CHAPTER 4

Consumer Choice

If this is coffee, please bring me some tea; but if this is tea, please bring me some coffee.
—Abraham Lincoln

Alexx's employer wants to transfer him to the firm's Paris office. Although Alexx likes the idea of living in Paris, he's concerned about the high cost of living there. The firm offers to pay him enough in French francs that he can buy the same combination of goods in Paris that he is buying currently in the United States. In terms of what he can consume, will this higher income undercompensate, fully compensate, or overcompensate Alexx for the higher prices in Paris?

The government gives poor people food stamps, which they may use in retail stores only to buy food. Would the benefit to recipients be greater if they were given cash instead of food stamps? Would they buy less food?

As we saw in Chapters 2 and 3, the supply-and-demand model is useful for analyzing economic questions concerning markets. We could use the supply-and-demand model to examine the market price of croissants in Paris and New York or the effect of food stamps on the market price of donuts. However, the supply-and-demand model cannot be used to answer questions concerning individuals, such as Alexx's problem about whether to move to Paris or whether cash or food stamps would be better for a given individual.

To answer questions about individual decision making, we need a model of individual behavior. Our model of consumer behavior is based on the following premises:

- Individual *tastes* or *preferences* determine the amount of pleasure people derive from the goods and services they consume.
- Consumers face *constraints* or limits on their choices.
- Consumers *maximize* their well-being or pleasure from consumption, subject to the constraints they face.

Consumers spend their money on the bundle of products that give them the most pleasure. If you like music and don't have much of a sweet tooth, you spend a lot of your money on concerts, tapes, and CDs and relatively little on candy. By contrast, your chocoholic friend with the tin ear may spend a great deal on Hershey's Kisses and very little on music.

All consumers must choose which goods to buy because limits on wealth prevent them from buying everything that catches their fancy. In addition, government rules restrict what they may buy: Young consumers cannot buy alcohol or cigarettes legally, and people of all ages are prohibited from buying crack and other "recreational" drugs. Therefore, consumers buy the goods that give them the most pleasure, subject to the constraints that they cannot spend more money than they have and that they cannot spend it in ways that the government prevents.

In economic analyses designed to explain behavior (positive analysis—see Chapter 1) rather than judge it (normative statements), economists assume that *the consumer is the boss*. If your brother gets pleasure from smoking, economists don't argue with him that it is bad for him any more than they'd tell your sister, who likes reading Stephen King, that she should read Adam Smith's *Wealth of Nations* instead. Accepting each consumer's tastes is not the same as condoning the resulting behaviors. Economists want to predict behavior. They want to know, for example, whether your brother will smoke more next year if the price of cigarettes decreases 10%. The prediction is unlikely to be correct if economists say, "He shouldn't smoke; therefore, we predict he'll stop smoking next year." A prediction based on your brother's actual tastes is more likely to be correct: "Given that he likes cigarettes, he is likely to smoke more of them next year if the price falls."

In this chapter, we examine four main topics

1. **Preferences:** We use three properties of preferences to predict which combinations, or bundle, of goods an individual prefers to other combinations.
2. **Utility:** Economists summarize a consumer's preferences using a *utility* function, which assigns a numerical value to each possible bundle of goods, reflecting the consumer's relative ranking of these bundles.
3. **Budget constraint:** Prices, income, and government restrictions limit a consumer's ability to make purchases by determining the rate at which a consumer can trade one good for another.
4. **Constrained consumer choice:** Consumers maximize their pleasure from consuming various possible bundles of goods given their income, which limits the amount of goods they can purchase.

4.1 PREFERENCES

> *Do not unto others as you would that they would do unto you. Their tastes may not be the same.*
> —George Bernard Shaw

We start our analysis of consumer behavior by examining consumer preferences. Using three basic assumptions, we can make many predictions about preferences. Once we know about consumers' preferences, we can add information about the constraints consumers face, so that we can answer many questions, such as the ones posed at the beginning of the chapter, or derive demand curves, as is done in the next chapter.

As a consumer, you choose among many goods. Should you have ice cream or cake for dessert? Should you spend most of your money on a large apartment or rent a single room and use the savings to pay for trips and concerts? In short, you must allocate your money to buy a *bundle* (*market basket* or combination) of goods.

How do consumers choose the bundle of goods they buy? One possibility is that consumers behave randomly and blindly choose one good or another without any thought. However, consumers appear to make systematic choices. For example, you probably buy more or less the same specific items each time you go to the grocery store.

To explain consumer behavior, economists *assume* that consumers have a set of tastes or preferences that they use to guide them in choosing between goods. These tastes differ substantially among individuals. Three out of four European men prefer colored underwear, while three out of four American men prefer white underwear.[1] Let's start by specifying the underlying assumptions in the economist's model of consumer behavior.

Properties of Consumer Preferences

Economists make three critical assumptions about the properties of consumers' preferences. For brevity, these properties are referred to as *completeness*, *transitivity*, and *more is better*.

Completeness. The completeness property holds that, when facing a choice between any two bundles of goods, a consumer can rank them so that one and only one of the following relationships is true: The consumer prefers the first bundle to the second, prefers the second to the first, or is indifferent between them. This property rules out the possibility that the consumer cannot decide which bundle is preferable.

It would be very difficult to predict behavior if consumers' rankings of bundles were not logically consistent. The next property eliminates the possibility of certain types of illogical behavior.

Transitivity. The transitivity (or what some people refer to as *rationality*) property is that a consumer's preferences over bundles is consistent in the sense that, if the consumer *weakly prefers* Bundle z to Bundle y (likes z at least as much as y) and weakly prefers Bundle y to Bundle x, the consumer also weakly prefers Bundle z to Bundle x.[2]

If your sister told you she preferred a scoop of ice cream to a piece of cake, a piece of cake to a bar of candy, and a bar of candy to a scoop of ice cream, you'd probably think she'd lost her mind. At the very least, you wouldn't know which of these desserts to serve her.

More Is Better. The more-is-better property holds that, all else the same, more of a commodity is better than less of it (always wanting more is known as *nonsatiation*). Indeed, economists define a **good** as a commodity for which more is preferred to less, at least at some levels of consumption. In contrast, a **bad** is something for which less is preferred to more, such as pollution. We now concentrate on goods.

Although the completeness and transitivity properties are crucial to the analysis that follows, the more-is-better property is included to simplify the analysis—our most important results would follow even without this property.

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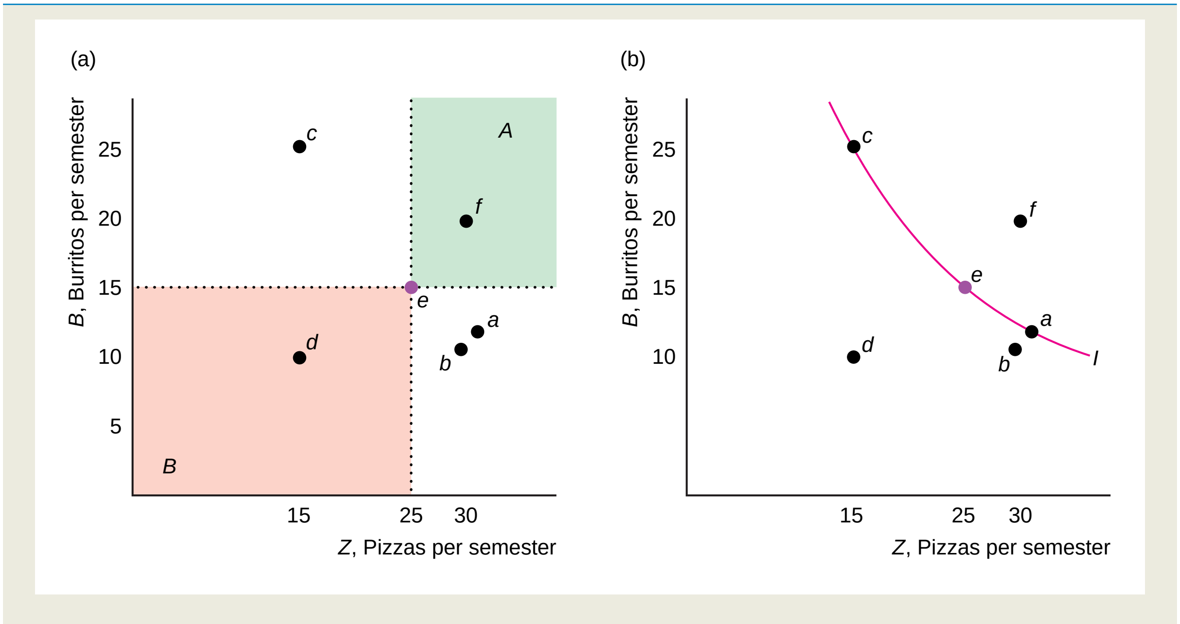
[1]L. M. Boyd, "The Grab Bag," *San Francisco Examiner*, September 11, 1994, p. 5.

[2]The assumption of transitivity of weak preferences is sufficient for the following analysis. However, it is easier (and plausible) to assume that other preference relations—strict preference and indifference between bundles—are also transitive.



So why do economists assume that the more-is-better property holds? The most compelling reason is that it appears to be true for most people.[3] A second reason is that if consumers can freely dispose of excess goods, a consumer can be no worse off with extra goods. (We examine a third reason later in the chapter: Consumers buy goods only when this condition is met.)

Preference Maps

Surprisingly enough, with just these three properties, we can tell a lot about a consumer's preferences. One of the simplest ways to summarize information about a consumer's preferences is to create a graphical interpretation—a map—of them. For graphical simplicity, we concentrate throughout this chapter on choices between only two goods, but the model can be generalized to handle any number of goods.

Each semester, Lisa, who lives for fast food, decides how many pizzas and burritos to eat. The various bundles of pizzas and burritos she might consume are shown in panel a of Figure 4.1, with (individual-size) pizzas per semester on the horizontal axis and burritos per semester on the vertical axis.

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[3]When teaching microeconomics to Wharton M.B.A.'s, I told them about a cousin of mine who had just joined a commune in Oregon. His worldly possessions consisted of a tent, a Franklin stove, enough food to live on, and a few clothes. He said that he didn't need any other goods—that he was *satiated*. A few years later, one of these students bumped into me on the street and said, "Professor, I don't remember your name or much of anything you taught me in your course, but I can't stop thinking about your cousin. Is it really true that he doesn't want *anything* else? His very existence is a repudiation of my whole way of life." Actually, my cousin had given up his ascetic life and was engaged in telemarketing, but I, for noble pedagogical reasons, responded, "Of course he still lives that way—you can't expect everyone to have the tastes of an M.B.A."

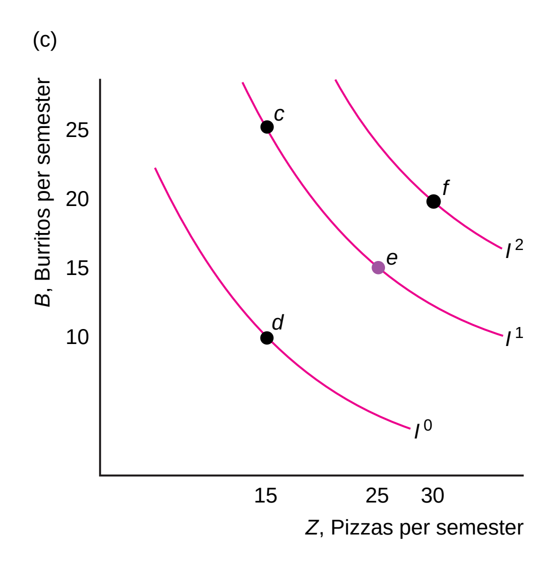


Figure 4.1 Bundles of Pizzas and Burritos Lisa Might Consume. Pizzas per semester are on the horizontal axis, and burritos per semester are on the vertical axis. (a) Lisa prefers more to less, so she prefers Bundle *e* to any bundle in area *B*, including *d*. Similarly, she prefers any bundle in area *A*, including *f*, to *e*. (b) The indifference curve, I^1, shows a set of bundles (including *c*, *e*, and *a*) among which she is indifferent. (c) The three indifference curves, I^0, I^1, and I^2 are part of Lisa's preference map, which summarizes her preferences.

