# section 14

**Module 79:** The Economics of Information

**Economics by Example:**
"How Gullible Are We?"

**Module 80:** Indifference Curves and Consumer Choice

**Economics by Example:**
"Why Is Cash the Ultimate Gift?"

# Appendix

Modules 79 and 80 present optional material. While these topics are not currently part of the AP exam, the economics of information and indifference curves are an important part of contemporary economic theory and you will be sure to see them in future courses.

What you will learn in this **Module:**

- The special problems posed by private information—situations in which some people know things that other people do not (also known as *asymmetric information*)
- How information asymmetries can lead to the problem of adverse selection (otherwise known as the *lemons problem*)
- How firms deal with the need for information, using screening and signaling
- How information asymmetries can lead to the problem of moral hazard

# Module 79 The Economics of Information

## Private Information: What You Don't Know Can Hurt You

Markets do very well at dealing with situations in which nobody knows what is going to happen. However, markets have much more trouble with situations in which *some people know things that other people don't know*—situations of **private information** (also known as "asymmetric information"). As we will see, private information can distort economic decisions and sometimes prevent mutually beneficial economic transactions from taking place.

Why is some information private? The most important reason is that people generally know more about themselves than other people do. For example, you know whether or not you are a careful driver; but unless you have already been in several accidents, your auto insurance company does not. You are more likely to have a better estimate than your health insurance company of whether or not you will need an expensive medical procedure. And if you are selling me your used car, you are more likely to be aware of any problems with it than I am.

But why should such differences in who knows what be a problem? It turns out that there are two distinct sources of trouble: *adverse selection,* which arises from having private information about the way things are, and *moral hazard,* which arises from having private information about what people do.

### Adverse Selection: The Economics of Lemons

Suppose that someone offers to sell you an almost brand-new car—purchased just three months ago, with only 2,000 miles on the odometer and no dents or scratches. Will you be willing to pay almost the same for it as for a car direct from the dealer?

Probably not, for one main reason: you cannot help but wonder why this car is being sold. Is it because the owner has discovered that something is wrong with it—that it is a "lemon"? Having driven the car for a while, the owner knows more about it than you do—and people are more likely to sell cars that give them trouble.

**Private information** is information that some people have that others do not.

You might think that the fact that sellers of used cars know more about them than buyers do represents an advantage to the sellers. But potential buyers know that potential sellers are likely to offer them lemons—they just don't know exactly which car is a lemon. Because potential buyers of a used car know that potential sellers are more likely to sell lemons than good cars, buyers will offer a lower price than they would if they had a guarantee of the car's quality. Worse yet, this poor opinion of used cars tends to be self-reinforcing, precisely because it depresses the prices that buyers offer. Used cars sell at a discount because buyers expect a disproportionate share of those cars to be lemons. Even a used car that is not a lemon would sell only at a large discount because buyers don't know whether it's a lemon or not. But potential sellers who have good cars are unwilling to sell them at a deep discount, except under exceptional circumstances. So good used cars are rarely offered for sale, and used cars that are offered for sale have a strong tendency to be lemons. (This is why people who have a compelling reason to sell a car, such as moving overseas, make a point of revealing that information to potential buyers—as if to say "This car is not a lemon!")

**Adverse selection** occurs when one person knows more about the way things are than other people do. Adverse selection exists, for example, when sellers offer items of particularly low (hidden) quality for sale, and when the people with the greatest need for insurance are those most likely to purchase it.

Adverse selection can be reduced through **screening:** using observable information about people to make inferences about their private information.



The end result, then, is not only that used cars sell for low prices but also that there are a large number of used cars with hidden problems. Equally important, many potentially beneficial transactions—sales of good cars by people who would like to get rid of them to people who would like to buy them—end up being frustrated by the inability of potential sellers to convince potential buyers that their cars are actually worth the higher price demanded. So some mutually beneficial trades between those who want to sell used cars and those who want to buy them go unexploited.

