text{Percent change in quantity}}{\text{Percent change in price}}$$

$$= \frac{100 \cdot \Delta Q/Q}{100 \cdot \Delta P/P}$$

$$= \frac{P \cdot \Delta Q}{Q \cdot \Delta P}$$

If your demand curve for X slopes downward, then the price elasticity is negative, because an increase (that is, a positive change) in price is associated with a decrease (that is, a negative change) in quantity. For example, suppose that a price of \$2 corresponds to a quantity of 5 and a price of \$3 corresponds to a quantity of 4. Then a 50% price increase yields a 20% quantity decrease, so the price elasticity of demand is (–20%)/50% = –.4

Just as we can talk about your personal price elasticity of demand for X, so we can talk about the market's price elasticity of demand for X. Again, we divide the percent change in quantity by the percent change in price, only now we take our quantities from the market demand curve instead of your personal demand curve.

EXERCISE 4.9

Use the formula for price elasticity and the information given at the beginning of this subsection to show that the price elasticities of demand for salt and for fresh tomatoes are –.1 and –4.6.

We say that the demand for a good is highly elastic when the price elasticity of demand for that good has a large absolute value. Thus the demand for tomatoes is highly elastic when compared with the demand for salt. We also say that the demand for tomatoes is *more elastic* than the demand for salt.

The next question is: why? Why are tomato buyers so much more price-sensitive than salt buyers? One key factor is the availability of substitutes. If the price of tomatoes goes up, you can substitute any of a dozen other vegetables in your salad. Whenever a good has many substitutes, the demand tends to be highly elastic. That's why the elasticity of demand for Chevrolets is about −4.0 even though the elasticity of demand for cars is around −1.3. There are many good substitutes for a Chevrolet (like a Ford), but not so many good substitutes for a car.

For the same reason, we expect that the demand for Hostess Twinkies is more elastic than the demand for packaged cakes; the demand for packaged cakes is more elastic than the demand for snack foods; and the demand for snack foods is more elastic than the demand for food generally.

> For a given income and quantity of X, high income elasticity is reflected in a relatively steep Engel curve. For a given price and quantity of X, high price elasticity is reflected in a relatively flat demand curve. The apparent paradox occurs because the quantity of X is plotted on the vertical axis for an Engel curve and on the horizontal axis for a demand curve.

The price elasticity of demand for electricity is −.13, for water −.20, for jewelry −.41, for shoes −.73, and for tobacco −1.4. If the price of electricity rises by 10%, the quantity demanded falls by 1.3%. If the price of water rises by 10%, the quantity demanded falls by 2%.

EXERCISE 4.10 If the price of jewelry rises by 10%, by how much does the quantity demanded fall? How about for shoes? For tobacco?

The Relationship between Price Elasticity and Income Elasticity

When the price goes up, the quantity demanded goes down, usually for two reasons: a substitution effect and an income effect. So the price elasticity of demand depends both on the size of the substitution effect and on the size and direction of the income effect.

The income effect is larger for goods that consume a larger fraction of your income. The income effect is also larger for goods with high income elasticities of demand.

The direction of the income effect depends on whether the good is normal or inferior. For normal goods, a larger income effect means a larger price elasticity of demand; for inferior goods the opposite is true.

For example, suppose you go to the movies once a week and spend $10 per movie, while you go to the live theater twice a year and spend $50 each time. Then over the course of a year, you're spending about five times as much on movies as on the theater. This suggests that changes in the price of movies should have larger income effects than changes in the price of live theater performances. So it's a good guess that your price elasticity of demand is higher for the movies.

Similarly, if you eat out at McDonald's 300 nights a year, spending $5 each time for a total of $1,500, and at the 21 Club once a year, spending $200, then your price elasticity of demand for McDonald's hamburgers is probably higher than your price elasticity of demand for dinners at the 21 Club. If the 21 Club raises its prices by 10%, it will lose some fraction of your business, but if McDonald's raises its prices by 10%, it will lose a larger fraction of your business.

One other circumstance that can affect your demand for *X* is a change in the price of some other good *Y*. The **cross elasticity of demand** for *X* with respect to *Y* is a measure of the size of this effect; it is the percent change in consumption of *X* divided by the percent change in the price of *Y*.

Cross elasticity of demand The percent change in consumption that results from a 1% increase in the price of a related good.

A change in the price of *Y* could cause your consumption of *X* to either rise or fall. In the first case, your cross elasticity of demand is positive, and in the second it is negative. If *X* is coffee and *Y* is tea, the cross elasticity is likely to be positive: When the price of tea increases by 1%, your coffee consumption is likely to increase. The percent by which it increases (a positive number) is the cross elasticity of demand. But if *X* is coffee and *Y* is cream, a 1% increase in the price of cream is likely to lead to a *decrease* (that is, a *negative* percentage change) in the price of coffee, and so in this case the cross elasticity of demand is negative.

When the cross elasticity of demand for *X* with respect to *Y* is positive, we say that *X* and *Y* are **substitutes.** When it is negative, we say that they are **complements.** Substitutes, as the name indicates, tend to be goods that can be substituted for each other, as in our example of tea and coffee. Other examples might be Coke and Pepsi, or train tickets and airline tickets. Complements tend to be goods that are used together—each complements the other. We have seen the example of coffee and cream. Other pairs of complements might be computers and floppy disks, or textbooks and college courses.

Substitutes Goods for which the cross elasticity of demand is positive.

Complements Goods for which the cross elasticity of demand is negative.

Elasticities and Monopoly Power

Does the McDonald's hamburger chain have a monopoly on the products it sells? If consumers think that there is no close substitute for a McDonald's hamburger, then the answer is yes. On the other hand, if consumers think that a Burger King hamburger and a McDonald's hamburger are indistinguishable, then McDonald's faces heavy competition.

When courts are called upon to decide whether a firm has monopoly power, they must ask whether competing firms offer products that are close substitutes in the minds of consumers. But how is the court to tell whether an alternative product is viewed as a close substitute? A solution is to examine the cross elasticity of demand.

Suppose that the cross elasticity of demand between McDonald's and Burger King hamburgers is positive and large. Then the goods are close substitutes and Burger King competes in essentially the same market as McDonald's. The large cross elasticity means that if McDonald's tries to raise its prices, a lot of customers will switch to Burger King, so that McDonald's monopoly power is severely limited. On the other hand, if the cross elasticity is small, McDonald's needs to worry much less about this kind of competition. Large cross elasticities are evidence of competition and small cross elasticities are evidence of monopoly. Cross elasticities routinely play major roles in antitrust cases.