At Bundle *e*, for example, Lisa consumes 25 pizzas and 15 burritos per semester. By the more-is-better property, all the bundles that lie above and to the right (area *A*) are preferred to Bundle *e* because they contain at least as much of both pizzas and burritos as Bundle *e*. Thus Bundle *f* (30 pizzas and 20 burritos) in that region is preferred to *e*. By the same reasoning, Lisa prefers *e* to all the bundles that lie in area *B*, below and to the left of *e*, such as Bundle *d* (15 pizzas and 10 burritos).

Bundles such as *b* (30 pizzas and 10 burritos), in the region below and to the right of *e*, or *c* (15 pizzas and 25 burritos), in the region above and to the left, may or may not be preferred to *e*. We can't use the more-is-better property to determine which bundle is preferred because these bundles each contain more of one good and less of the other than *e* does.

Indifference Curves. Suppose we asked Lisa to identify all the bundles that gave her the same amount of pleasure as consuming Bundle *e*. Using her answers, we draw curve *I* in panel b of Figure 4.1 through all bundles she likes as much as *e*. Curve *I* is an **indifference curve**: the set of all bundles of goods that a consumer views as being equally desirable.

Indifference curve *I* includes Bundles *c*, *e*, and *a*, so Lisa is indifferent between consuming Bundles *c*, *e*, and *a*. From this indifference curve, we also know that Lisa prefers *e* (25 pizzas and 15 burritos) to *b* (30 pizzas and 10 burritos). How do we know that? Bundle *b* lies below and to the left of Bundle *a*, so Bundle *a* is preferred to Bundle *b* by the more-is-better property. Both Bundle *a* and Bundle *e* are on indifference curve *I*, so Lisa likes Bundle *e* as much as Bundle *a*. Because Lisa is indifferent between *e* and *a* and she prefers *a* to *b*, she must prefer *e* to *b* by transitivity.

If we asked Lisa many, many questions, in principle, we could draw an entire set of indifference curves through every possible bundle of burritos and pizzas. Lisa's preferences are summarized in an **indifference map** or *preference map*, which is a complete set of indifference curves that summarize a consumer's tastes. Panel c of Figure 4.1 shows three of Lisa's indifference curves, I^0, I^1, and I^2.

We assume that indifference curves are continuous—have no gaps—as the figure shows. The indifference curves are parallel in the figure, but they need not be. All indifference curve maps must have four important properties:

1. Bundles on indifference curves farther from the origin are preferred to those on indifference curves closer to the origin.
2. There is an indifference curve through every possible bundle.
3. Indifference curves cannot cross.
4. Indifference curves slope downward.

First, we show that bundles on indifference curves farther from the origin (zero units of both goods) are preferred to those on indifference curves closer to the origin. By the more-is-better property, Lisa prefers Bundle *f* to Bundle *e* in panel c of Figure 4.1. She is indifferent among all the bundles on indifference curve I^2 and Bundle *f*, just as she is indifferent among all the bundles, such as Bundle *c*, on indifference curve I^1, and Bundle *e*. By the transitivity property, she prefers Bundle *f* to Bundle *e*, which she likes as much as Bundle *c*, so she prefers Bundle *f* to Bundle *c*. By this type of reasoning, she prefers all bundles on I^2 to all bundles on I^1.

Second, we show that there is an indifference curve through every possible bundle as a consequence of the completeness property: The consumer can compare any bundle to another. Compared to a given bundle, some bundles are preferred, some are enjoyed equally, and some are inferior. Connecting the bundles that give the same pleasure produces an indifference curve that includes the given bundle.

Third, we show that indifference curves cannot cross: A given bundle cannot be on two indifference curves. Suppose that two indifference curves crossed at Bundle *e* as in panel a of Figure 4.2. Because Bundles *e* and *a* lie on the same indifference curve I^0, Lisa is indifferent between *e* and *a*. Similarly, she is indifferent between *e* and *b* because both are on I^1. By transitivity, if Lisa is indifferent between *e* and *a* and she is indifferent between *e* and *b*, she must be indifferent between *a* and *b*. But that's impossible! Bundle *b* is above and to the right of bundle *a*, so Lisa *must* prefer *b* to *a* by the more-is-better property. Thus because preferences are transitive and more is better than less, indifference curves cannot cross.

Fourth, we show that indifference curves must be downward sloping. Suppose to the contrary that an indifference curve sloped upward, as in panel b of Figure 4.2. The consumer is indifferent between Bundles *a* and *b* because both lie on the same indifference curve, *I*. But the consumer prefers *b* to *a* by the more-is-better property: Bundle *a* lies strictly below and to the left of Bundle *b*. Because of this contradiction—the consumer cannot both be indifferent between *a* and *b* and strictly prefer *b* to *a*—indifference curves cannot be upward sloping.

Solved Problem 4.1

Can indifference curves be thick?

Answer

Draw an indifference curve that is at least two bundles thick, and show that a preference property is violated: Panel c of Figure 4.2 shows a thick indifference curve, *I*, with two bundles, *a* and *b*, identified. Bundle *b* lies above and to the right of *a*: Bundle *b* has more of both burritos and pizza. Thus by the more-is-better property, Bundle *b* must be strictly preferred to Bundle *a*. But the consumer must be indifferent between *a* and *b* because both bundles are on the same indifference curve. Because both relationships between *a* and *b* cannot be true, there is a contradiction. Consequently, indifference curves cannot be thick. (We illustrate this point by drawing indifference curves with very thin lines in our figures.)

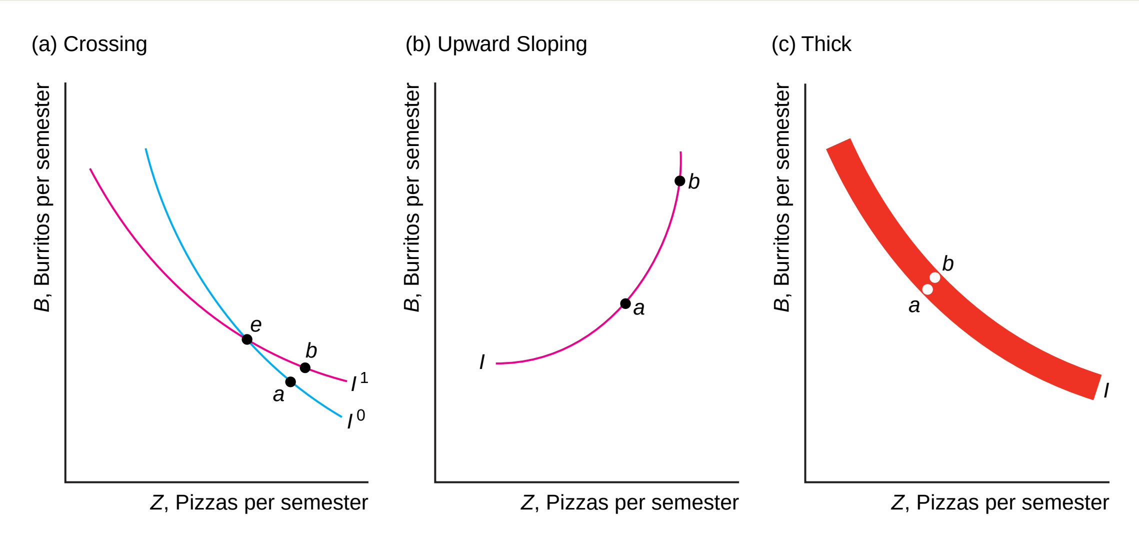


Figure 4.2 Impossible Indifference Curves. (a) Suppose that the indifference curves cross at Bundle *e*. Lisa is indifferent between *e* and *a* on indifference curve I^0 and between *e* and *b* on I^1. If Lisa is indifferent between *e* and *a* and she is indifferent between *e* and *b*, she must be indifferent between *a* and *b* by transitivity. But *b* has more of both pizzas and burritos than *a*, so she *must* prefer *a* to *b*. Because of this contradiction, indifference curves cannot cross. (b) Suppose that indifference curve *I* slopes upward. The consumer is indifferent between *b* and *a* because they lie on *I* but prefers *b* to *a* by the more-is-better assumption. Because of this contradiction, indifference curves cannot be upward sloping. (c) Suppose that indifference curve *I* is thick enough to contain both *a* and *b*. The consumer is indifferent between *a* and *b* because both are on *I* but prefers *b* to *a* by the more-is-better assumption because *b* lies above and to the right of *a*. Because of this contradiction, indifference curves cannot be thick.

Willingness to Substitute Between Goods. Lisa is willing to make some trades between goods. The downward slope of her indifference curves shows that Lisa is willing to give up some burritos for more pizza or vice versa. She is indifferent between Bundles *a* and *b* on her indifference curve *I* in panel a of Figure 4.3. If she initially has Bundle *a* (eight burritos and three pizzas), she could get to Bundle *b* (five burritos and four pizzas) by trading three burritos for one more pizza. She is indifferent whether she makes this trade or not.

Lisa's willingness to trade one good for another is measured by her **marginal rate of substitution** (*MRS*): the maximum amount of one good a consumer will sacrifice to obtain one more unit of another good. The marginal rate of substitution refers to the trade-off (rate of substitution) of burritos for a marginal (small additional or incremental) change in the number of pizzas. Lisa's marginal rate of substitution of burritos for pizza is

$$MRS = \frac{\Delta B}{\Delta Z},$$

where ΔZ is the number of pizzas Lisa will give up to get ΔB more burritos or vice versa and pizza (Z) is on the horizontal axis. *The marginal rate of substitution is the slope of the indifference curve.*[4]

Moving from Bundle *a* to Bundle *b* in panel a of Figure 4.3, Lisa will give up three burritos, $\Delta B = -3$, to obtain one more pizza, $\Delta Z = 1$, so her marginal rate of substitution is $-3/1 = -3$. That is, the slope of the indifference curve is -3. The negative sign shows that Lisa is willing to give up some of one good to get more of the other: Her indifference curve slopes downward.

Curvature of Indifference Curves. Must an indifference curve, such as *I* in panel a of Figure 4.3, be *convex* to the origin (that is, must the middle of the curve be closer to the origin than if the indifference curve were a straight line)? An indifference curve doesn't have to be convex, but casual observation suggests that most people's indifference curves are convex. When people have a lot of one good, they are willing to give up a relatively large amount of it to get a good of which they have relatively little. However, after that first trade, they are willing to give up less of the first good to get the same amount more of the second good.

Lisa is willing to give up three burritos to obtain one more pizza when she is at *a* in panel a of Figure 4.3. At *b*, she is willing to trade only two burritos for a pizza. At *c*, she is even less willing to trade; she will give up only one burrito for another pizza. This willingness to trade fewer burritos for one more pizza as we move down and to the right along the indifference curve reflects a *diminishing marginal rate of substitution*: The marginal rate of substitution approaches zero as we move down and to the right along an indifference curve. That is, the indifference curve becomes flatter (less sloped) as we move down and to the right.

[4]The *slope* is "the rise over the run": how much we move along the vertical axis (rise) as we move along the horizontal axis (run). Technically, by the marginal rate of substitution, we mean the slope at a particular bundle. That is, we want to know what the slope is as ΔZ gets very small. In calculus terms, the relevant slope is a derivative. See Appendix 4A.