Although economists sometimes refer to situations like this as the "lemons problem" (the issue was introduced in a famous 1970 paper by economist and Nobel laureate George Akerlof entitled "The Market for Lemons"), the more formal name of the problem is **adverse selection.** The reason for the name is obvious: because the potential sellers know more about the quality of what they are selling than the potential buyers, they have an incentive to select the worst things to sell.

Adverse selection does not apply only to used cars. It is a problem for many parts of the economy—notably for insurance companies, and most notably for health insurance companies. Suppose that a health insurance company were to offer a standard policy to everyone with the same premium. The premium would reflect the *average* risk of incurring a medical expense. But that would make the policy look very expensive to healthy people, who know that they are less likely than the average person to incur medical expenses. So healthy people would be less likely than less healthy people to buy the policy, leaving the health insurance company with exactly the customers it doesn't want: people with a higher-than-average risk of needing medical care, who would find the premium to be a good deal. In order to cover its expected losses from this sicker customer pool, the health insurance company is compelled to raise premiums, driving away more of the remaining healthier customers, and so on. Because the insurance company can't determine who is healthy and who is not, it must charge everyone the same premium, thereby discouraging healthy people from purchasing policies and encouraging unhealthy people to buy policies.

Adverse selection can lead to a phenomenon called an *adverse selection death spiral* as the market for health insurance collapses: insurance companies refuse to offer policies because there is no premium at which the company can cover its losses. Because of the severe adverse selection problems, governments in many advanced countries assume the role of providing health insurance to their citizens. The U.S. government, through its various health insurance programs including Medicare, Medicaid, and the Children's Health Insurance Program, now disburses more than half the total payments for medical care in the United States.

In general, people or firms faced with the problem of adverse selection follow one of several well-established strategies for dealing with it. One strategy is **screening:** using observable information to make inferences about private information. If you apply to purchase health insurance, you'll find that the insurance company will demand documentation of your health status in an attempt to "screen out" sicker applicants, whom

Adverse selection can be diminished by people **signaling** their private information through actions that credibly reveal what they know.

A long-term **reputation** allows an individual to assure others that he or she isn't concealing adverse private information.

they will refuse to insure or will insure only at very high premiums. Auto insurance also provides a very good example. An insurance company may not know whether you are a careful driver, but it has statistical data on the accident rates of people who resemble your profile—and it uses those data in setting premiums. A 19-year-old male who drives a sports car and has already had a fender-bender is likely to pay a very high premium. A 40-year-old female who drives a minivan and has never had an accident is likely to pay much less. In some cases, this may be quite unfair: some adolescent males are very careful drivers, and some mature women drive their minivans as if they were F-16s. But nobody can deny that the insurance companies are right on average.

Another strategy is for people who are good prospects to somehow *signal* their private information. **Signaling** involves taking some action that wouldn't be worth taking unless they were indeed good prospects. Reputable used-car dealers often offer warranties—promises to repair any problems with the cars they sell that arise within a given amount of time. This isn't just a way of insuring their customers against possible expenses; it's a way of credibly showing that they are not selling lemons. As a result, more sales occur and dealers can command higher prices for their used cars.

Finally, in the face of adverse selection, it can be very valuable to establish a good **reputation:** a used-car dealership will often advertise how long it has been in business to show that it has continued to satisfy its customers. As a result, new customers will be willing to purchase cars and to pay more for that dealer's cars.

## Moral Hazard

In the late 1970s, New York and other major cities experienced an epidemic of suspicious fires—fires that appeared to be deliberately set. Some of the fires were probably started by teenagers on a lark, others by gang members struggling over turf. But investigators eventually became aware of patterns in a number of the fires. Particular landlords who owned several buildings seemed to have an unusually large number of their buildings burn down. Although it was difficult to prove, police had few doubts that most of these fire-prone landlords were hiring professional arsonists to torch their own properties.