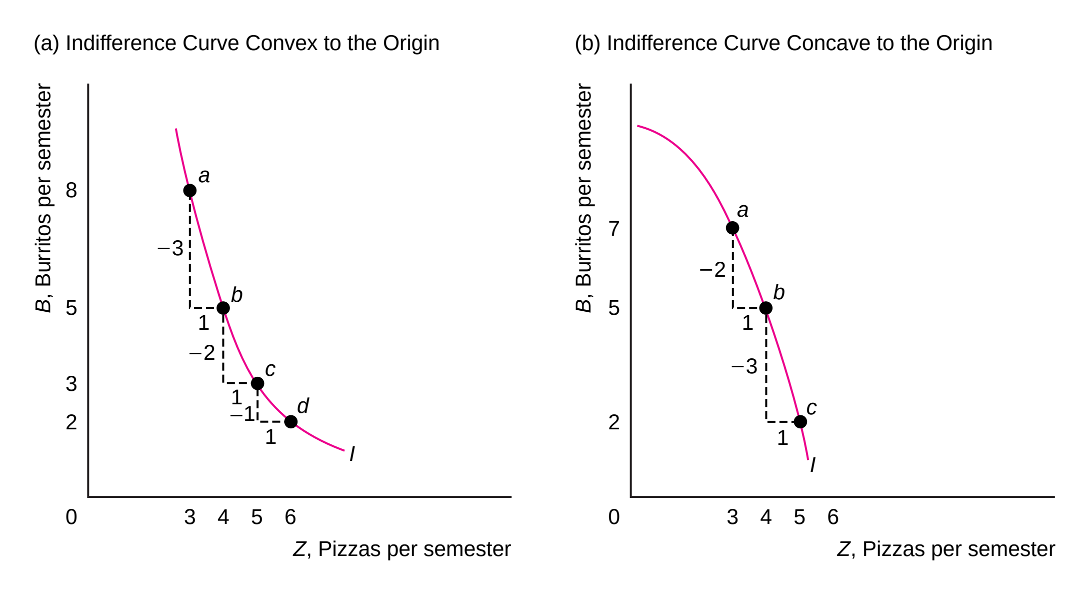


Figure 4.3 Marginal Rate of Substitution. (a) At Bundle *a*, Lisa is willing to give up three burritos for one more pizza; whereas at *b*, she is willing to give only two burritos to obtain another pizza. That is, the relatively more burritos she has, the more she is willing to trade for another pizza. (b) An indifference curve of this shape is unlikely to be observed. Lisa would be willing to give up more burritos to get one more pizza, the fewer the burritos she has. Moving from Bundle *c* to *b*, she will trade one pizza for three burritos, whereas moving from *b* to *a*, she will trade one pizza for two burritos, even though she now has relatively more burritos to pizzas.

It is hard to imagine that Lisa's indifference curves are *concave*, as in panel b of Figure 4.3, rather than *convex*, as in panel a. If her indifference curve is concave, Lisa would be willing to give up more burritos to get one more pizza, the fewer the burritos she has. In panel b, she trades one pizza for three burritos moving from Bundle *c* to *b*, and she trades one pizza for only two burritos moving from *b* to *a*, even though her ratio of burritos to pizza is greater. Though it is difficult to imagine concave indifference curves, two extreme versions of downward-sloping, convex indifference curves are plausible: straight-line or right-angle indifference curves.

One extreme case is **perfect substitutes**: goods that a consumer is completely indifferent as to which to consume. Because Bill cannot taste any difference between Coca-Cola and Pepsi-Cola, he views them as perfect substitutes: He is indifferent between one additional can of Coke and one additional can of Pepsi. His indifference curves for these two goods are straight, parallel lines with a slope of –1 everywhere along the curve, as in panel a of Figure 4.4. Thus Bill's marginal rate of substitution is –1 at every point along these indifference curves.

The slope of indifference curves of perfect substitutes need not always be –1; it can be any constant rate. For example, Ben knows from reading the labels that Clorox bleach is twice as strong as a generic brand. As a result, Ben is indifferent between one

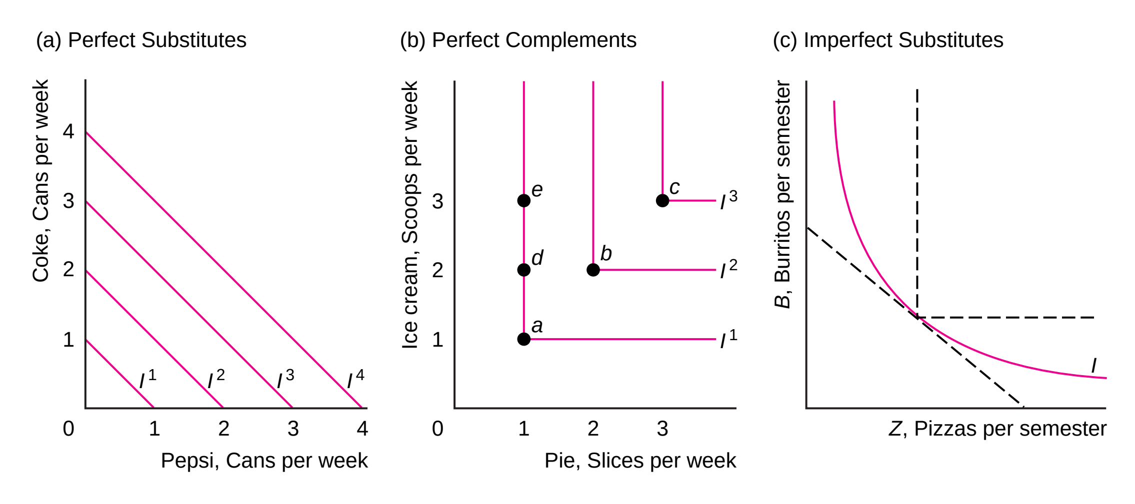


Figure 4.4 Perfect Substitutes, Perfect Complements, Imperfect Substitutes. (a) Bill views Coke and Pepsi as perfect substitutes. His indifference curves are straight, parallel lines with a marginal rate of substitution (slope) of –1. Bill is willing to exchange one can of Coke for one can of Pepsi. (b) Maureen likes pie à la mode but does not like pie or ice cream by itself: She views ice cream and pie as perfect complements. She will not substitute between the two; she consumes them only in equal quantities. (c) Lisa views burritos and pizza as imperfect substitutes. Her indifference curve lies between the extreme cases of perfect substitutes and perfect complements.

cup of Clorox and two cups of the generic bleach. The slope of his indifference curve is –2 (where the generic bleach is on the vertical axis).[5]

The other extreme case is **perfect complements**: goods that a consumer is interested in consuming only in fixed proportions. Maureen doesn't like pie by itself or ice cream by itself but loves pie à la mode: a slice of pie with a scoop of vanilla ice cream on top. Her indifference curves have right angles in panel b of Figure 4.4. If she has only one piece of pie, she gets as much pleasure from it and one scoop of ice cream, Bundle *a*, as from it and two scoops, Bundle *d*, or as from it and three scoops, Bundle *e*. That is, she won't eat the extra scoops because she does not have pieces of pie to go with the ice cream. Therefore, she consumes only bundles like *a*, *b*, and *c* in which pie and ice cream are in equal proportions.

With a bundle like *a*, *b*, or *c*, she will not substitute a piece of pie for an extra scoop of ice cream. For example, if she were at *b*, she would be unwilling to give up an extra slice of pie to get, say, two extra scoops of ice cream, as at point *e*. Indeed,

[5]Sometimes it is difficult to guess what goods are close substitutes. According to Harper's Index (*San Francisco Examiner*, May 22, 1994, p. 6), flowers, perfume, and fire extinguishers rank 1, 2, and 3 among Mother's Day gifts that Americans consider "very appropriate."

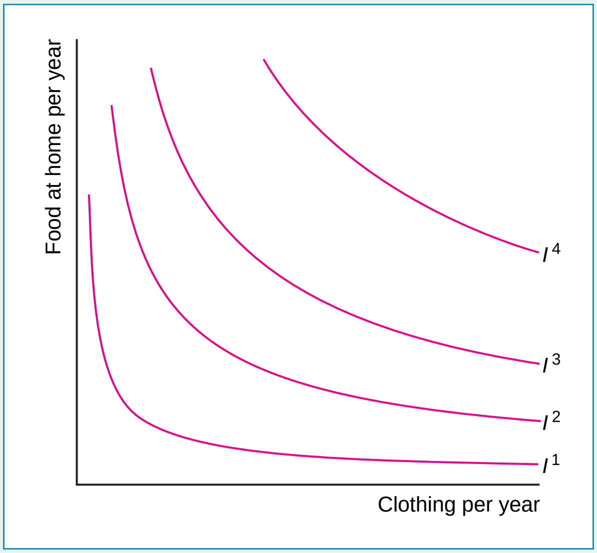
she wouldn't give up the slice of pie for a virtually unlimited amount of extra ice cream because the extra ice cream is worthless to her.

The standard-shaped, convex indifference curve in panel c of Figure 4.4 lies between these two extreme examples. Convex indifference curves show that a consumer views two goods as imperfect substitutes.

Application

INDIFFERENCE CURVES BETWEEN FOOD AND CLOTHING

Using the estimates of Eastwood and Craven (1981), the figure shows the indifference curves of the average U.S. consumer between food consumed at home and clothing. The food and clothing measures are weighted averages of various goods. At relatively low quantities of food and clothing, the indifference curves, such as I^1, are nearly right angles: perfect complements. As we move away from the origin, the indifference curves become flatter: closer to perfect substitutes.



One interpretation of these indifference curves is that there are minimum levels of food and clothing necessary to support life. The consumer cannot trade one good for the other if it means having less than these critical levels. As the consumer obtains more of both goods, however, the consumer is increasingly willing to trade between the two goods. According to these estimates, food and clothing are perfect complements when the consumer has little of either good and perfect substitutes when the consumer has large quantities of both goods.

4.2 UTILITY

Underlying our model of consumer behavior is the belief that consumers can compare various bundles of goods and decide which gives them the greatest pleasure. We can summarize a consumer's preferences by assigning a numerical value to each possible bundle to reflect the consumer's relative ranking of these bundles.

Following Jeremy Bentham, John Stuart Mill, and other nineteenth-century British economist-philosophers, economists apply the term **utility** to this set of numerical values that reflect the relative rankings of various bundles of goods. The statement that "Bonnie prefers Bundle x to Bundle y" is equivalent to the statement that "consuming Bundle x gives Bonnie more utility than consuming Bundle y." Bonnie prefers x to y if Bundle x gives Bonnie 10 *utils* (the name given to a unit of utility) and Bundle y gives her 8 utils.

Utility Function

If we knew the **utility function**—the relationship between utility measures and every possible bundle of goods—we could summarize the information in indifference maps succinctly. Suppose that the utility, U, that Lisa gets from burritos and pizzas is

$$U = \sqrt{BZ}.$$

From this function, we know that the more she consumes of either good, the greater the utility that Lisa receives. Using this function, we can determine whether she would be happier if she had Bundle x with 9 burritos and 16 pizzas or Bundle y with 13 of each. The utility she gets from x is 12 (= $\sqrt{9 \times 16}$) utils. The utility she gets from y is 13 (= $\sqrt{13 \times 13}$) utils. Therefore, she prefers y to x.

The utility function is a concept that economists use to help them think about consumer behavior; utility functions do not exist in any fundamental sense. If you ask your mother what her utility function is, she would be puzzled—unless, of course, she is an economist. But if you asked her enough questions about choices of bundles of goods, you could construct a function that accurately summarizes her preferences. For example, by questioning people, Rousseas and Hart (1951) constructed indifference curves between eggs and bacon, and MacCrimmon and Toda (1969) constructed indifference curves between French pastries and money (which can be used to buy all other goods).

Typically, consumers can easily answer questions about whether they prefer one bundle to another, such as "Do you prefer a bundle with one scoop of ice cream and two pieces of cake to another bundle with two scoops of ice cream and one piece of cake?" But they have difficulty answering questions about how much more they prefer one bundle to another because they don't have a measure to describe how their pleasure from two goods or bundles differs. Therefore, we may know a consumer's rank-ordering of bundles, but we are unlikely to know by how much more that consumer prefers one bundle to another.

Ordinal Preferences

If we know only consumers' relative rankings of bundles, our measure of pleasure is *ordinal* rather than *cardinal*. An ordinal measure is one that tells us the relative ranking of two things but not how much more one rank is than another.

If a professor assigns only letter grades to an exam, we know that a student who receives a grade of A did better than a student who received a B, but we can't say how much better from that ordinal scale. Nor can we tell whether the difference in performance between an A student and a B student is greater or less than the difference between a B student and a C student.

A cardinal measure is one by which absolute comparisons between ranks may be made. Money is a cardinal measure. If you have \$100 and your brother has \$50, we know not only that you have more money than your brother but also that you have exactly twice as much money as he does.

Because utility is an ordinal measure, we should not put any weight on the absolute differences between the utility associated with one bundle and another.[6] We care only about the relative utility or ranking of the two bundles.

Utility and Indifference Curves

We can use Lisa's utility function to construct a three-dimensional diagram that shows how utility varies with changes in the consumption of B and Z. Imagine that you are standing with your back against a corner of a room. Walking away from the corner along the wall to your left, you are tracing out the B axis: The farther you get from the corner, the more burritos Lisa has. Similarly, starting back at the corner and walking along the wall to your right, you are moving along the Z axis. When you stand in the corner, you are leaning against the utility axis, where the two walls meet. The higher the point along your back, the greater Lisa's utility. Because her utility is increasing (more is preferred to less) in both B and Z, her utility rises as you walk away from the corner (origin) along either wall or into the room, where Lisa has more B or Z or both. Lisa's utility or *hill of happiness* rises as you move away from the corner.

What is the relationship between Lisa's utility and one of her indifference curves, those combinations of B and Z that give Lisa a particular level of utility? Imagine that the hill of happiness is made of clay. If you were to cut the hill parallel to the floor at a particular height on the wall—a given level of utility—you'd get a smaller hill above the cut. Now suppose that you place that smaller hill directly on the floor and trace the outside edge of the hill. Looking down at the floor, the traced outer edge of the hill represents an indifference curve on the two-dimensional floor. Making other parallel cuts in the hill of happiness, placing the smaller hills on the floor, and tracing their outside edges, you could obtain a map of indifference curves on which each indifference curve reflects a different level of utility.

Utility and Marginal Utility

Using Lisa's utility function over burritos and pizza, we can show how her utility changes if she gets to consume more of one of the goods. We now suppose that Lisa has the utility function in Figure 4.5. The curve in panel a shows how

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[6]Let $U(B, Z)$ be the original utility function and $V(B, Z)$ be the new utility function after we have applied a *positive monotonic transformation*: a change that increases the value of the function at every point. These two utility functions give the same ordinal ranking to any bundle of goods. (Economists often express this idea by saying that a *utility function is unique only up to a positive monotonic transformation*.) Suppose that $V(B, Z) = \alpha + \beta U(B, Z)$, where $\beta > 0$. The rank ordering is the same for these utility functions because $V(B, Z) = \alpha + \beta U(B, Z) > V(B^*, Z^*) = \alpha + \beta U(B^*, Z^*)$ if and only if $U(B, Z) > U(B^*, Z^*)$.

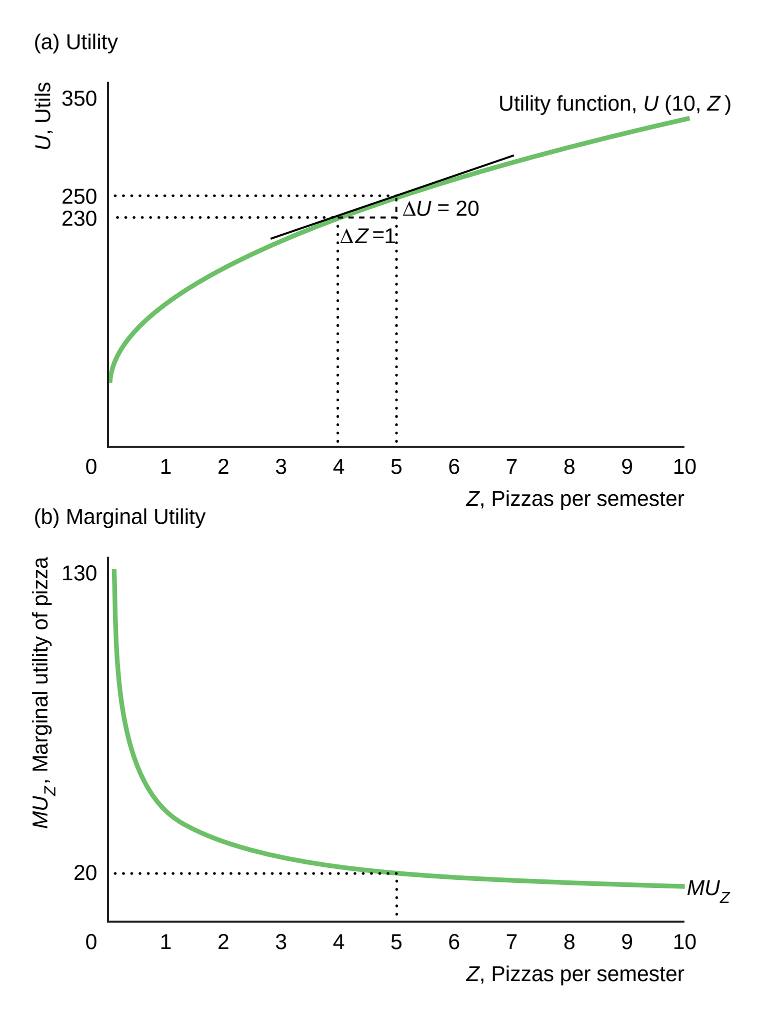


Figure 4.5 Utility and Marginal Utility. As Lisa consumes more pizza, holding her consumption of burritos constant at 10, her total utility, U, increases and her marginal utility of pizza, MU_Z, decreases (though it remains positive).

Lisa's utility rises as she consumes more pizzas while we hold her consumption of burritos fixed at 10. Because pizza is a *good*, Lisa's utility rises as she consumes more pizza.

If her consumption of pizzas increases from $Z = 4$ to 5, $\Delta Z = 5 - 4 = 1$, her utility increases from $U = 230$ to 250, $\Delta U = 250 - 230 = 20$. The extra utility ($\Delta U$) that she gets from consuming the last unit of a good ($\Delta Z = 1$) is the **marginal utility** from that good. Thus marginal utility is the slope of the utility function (Appendix 4A):

$$MU_Z = \frac{\Delta U}{\Delta Z}.$$

Lisa's marginal utility from increasing her consumption of pizza from 4 to 5 is

$$MU_Z = \frac{\Delta U}{\Delta Z} = \frac{20}{1} = 20.$$

Panel b shows that Lisa's marginal utility from consuming one more pizza varies with the number of pizzas she consumes, holding her consumption of burritos constant. Her marginal utility of pizza curve falls as her consumption of pizza increases, but the marginal utility remains positive: Each extra pizza gives Lisa pleasure, but it gives her less pleasure than the previous pizza relative to other goods.

Utility and Marginal Rates of Substitution

Earlier we learned that the marginal rate of substitution (*MRS*) is the slope of the indifference curve. The marginal rate of substitution can also be expressed in terms of marginal utilities. If Lisa has 10 burritos and 4 pizzas in a semester and gets one more pizza, her utility rises. That extra utility is the marginal utility from the last pizza, MU_Z. Similarly, if she received one extra burrito instead, her marginal utility from the last burrito is MU_B.

Suppose that Lisa trades from one bundle on an indifference curve to another by giving up some burritos to gain more pizza. She gains marginal utility from the extra pizza but loses marginal utility from fewer burritos. As Appendix 4A shows, the marginal rate of substitution can be written as

$$MRS = \frac{\Delta B}{\Delta Z} = -\frac{MU_Z}{MU_B}. \tag{4.1}$$

The *MRS* is the negative of the ratio of the marginal utility of another pizza to the marginal utility of another burrito.

4.3 BUDGET CONSTRAINT

You can't have everything. . . . Where would you put it? —Steven Wright

Knowing an individual's preferences is only the first step in analyzing that person's consumption behavior. Consumers maximize their well-being subject to constraints. The most important constraint most of us face in deciding what to consume is our personal budget constraint.

If we cannot save and borrow, our budget is the income we receive in a given period. If we can save and borrow, we can save money early in life to consume later, such as when we retire; or we can borrow money when we are young and repay these sums later in life. Savings is, in effect, a good that consumers can buy. For simplicity, we assume that each consumer has a fixed amount of money to spend now, so we can use the terms *budget* and *income* interchangeably.

For graphical simplicity, we assume that consumers spend their money on only two goods. If Lisa spends all her budget, Y, on pizza and burritos, then

$$p_B B + p_Z Z = Y, \tag{4.2}$$

where $p_B B$ is the amount she spends on burritos and $p_Z Z$ is the amount she spends on pizzas. Equation 4.2 is her budget constraint. It shows that her expenditures on burritos and pizza use up her entire budget.

How many burritos can Lisa buy? Subtracting $p_Z Z$ from both sides of Equation 4.2 and dividing both sides by p_B, we determine the number of burritos she can purchase to be

$$B = \frac{Y - p_Z Z}{p_B}. \tag{4.3}$$

According to Equation 4.3, she can buy more burritos with a higher income, a lower price of burritos or pizza, or the purchase of fewer pizzas.[7] For example, if she has one more dollar of income (Y), she can buy $1/p_B$ more burritos.

If $p_Z = \$1$, $p_B = \$2$, and $Y = \$50$, Equation 4.2 is

$$B = \frac{\$50 - (\$1 \times Z)}{\$2} = 25 - \tfrac{1}{2}Z. \tag{4.4}$$

As this equation shows, every two pizzas cost Lisa one burrito. How many burritos can she buy if she spends all her money on burritos? By setting $Z = 0$ in Equation 4.3, we find that $B = Y/p_B = \$50/\$2 = 25$. Similarly, if she spends all her money on pizza, $B = 0$ and $Z = Y/p_Z = \$50/\$1 = 50$.

Instead of spending all her money on pizza or all on burritos, she can buy some of each. Table 4.1 shows four possible bundles she could buy. For example, she can buy 20 burritos and 10 pizzas with \$50.

Equation 4.4 is plotted in Figure 4.6. This line is called a **budget line** or *budget constraint*: the bundles of goods that can be bought if the entire budget is spent on those goods at given prices. This budget line shows the combinations of burritos and pizzas that Lisa can buy if she spends all of her \$50 on these two goods. The four bundles in Table 4.1 are labeled on this line.

Table 4.1 Allocations of a \$50 Budget Between Burritos and Pizza

Bundle	Burritos	Pizza
a	25	0
b	20	10
c	10	30
d	0	50

[7] Using calculus, we find that $dB/dY = 1/p_B > 0$, $dB/dZ = -p_Z/p_B < 0$, $dB/dp_Z = -Z/p_B < 0$, and $dB/dp_B = -(Y - p_Z Z)/(p_B)^2 = -B/p_B < 0$.

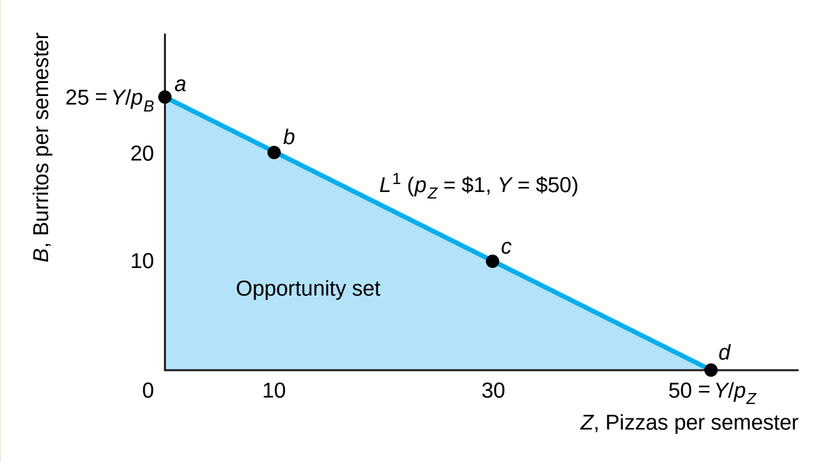


Figure 4.6 Budget Constraint. If $Y = \$50$, $p_Z = \$1$, and $p_B = \$2$, Lisa can buy any bundle in the opportunity set, the shaded area, including points on the *budget line*, L^1, which has a slope of $-\frac{1}{2}$.

Lisa could, of course, buy any bundle that cost less than \$50. The **opportunity set** is all the bundles a consumer can buy, including all the bundles inside the budget constraint and on the budget constraint (all those bundles of positive Z and B such that $p_B B + p_Z Z \le Y$). Lisa's opportunity set is the shaded area in the figure. She could buy 10 burritos and 15 pieces of pizza for \$35, which falls inside the constraint. Unless she wants to spend the other \$15 on some other good, though, she might as well spend all of it on the food she loves and pick a bundle on the budget constraint rather than inside it.

Slope of the Budget Constraint

Every extra unit of Z that Lisa purchases reduces B by $-p_Z/p_B$, according to Equation 4.3, so the slope of the budget line is $\Delta B/\Delta Z = -p_Z/p_B$. The slope of the budget line is called the **marginal rate of transformation** (MRT): the trade-off the market imposes on the consumer in terms of the amount of one good the consumer must give up to obtain more of the other good. The marginal rate of transformation is the rate at which Lisa can trade burritos for pizza in the marketplace:

$$MRT = \frac{\Delta B}{\Delta Z} = -\frac{p_Z}{p_B}. \tag{4.5}$$

Because the price of pizza is half that of a burrito ($p_Z = \$1$ and $p_B = \$2$), the marginal rate of transformation Lisa faces is

$$MRT = -\frac{p_Z}{p_B} = -\frac{\$1}{\$2} = -\frac{1}{2}.$$

An extra pizza costs her half an extra burrito—or, equivalently, an extra burrito costs her two pizzas.

Purchasing Fractional Quantities

The budget constraint in Figure 4.6 is a smooth, continuous line, and the opportunity set includes all the points inside that constraint. Implicitly, this drawing implies that Lisa can buy fractional numbers of burritos and pizzas. Is that true? Do you know of a restaurant that will sell you a quarter of a burrito? Probably not.

Why then don't we draw the opportunity set and the budget constraint as points (bundles) of whole numbers of burritos and pizzas? The reason is that Lisa can buy a burrito at a *rate* of one-half per time period. If Lisa buys one burrito every other week, she buys an average of one-half burrito every week. Thus it is plausible that she could purchase fractional amounts over time, and this diagram concerns her behavior over a semester.

Effect of a Change in Price on Consumption

If the price of pizza doubles but the price of burritos is unchanged, the budget constraint swings in toward the origin in panel a of Figure 4.7. If Lisa spends all her money on burritos, she can buy as many burritos as before, so the budget line still hits the burrito axis at 25. If she spends all her money on pizza, however, she can now buy only half as many pizzas as before, so the budget line intercepts the pizza axis at 25 instead of at 50.

The new budget constraint is steeper and lies inside the original one. As the price of pizza increases, the slope of the budget line, MRT, changes. On the original line, L^1, $MRT = -\frac{1}{2}$. On the new line, L^2, $MRT = p_Z/p_B = -\$2/\$2 = -1$. Lisa is unambiguously worse off (unless she wants to eat burritos only), because she can no longer afford the combinations of pizza and burritos in the shaded area.

A decrease in the price of pizza would have the opposite effect: The budget line would rotate outward around the intercept of the line and the burrito axis. As a result, the opportunity set would increase.

Effect of a Change in Income on Consumption

If the consumer's income increases, the consumer can buy more of all goods. Suppose that Lisa's income increases by \$50 per semester to $Y = \$100$. Her budget constraint shifts outward—away from the origin—and is parallel to the original constraint in panel b of Figure 4.7. Why is the new constraint parallel to the original one? The intercept of the budget line on the burrito axis is Y/p_B, and the intercept on the pizza axis is Y/p_Z. Thus holding prices constant, the intercepts shift outward in proportion to the change in income. Originally, if she spent all her money on pizza, Lisa could buy $50 = \$50/\$1$ pizzas; now she can buy $100 = \$100/\$1$. Similarly, the burrito axis intercept goes from $25 = \$50/\$2$ to $50 = \$100/\$2$.

A change in income affects only the position and not the slope of the budget line. The slope is determined solely by the relative prices of pizza and burritos. If the prices of both pizza and burritos fall by half, Lisa can buy twice as much as previously with the same budget. The budget line shifts outward parallel by the

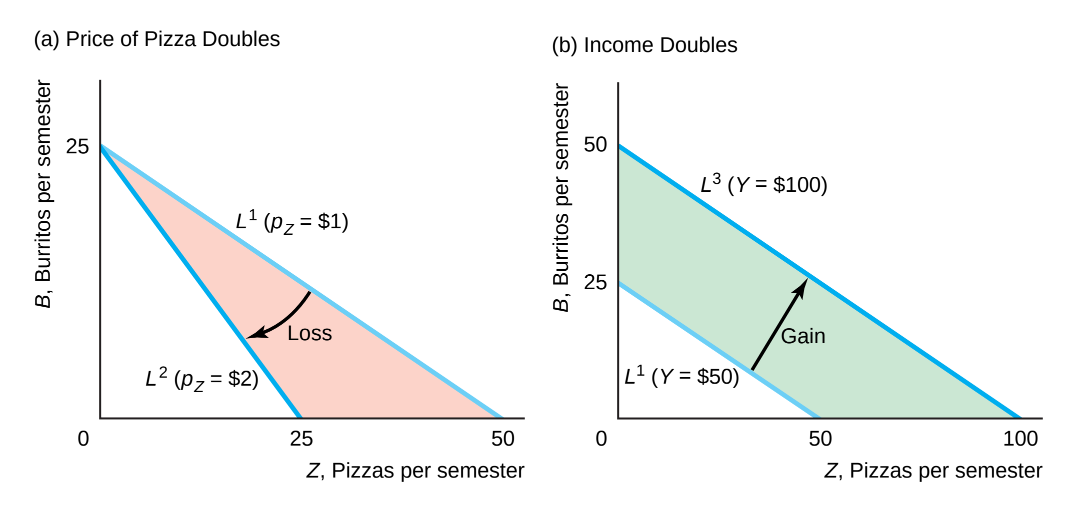


Figure 4.7 **Changes in the Budget Constraint.** (a) If the price of pizza increases from \$1 to \$2 a slice, Lisa's budget constraint rotates from L^1 to L^2 around the intercept on the burrito axis. The slope of the new budget line, L^2, is –1. The shaded area shows the combinations of pizza and burritos that she can no longer afford. (b) At the original prices, her new budget constraint moves from L^1 to L^2 if Lisa's income increases by \$50. This shift is parallel: Both budget lines have the same slope of $-\frac{1}{2}$. The new opportunity set is larger by the shaded area.

same amount as if her income doubles. Thus her opportunity set is identical if both prices drop by half *or* her budget doubles.

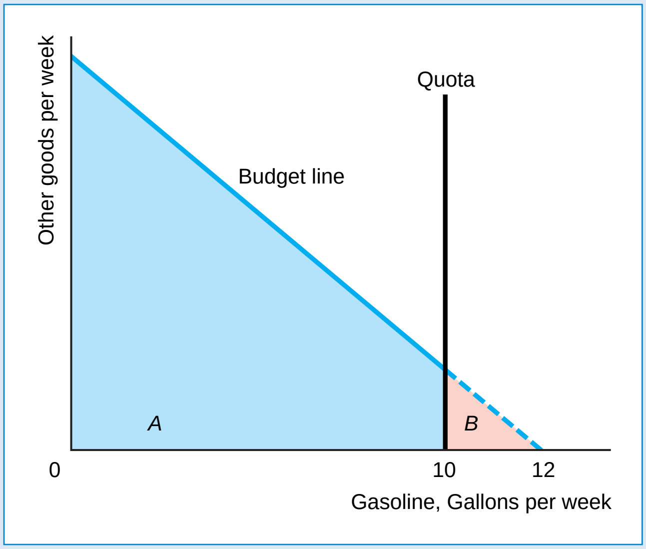
4.2 **During World War II, the U.S. and British governments rationed gasoline, setting quotas on how much a consumer could purchase. If a consumer could afford to buy 12 gallons a week but the government restricted purchases to no more than 10 gallons a week, what happened to the consumer's opportunity set?[8]**

Answer

1. *Draw the original opportunity set using a budget line between gasoline and all other goods*: In the graph, the consumer can afford to buy up to 12 gallons of gasoline a week if not constrained. The opportunity set, areas *A* and *B*, is bounded by the axes and the budget line.

[8]Jack Benny, Gracie Allen, and Eddie Cantor humorously describe gas rationing at **www.ibiscom.com/vogas.htm.**

2. *Add a line to the figure showing the quota, and determine the new opportunity set*: A vertical line at 10 on the gasoline axis indicates the quota.



The new opportunity set, area *A*, is bounded by the axes, the budget line, and the quota line.

3. *Compare the two opportunity sets*: Because of the rationing, the consumer loses part of the original opportunity set: the triangle *B* to the right of the 10 gallons line. The consumer has fewer opportunities because of rationing.

4.4 CONSTRAINED CONSUMER CHOICE

My problem lies in reconciling my gross habits with my net income.

—Errol Flynn

Were it not for the budget constraint, consumers who prefer more to less would consume unlimited amounts of all goods. Well, they can't have it all! Instead, consumers maximize their well-being subject to their budget constraints. To complete our analysis of consumer behavior, we have to determine the bundle of goods that maximizes well-being subject to the budget constraint.

The Consumer's Optimal Bundle

To determine which of the points on the budget constraint gives Lisa the highest level of pleasure, we use her indifference curves in panel a of Figure 4.8.[9] We will show that her optimal bundle lies on an indifference curve that touches the budget constraint at only one point (e on I^2)—hence the indifference curve does not cross

[9]Appendix 4B uses calculus to determine the bundle that maximizes utility subject to the budget constraint.

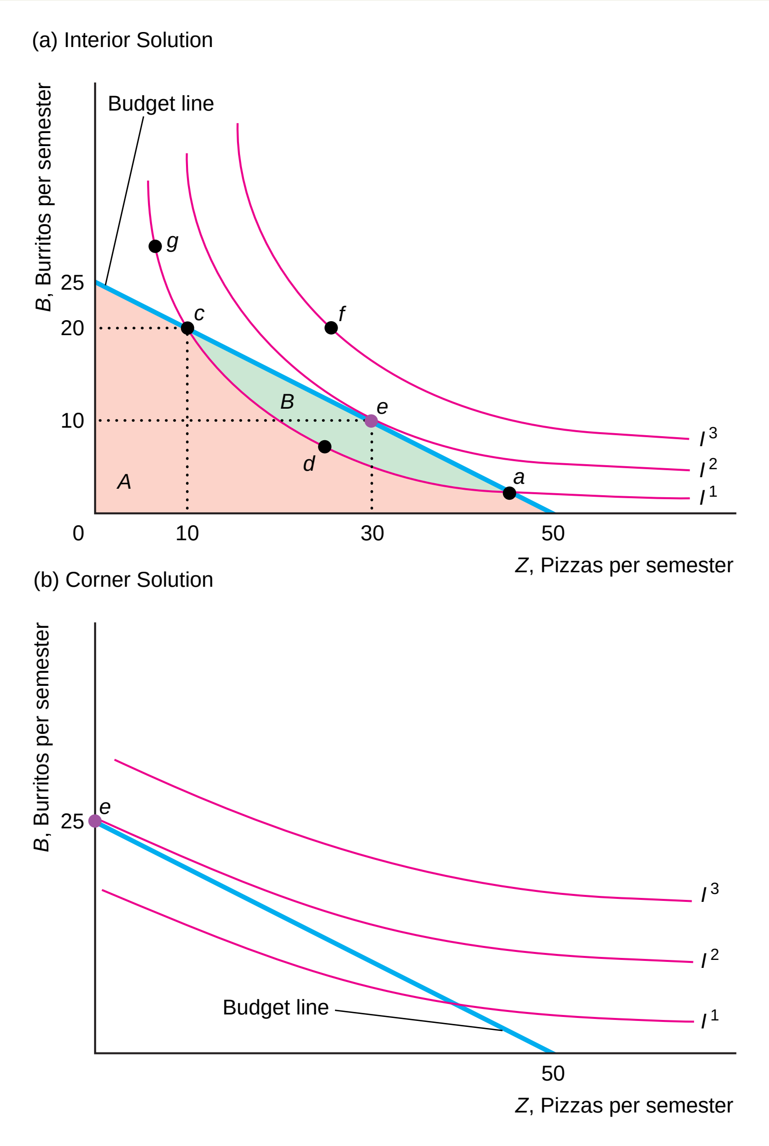


Figure 4.8 Consumer Maximization. (a) *Interior solution:* Lisa's optimal bundle is *e* (10 burritos and 30 slices of pizza) on indifference curve I^2. Any bundle that is preferred to *e* (such as points on indifference curve I^3) lies outside of the opportunity set—it can't be purchased. Bundles inside the opportunity set, such as *d*, are less desirable than *e*. (b) *Corner solution:* Spenser's indifference curves are relatively flat (he'll give up many pizzas for one more burrito), so his optimal bundle occurs at a corner of the opportunity set at Bundle *e*: 25 burritos and 0 pizzas.

the constraint. We show this result by rejecting the possibility that the optimal bundle could be located off the budget constraint or that it lies on an indifference curve that intersects the budget constraint.

The optimal bundle must be on the budget constraint. Bundles that lie on indifference curves above the constraint, such as those on I^3, are not in the opportunity set. So even though Lisa prefers *f* on indifference curve I^3 to *e* on I^2, *f* is too expensive and she can't purchase it. Although Lisa could buy a bundle inside the budget constraint, she does not want to do so, because more is better than less: For any bundle inside the constraint (such as *d* on I^1), there is another bundle on the constraint with more of at least one of the two goods, and hence she prefers that bundle. Therefore, the optimal bundle must lie on the budget constraint.

Bundles that lie on indifference curves that cross the budget constraint (such as I^1, which crosses the constraint at *a* and *c*) are less desirable than certain other bundles on the constraint. Only some of the bundles on indifference curve I^1 lie within the opportunity set: Bundles *a* and *c* and all the points on I^1 between them, such as *d*, can be purchased. Because I^1 crosses the budget constraint, the bundles between *a* and *c* on I^1 lie strictly inside the constraint, so there are bundles in the opportunity set (area $A + B$) that are preferable to these bundles on I^1 and affordable. By the more-is-better property, Lisa prefers *e* to *d* because *e* has more of both pizza and burritos than *d*. By transitivity, *e* is preferred to *a*, *c*, and all the other points on I^1—even those, like *g*, that Lisa can't afford. Because indifference curve I^1 crosses the budget constraint, area *B* contains at least one bundle that is preferred to—lies above and to the right of—at least one bundle on the indifference curve.

Thus the optimal bundle must lie on the budget constraint and be on an indifference curve that does not cross it. Such a bundle is the *consumer's optimum*. If Lisa is consuming this bundle, she has no incentive to change her behavior by substituting one good for another.

So far we've shown that the optimal bundle must lie on an indifference curve that touches the budget constraint but does not cross it. There are two ways that outcome can be reached. The first is an *interior solution*, in which the optimal bundle has positive quantities of both goods: The optimal bundle is on the budget line other than at one end or the other. The other possibility is called a *corner solution*, where the optimal bundle is at one end or the other of the budget line: It is at a corner with one of the axes.

Interior Solution. In panel a of Figure 4.8, Bundle *e* on indifference curve I^2 is the optimum bundle. It lies in the interior of the budget line away from the corners. Lisa prefers consuming a balanced diet, *e*, of 10 burritos and 30 pizzas, to eating only one type of food or the other.

For the indifference curve I^2 to touch the budget constraint but not cross it, it must be *tangent* to the budget constraint: The budget constraint and the indifference curve have the same slope at the point *e* where they touch. The slope of the indifference curve, the marginal rate of substitution, measures the rate at which Lisa is *willing* to trade burritos for pizza: $MRS = -MU_Z/MU_B$, Equation 4.1. The slope of the budget line, the marginal rate of transformation, measures the rate at which Lisa *can* trade her money for burritos or pizza in the market: $MRT = -p_Z/p_B$, Equation 4.5. Thus Lisa's utility is maximized at the bundle where the rate at which she is willing to trade burritos for pizza equals the rate at which she can trade:

$$MRS = -\frac{MU_Z}{MU_B} = -\frac{p_Z}{p_B} = MRT.$$

Rearranging terms, this condition is equivalent to

$$\frac{MU_Z}{p_Z} = \frac{MU_B}{p_B}. \tag{4.6}$$

Equation 4.6 says that the marginal utility of pizza divided by the price of a pizza (the amount of extra utility from pizza per dollar spent on pizza), MU_Z/p_Z, equals the marginal utility of burritos divided by the price of a burrito, MU_B/p_B. Thus Lisa's utility is maximized if the last dollar she spends on pizza gets her as much extra utility as the last dollar she spends on burritos. If the last dollar spent on pizza gave Lisa more extra utility than the last dollar spent on burritos, Lisa could increase her happiness by spending more on pizza and less on burritos.

Corner Solution. Spenser's indifference curves in panel b of Figure 4.8 are flatter than Lisa's. His optimal bundle lies on an indifference curve that touches the opportunity set only once, at the upper-left corner of the opportunity set, *e*, where he buys only burritos (25 burritos and 0 pizzas).

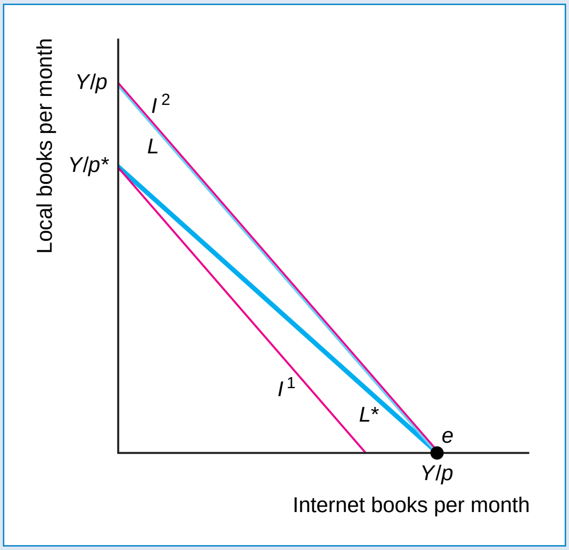
Bundle *e* is the optimal bundle because the indifference curve does not cross the constraint into the opportunity set. If it did, another bundle would give Spenser more pleasure.

Spenser's indifference curve is not tangent to his budget line. It would cross the budget line if both the indifference curve and the budget line were continued into the "negative pizza" region of the diagram, on the other side of the burrito axis.

4.3 **Steven is indifferent between purchasing books from a local store and ordering them over the Internet because the price per book is *p* at either outlet. The local government introduces a tax on purchases from the local bookstore that raises the price per book to p^*, but Internet purchases remain untaxed. How will the tax affect the number of books Steven purchases and where he buys them?**

Answer

1. *Describe Steven's indifference curves for local and Internet books*: Because Steven views these books as perfect substitutes, his indifference curves, such as I^1 and I^2 in the figure, are straight lines with a slope of –1.



2. *Draw his initial budget line, and describe his optimum*: If Steven spends Y per week on books, he can buy Y/p books locally or Y/p over the Internet or any combination adding to Y/p from the two sources. Thus his initial budget constraint, L, is a straight line with a slope of –1 that hits each axis at Y/p. Because L is identical to his indifference curve I^2, any point along I^2 could be his optimal bundle.

3. *Draw the new budget line after the local tax is imposed, and show the new optimum:* After the tax is imposed, Steven's budget line L^* hits the Internet (horizontal) axis at Y/p and the local (vertical) axis at Y/p^*. Thus he can still buy Y/p books over the Internet but fewer books, Y/p^*, locally. He maximizes his utility by purchasing Y/p books over the Internet, point e, where I^2 hits L^* at the Internet axis.

Application

TAXES AND INTERNET SHOPPING

The 1998 Internet Tax Freedom Act put a three-year moratorium on e-commerce taxation. U.S. consumers who buy goods over the Internet (or by mail) are not liable for sales taxes on purchases from out-of-state vendors. Freedom from taxes has helped drive the 300%-per-year growth of online sales. This ban was extended for two more years in 2001.

As consumers shift their purchases to the Internet, state and local governments lose tax revenues. Consequently, the National Governors Association (NGA) called for a uniform tax of 5% on all Internet sales. In addition, many traditional retailers, including Wal-Mart, called for a change in the e-commerce taxation policy in 2000.

Some people are willing to pay a premium to shop locally. Others would pay more for the convenience of shopping over the Internet. However, those who are indifferent between the two means of shopping are sensitive to the higher local taxes.

Goolsbee (2001) finds that a 1% increase in computer retail prices in a city raises the likelihood that a resident of that city will buy over the Internet by 1.55%. Goolsbee (2000) finds that people who live in high-sales-tax areas are much more likely than other consumers to purchase over the Internet. He estimates that the NGA's flat 5% tax would lower the number of online customers by 18% and total sales by 23%. Alternatively, if each state could impose its own taxes (which average 6.33%), the number of buyers would fall by 24% and spending by 30%.

★Optimal Bundles on Convex Sections of Indifference Curves

Earlier we argued, on the basis of introspection, that most indifference curves are convex to the origin. Now that we know how to determine a consumer's optimal bundle, we can give a more compelling explanation about why we assume that indifference curves are convex. We can show that, if indifference curves are smooth,

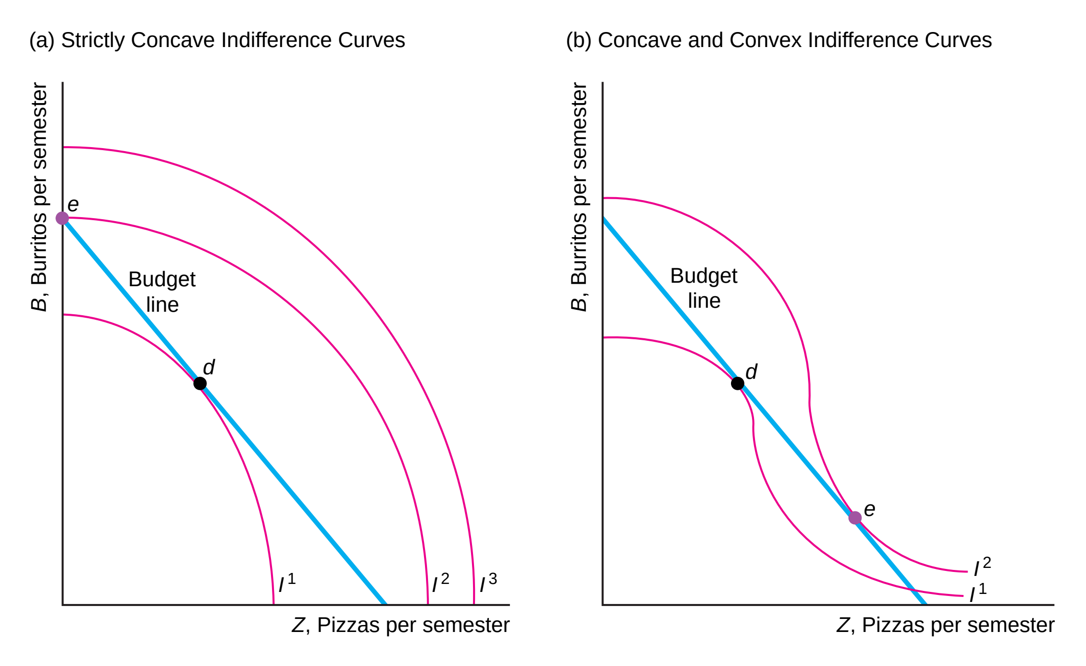


Figure 4.9 Optimal Bundles on Convex Sections of Indifference Curves. (a) Indifference curve I^1 is tangent to the budget line at Bundle *d*, but Bundle *e* is superior because it lies on a higher indifference curve, I^2. If indifference curves are strictly concave to the origin, the optimal bundle, *e*, is at a corner. (b) If indifference curves have both concave and convex sections, a bundle such as *d*, which is tangent to the budget line in the concave portion of indifference curve I^1, cannot be an optimal bundle because there must be a preferable bundle in the convex portion of a higher indifference curve, *e* on I^2 (or at a corner).

optimal bundles lie either on convex sections of indifference curves or at the point where the budget constraint hits an axis.

Suppose that indifference curves were strictly concave to the origin as in panel a of Figure 4.9. Indifference curve I^1 is tangent to the budget line at *d*, but that bundle is not optimal. Bundle *e* on the corner between the budget constraint and the burrito axis is on a higher indifference curve, I^2, than *d* is. Thus if a consumer had strictly concave indifference curves, the consumer would buy only one good—here, burritos. Similarly, as we saw in Solved Problem 4.3, consumers with straight-line indifference curves buy only the cheapest good. Because we do not see consumers buying only one good, indifference curves must have convex sections.

If indifference curves have both concave and convex sections as in panel b of Figure 4.9, the optimal bundle lies in a convex section or at a corner. Bundle *d*, where a concave section of indifference curve I^1 is tangent to the budget line, cannot be an optimal bundle. Here, e is the optimal bundle and is tangent to the budget constraint in the convex portion of the higher indifference curve I^2. *If a consumer buys positive quantities of two goods, the indifference curve is convex and tangent to the budget line at that optimal bundle.*

Buying Where More Is Better

A key assumption in our analysis of consumer behavior is that more is preferred to less: Consumers are not satiated. We now show that, if both goods are consumed in positive quantities and their prices are positive, more of either good must be preferred to less. Suppose that the opposite were true and that Lisa prefers fewer burritos to more. Because burritos cost her money, she could increase her well-being by reducing the amount of burritos she consumes until she consumes no burritos—a scenario that violates our assumption that she consumes positive quantities of both goods.[10] Though it is possible that consumers prefer less to more at some large quantities, we do not observe consumers making purchases where that occurs.

In summary, we do not observe consumer optima at bundles where indifference curves are concave or consumers are satiated. Thus we can safely assume that indifference curves are convex and that consumers prefer more to less in the ranges of goods that we actually observe.

4.4 **Alexx doesn't care about where he lives, but he does care about what he eats. Alexx spends all his money on restaurant meals at either American or French restaurants. His firm offers to transfer him from its Miami office to its Paris office, where he will face different prices. The firm will pay him a salary in French francs such that he can buy the same bundle of goods in Paris that he is currently buying in Miami.[11] Will Alexx benefit by moving to Paris?**

Answer

1. *Show Alexx's optimum in the United States*: Alexx's optimal bundle, a, in the United States is determined by the tangency of his indifference curve I^1 and his American budget constraint L^A in the graph.

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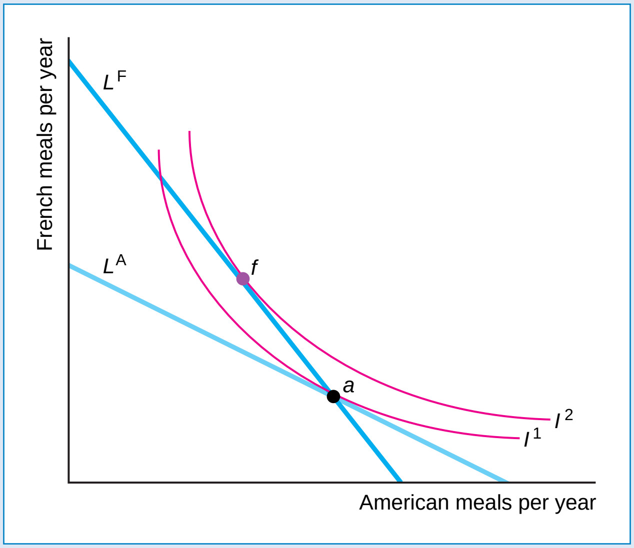
[10]Similarly, at her optimal bundle, Lisa cannot be *satiated*—indifferent between consuming more or fewer burritos. Suppose that her budget is obtained by working and that Lisa does not like working at the margin. Were it not for the goods she can buy with what she earns, she would not work as many hours as she does. Thus if she were satiated and did not care if she consumed fewer burritos, she would reduce the number of hours she worked, thereby lowering her income, until her optimal bundle occurred at a point where more was preferred to less or she consumed none.

[11]According to Organization Resource Copunselors, Inc., 79% of international firms surveyed report that they provide their workers with enough income abroad to maintain their home lifestyle.



2. *Discuss what happens if prices are higher in France but the relative prices between American and French meals are the same*: If the prices of both French and American meals are x times higher in France than in the United States, the relative cost of French and American meals are the same. If the firm raises Alexx's income x times, his budget line does not change. Thus if relative prices are the same in Miami and Paris, his budget line and optimal bundle are unchanged, so his level of utility is unchanged.

3. *Show the new optimum if relative prices in France differ from those in the United States*: Alexx's firm adjusts his income so that Alexx can buy the same bundle, a, as in the United States, so his new budget line in France, L^F, must go through a. Suppose that French meals are relatively less expensive than American meals in Paris. If Alexx spends all his money on French meals, he can buy more in Paris than in the United States, and if he spends all his money on American meals, he can buy fewer in Paris than in the United States. As a result, L^F hits the vertical axis at a higher point than the L^A line and cuts the L^A line at Bundle a. Alexx's new optimal bundle, f, is determined by the tangency of I^2 and L^F. Thus if relative prices are different in Paris and Miami, Alexx is better off with the transfer. He was on I^1 and is now on I^2. Alexx could buy his original bundle, a, but chooses to substitute toward French meals, which are relatively inexpensive in France, thereby raising his utility.[12]

[12]If French meals were relatively more expensive than American meals in Paris, the L^F budget line would cut the L^A budget line from below rather than from above as shown. However, the analysis would be essentially unchanged. Whether both prices, one price, or neither price is higher than in the United States is irrelevant to our analysis.

Food Stamps

I've known what it is to be hungry, but I always went right to a restaurant.

—Ring Lardner

We can use the theory of consumer choice to analyze whether poor people are better off receiving food stamps or a comparable amount of cash. Currently, federal, state, and local governments work together to provide a food subsidy for poor Americans. Nearly 11% of U.S. households worry about having enough money to buy food and 3.3% report that they suffer from inadequate food (Sullivan and Choi, 2002). Households that meet income, asset, and employment eligibility requirements receive coupons that can be used to purchase food from retail stores. The Food Stamps Program is one of the nation's largest social welfare programs with expenditures of $17.7 billion for nearly 17.3 million people per month in 2001.

Since the food stamp programs started in the early 1960s, economists, nutritionists, and policymakers have debated "cashing out" food stamps by providing checks or cash instead of coupons that can be spent only on food. Legally, food stamps may not be sold, though a black market for them exists. Because of technological advances in electronic fund transfers, switching from food stamps to a cash program would lower administrative costs and reduce losses due to fraud and theft.

Would a switch to a comparable cash subsidy increase the well-being of food stamp recipients? Would the recipients spend less on food and more on other goods?

Cash Preferred to Food Stamps. Poor people who receive cash have more choices than those who receive a comparable amount of food stamps. With food stamps, only extra food can be obtained. With cash, either food or other goods can be purchased. As a result, a cash grant raises a recipient's opportunity set by more than food stamps of the same value do, as we now show.

In Figure 4.10, the price of a unit of food and the price of all other goods are both $1, with an appropriate choice of units. A person with a monthly income of Y has a budget line that hits both axes at Y: The person can buy Y units of food per month, Y units of all other goods, or any linear combination. The opportunity set is area A.

If that person receives a subsidy of $100 in cash per month, the person's new monthly income is $Y + \$100$. The budget constraint with cash hits both axes at $Y + 100$ and is parallel to the original budget constraint. The opportunity set increases by $B + C$ to $A + B + C$.

If the person receives $100 worth of food stamps, the food stamp budget constraint has a kink. Because the food stamps can be spent only on food, the budget constraint shifts 100 units to the right for any quantity of other goods up to Y units. For example, if the recipient buys only food, now $Y + 100$ units of food can be purchased. If the recipient buys only other goods with the original Y income, that person can get Y units of other goods plus 100 units of food. However, the food stamps cannot be turned into other goods, so the recipient can't buy $Y + 100$ units of other goods, as can be done under the cash transfer program. The food stamps opportunity set is areas $A + B$, which is larger than the presubsidy opportunity set by B. The opportunity set with food stamps is smaller than that with the cash transfer program by C.

A recipient benefits as much from cash or an equivalent amount of food stamps if the recipient would have spent at least $100 on food if given cash. In other words, the

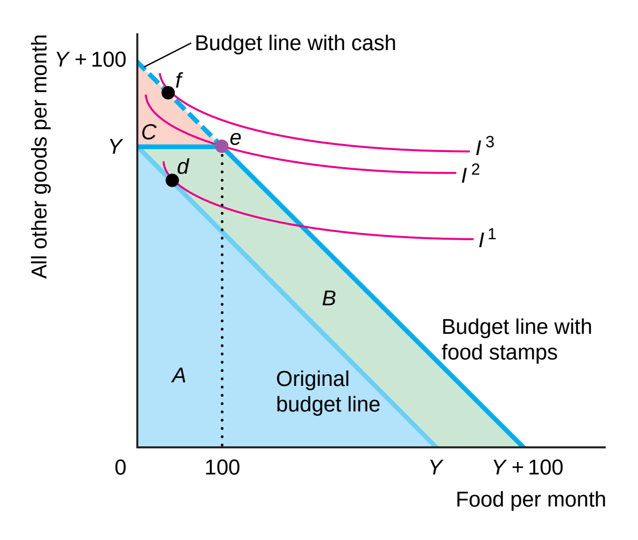


Figure 4.10 Food Stamps Versus Cash. The lighter line shows the original budget line of an individual with *Y* income per month. The heavier line shows the budget constraint with \$100 worth of food stamps. The budget constraint with a grant of \$100 in cash is a line between *Y* + 100 on both axes. The opportunity set increases by area *B* with food stamps but by *B* + *C* with cash. An individual with these indifference curves consumes Bundle *d* (with less than 100 units of food) with no subsidy, *e* (*Y* units of all other goods and 100 units of food) with food stamps, and *f* (more than *Y* units of all other goods and less than 100 units of food) with a cash subsidy. This individual's utility is greater with a cash subsidy than with food stamps.

individual is indifferent between cash and food stamps if that person's indifference curve is tangent to the downward-sloping section of the food stamp budget constraint.

Conversely, if the recipient would not spend at least \$100 on food if given cash, the recipient prefers receiving cash to food stamps. Figure 4.10 shows the indifference curves of an individual who prefers cash to food stamps. This person chooses Bundle *e* (*Y* units of all other goods and 100 units of food) if given food stamps but Bundle *f* (more than *Y* units of all other goods and less than 100 units of food) if given cash. This individual is on a higher indifference curve, I^2 rather than I^1, if given cash rather than food stamps.

FOOD STAMP EXPERIMENTS

There are four effects of giving recipients cash instead of food stamps: (1) some individuals consume less food and more of other goods, (2) some individuals consume fewer nutrients, (3) the administrative costs of these welfare programs fall, and (4) each recipient's utility stays the same or rises.

According to a review of statistical analyses (Fraker, 1990), an additional dollar of income causes an average low-income household to increase its food expenditures by 5¢ to 10¢, and an additional dollar of food stamps leads to a 20¢ to 45¢ increase in food expenditures. Experiments (Moffitt, 1989; Fasciano, Hall, and Beebout, 1993; Carlson, 1993) show that responses to cashing out vary by area and demographic group. In Puerto Rico, giving cash instead of food stamps had no detectable influence on food expenditures; however, black market trafficking in food stamps was apparently widespread. In three out of four studies in the United States, researchers found that giving cash reduces household food expenditures, but the magnitude of the effect varies widely, from negligible to 17%. However, Gunderson and Olivera (2001) find that food stamp participants are more likely to have inadequate food than eligible nonparticipants, suggesting that recipients are the hungriest of the poor.

Three studies of the nutrition effects of substituting cash for food stamps found no effect in Alabama, a 5% drop in San Diego, and a 6% to 11% decline in nutrients in Washington State. Even in Washington, however, cash recipients consumed far in excess of the recommended daily allowance of most nutrients. However, Gundersen and Olivera (2001) find that food stamp participants are more likely to have inadequate food then eligible nonparticpants, suggesting that recipients are the hungriest of the poor.

A 1980 experiment involving elderly recipients in nine sites around the United States and a 1982 experiment in Puerto Rico show that the administrative costs and losses due to fraud and theft could be substantially reduced by switching to cash. Administrative costs fell from $2.05 to $1.03 per case per month in Alabama when checks were used. The government replaces lost or stolen checks but not clients' coupons that are lost or stolen, an additional benefit to recipients under the cash program.

If recipients spend less on food under the cash program, presumably they achieve higher utility from that program. Recipients report preferring cash. Of recipients in San Diego and Alabama, 4 out of 10 mentioned the greater choice of goods with cash. Other reported advantages of the cash program were a greater choice of stores and fewer feelings of embarrassment. Indeed, it is possible that the stigma of using food stamps may discourage participation in food stamp programs. Only 54% of families with children and incomes below the poverty line participated in the program in 1999 (Winick, 2001). To make participating easier, the federal government required that all states provide food stamps using ATM-like cards by 2001, as shown in the photo.

Why We Give Food Stamps. Two groups in particular object to giving cash instead of food stamps: some policymakers, because they fear that cash might be spent on booze or drugs, and some nutritionists, who worry that poor people will spend the money on housing or other goods and get too little nutrition.

In response, many economists argue that poor people are the best judges of how to spend their scarce resources. The question of whether it is desirable to let poor people choose what to consume is normative (a question of values), and economic theory cannot answer it. How poor people will change their behavior, however, is a positive (scientific) question, which we can analyze. Experiments to date find that cash recipients consume slightly lower levels of food but receive at least adequate levels of nutrients and that they prefer receiving cash.

Given that recipients are as well off or better off receiving cash than food stamps, why do we have food stamp programs instead of providing cash? The introduction to a report by the U.S. Department of Agriculture's Food and Nutrition Service, which administers the food stamp program (Fasciano, Hall, and Beebout, 1993, p. 6), offers this explanation:

> From the perspective of recipient households, cash is more efficient than coupons in that it permits each household to allocate its resources as it sees fit. . . . But in a more general sense, recipients' welfare clearly depends on public support for the program. And what evidence we have suggests that taxpayers are more comfortable providing in-kind, rather than cash, benefits and may consequently be more generous in their support of a coupon-based program. The question of which benefit form best promotes the welfare of financially needy households is thus more complex than it might appear.

Summary

Consumers maximize their utility (well-being) subject to constraints based on their income and the prices of goods.

1. **Preferences:** To predict consumers' responses to changes in these constraints, economists use a theory about individuals' preferences. One way of summarizing consumers' preferences is with a family of indifference curves. An indifference curve consists of all bundles of goods that give the consumer a particular level of utility. On the basis of observations of consumers' behavior, economists assume that consumers' preferences have three properties: completeness, transitivity, and more is better. Given these three assumptions, indifference curves have the following properties:
   - Consumers get more pleasure from bundles on indifference curves the farther from the origin the curves are.
   - Indifference curves cannot cross.
   - There is an indifference curve through any given bundle.
   - Indifference curves have no thickness.
   - Indifference curves slope downward.
   - Consumers are observed purchasing positive quantities of all relevant goods only where their indifference curves are convex to the origin.
2. **Utility:** Economists call the set of numerical values that reflect the relative rankings of bundles of goods *utility*. Utility is an ordinal measure: By comparing the utility a consumer gets from each of two bundles, we know that the consumer prefers the bundle with the higher utility, but we can't tell by how much the consumer prefers that bundle. The marginal utility from a good is the extra utility a person gets from consuming one more unit of that good, holding the consumption of all other goods constant. The rate at which a consumer is willing to substitute Good 1 for Good 2, the marginal rate of substitution, *MRS*, depends on the relative amounts of marginal utility the consumer gets from each of the two goods.
3. **Budget constraint:** The amount of goods consumers can buy at given prices is limited by their income. As a result, the greater their income and the lower the prices of goods, the better off they

are. The rate at which they can exchange Good 1 for Good 2 in the market, the marginal rate of transformation, *MRT*, depends on the relative prices of the two goods.

4. **Constrained consumer choice:** Each person picks an affordable bundle of goods to consume so as to maximize his or her pleasure. If an individual consumes both Good 1 and Good 2 (an interior solution), the individual's utility is maximized when the following four equivalent conditions hold:
   - The indifference curve between the two goods is tangent to the budget constraint.
   - The consumer buys the bundle of goods that is on the highest obtainable indifference curve.
   - The consumer's marginal rate of substitution (the slope of the indifference curve) equals the marginal rate of transformation (the slope of the budget line).
   - The last dollar spent on Good 1 gives the consumer as much extra utility as the last dollar spent on Good 2.

   However, consumers do not buy some of all possible goods (corner solutions). The last dollar spent on a good that is actually purchased gives more extra utility than would a dollar's worth of a good the consumer chose not to buy.

Questions

QUIZ

1. Which of the following pairs of goods are complements, and which are substitutes? Are the goods that are substitutes likely to be perfect substitutes for some or all consumers?
   a. A popular novel and a gossip magazine
   b. A camera and film
   c. A gun and a stick of butter
   d. A Panasonic CD player and a JVC CD player
2. Gasoline was once less expensive in the United States than in Canada, but now gasoline costs less in Canada than in the United States due to a change in taxes. How will the gasoline-purchasing behavior of a Canadian who lives equally close to gas stations in both countries change? Answer using an indifference curve and budget line diagram.
3. Don is altruistic. Show the possible shape of his indifference curves between charity and all other goods.
4. Draw indifference curves with a good on one axis and a *neutral* product—one that the consumer is indifferent about whether or not to consume—on the other axis.
5. Give as many reasons as you can why we believe that indifference curves are convex.
6. What happens to a consumer's optimum if all prices and income double? (*Hint:* What happens to the intercepts of the budget line?)
7. In Spenser's state, a sales tax of 10% is applied to clothing but not to food. Show the effect of this tax on Spenser's choice between food and clothing using indifference curves.
8. What happens to the budget line if the government applies a specific tax of $1 per gallon on gasoline but does not tax other goods? What happens to the budget line if the tax applies only to purchases of gasoline in excess of 10 gallons per week?
9. What is the effect of a 50% income tax on Dale's budget line and opportunity set?
10. A poor person who has an income of $1,000 receives $100 worth of food stamps. Draw the budget constraint if the food stamp recipient can sell these coupons on the black market for less than their face value.
11. Is a poor person more likely to benefit from $100 a month worth of food stamps (that can be used only to buy food) or $100 a month worth of clothing stamps (that can be used only to buy clothing)? Why?
12. Since 1979, recipients have been given food stamps. Before 1979, however, people bought food stamps at a subsidized rate. For example, to get $1 worth of food stamps, a household paid about 15¢ (the exact amount varied by household characteristics and other factors). What is the budget constraint facing an individual if that individual may buy up to $100 per month in food stamps at 15¢ per each $1 coupon?
13. Show how much an individual's opportunity set increases if the government gives food stamps rather than sells them at subsidized rates.
14. *Review* (Chapter 2): The Clinton administration removed the ban that prevented U.S. companies from exporting personal computers to Eastern

European countries. Companies in other countries also sell computers in those countries. What is the likely effect of this change in policy on the equilibrium price and quantity in Eastern Europe?

15. *Review* (Chapter 3): As a consumer, should you care whether a 15¢-per-gallon milk tax is collected from stores or from consumers? Use graphs to explain why or why not.

Problems

16. Julia consumes cans of anchovies, A, and boxes of biscuits, B. Each of her indifference curves reflects strictly diminishing marginal rates of substitution. Where $A = 2$ and $B = 2$, her marginal rate of substitution between cans of anchovies and boxes of biscuits equals -1 ($= MU_A/MU_B$). Will she prefer a bundle with three cans of anchovies and a box of biscuits to a bundle with two of each? Why?
17. David's utility function is $U = B + 2Z$. Describe the location of his optimal bundle (if possible) in terms of the relative prices of B and Z.
18. Linda loves buying shoes and going out to dance. Her utility function for pairs of shoes, S, and the number of times she goes dancing per month, T, is $U(S, T) = 2ST$. It costs Linda \$50 to buy a new pair of shoes or to spend an evening out dancing. Assume that she has \$500 to spend on clothing and dancing.
    a. What is the equation for her budget line? Draw it (with T on the vertical axis), and label the slope and intercepts.
    b. What is Linda's marginal rate of substitution? Explain.
    c. Solve mathematically for her optimal bundle. Show how to determine this bundle in a diagram using indifference curves and a budget line.
19. Vasco's utility function is $U = 10X^2Z$. The price of X is $p_X = \$10$, the price of Z is $p_z = \$5$, and his income is $Y = \$150$. What is his optimal consumption bundle? Show in a graph.
20. Diogo has a utility function $U(B, Z) = AB^{\alpha}Z^{\beta}$, where A, α, and β are constants, B is burritos, and Z is pizzas. If the price of burritos, p_B, is \$2 and the price of pizzas, p_Z, is \$1, what is Tara's optimal bundle?
21. If José Maria's utility function is $U(B, Z) = B + AB^{\alpha}Z^{\beta} + Z$, what is his marginal utility of Z? What is his marginal rate of substitution between these two goods?
22. ★ Fiona requires a minimum level of consumption, a *threshold*, to derive additional utility: $U(X, Z)$ is 0 if $X + Z \le 5$ and is $X + Z$ otherwise. Draw Fiona's indifference curves. Which of our usual assumptions are violated by this example?