Why burn your own buildings? These buildings were typically in declining neighborhoods, where rising crime and middle-class flight had led to a decline in property values. But the insurance policies on the buildings were written to compensate owners based on historical property values, and so would pay the owner of a destroyed building more than the building was worth in the current market. For an unscrupulous landlord who knew the right people, this presented a profitable opportunity.

The arson epidemic became less severe during the 1980s, partly because insurance companies began making it difficult to over-insure properties and partly because a boom in real estate values made many previously arson-threatened buildings worth more unburned.

The arson episodes make it clear that it is a bad idea for insurance companies to let customers insure buildings for more than their value—it gives the customers some destructive incentives. You might think, however, that the incentive problem would go away as long as the insurance is no more than 100% of the value of what is being insured.

But, unfortunately, anything close to 100% insurance still distorts incentives—it induces policyholders to behave differently from how they would in the absence of insurance. The reason is that preventing fires requires effort and cost on the part of a building's owner. Fire alarms and sprinkler systems have to be kept in good repair, fire safety rules have to be strictly enforced, and so on. All of this takes time and money—time and money that the owner may not find worth spending if the insurance policy will provide close to full compensation for any losses.

Of course, the insurance company could specify in the policy that it won't pay if basic safety precautions have not been taken. But it isn't always easy to tell how careful a building's owner has been—the owner knows, but the insurance company does not.

The point is that the building's owner has private information about his or her own actions; the owner knows whether he or she has really taken all appropriate precautions.

As a result, the insurance company is likely to face greater claims than if it were able to determine exactly how much effort a building owner exerts to prevent a loss. The problem of distorted incentives arises when an individual has private information about his or her own actions but someone else bears the costs of a lack of care or effort. This is known as **moral hazard.**

To deal with moral hazard, it is necessary to give individuals with private information some personal stake in what happens, a stake that gives them a reason to exert effort even if others cannot verify that they have done so. Moral hazard is the reason salespeople in many stores receive a commission on sales: it's hard for managers to be sure how hard the salespeople are really working, and if they were paid only straight salary, they would not have an incentive to exert effort to make those sales. Similar logic explains why many stores and restaurants, even if they are part of national chains, are actually franchises, licensed outlets owned by the people who run them.

Insurance companies deal with moral hazard by requiring a **deductible:** they compensate for losses only above a certain amount, so that coverage is always less than 100%. The insurance on your car, for example, may pay for repairs only after the first $500 in loss. This means that a careless driver who gets into a fender-bender will end up paying $500 for repairs even if he is insured, which provides at least some incentive to be careful and reduces moral hazard.

In addition to reducing moral hazard, deductibles provide a partial solution to the problem of adverse selection. Your insurance premium often drops substantially if you are willing to accept a large deductible. This is an attractive option to people who know they are low-risk customers; it is less attractive to people who know they are high-risk—and so are likely to have an accident and end up paying the deductible. By offering a menu of policies with different premiums and deductibles, insurance companies can screen their customers, inducing them to sort themselves out on the basis of their private information.

As the example of deductibles suggests, moral hazard limits the ability of the economy to allocate risks efficiently. You generally can't get full (100%) insurance on your home or car, even though you would like to buy full insurance, and you bear the risk of large deductibles, even though you would prefer not to.

**Moral hazard** occurs when an individual knows more about his or her own actions than other people do. This leads to a distortion of incentives to take care or to exert effort when someone else bears the costs of the lack of care or effort.

A **deductible** is a sum specified in an insurance policy that the insured individuals must pay before being compensated for a claim; deductibles reduce *moral hazard.*



## Module 79 AP Review

*Solutions appear at the back of the book.*

### Check Your Understanding

1. Your car insurance premiums are lower if you have had no moving violations for several years. Explain how this feature tends to decrease the potential inefficiency caused by adverse selection.
2. A common feature of home construction contracts is that when it costs more to construct a building than was originally estimated, the contractor must absorb the additional cost. Explain how this feature reduces the problem of moral hazard but also forces the contractor to bear more risk than she would like.
3. True or false? Explain your answer, stating what concept analyzed in this module accounts for the feature.

   People with higher deductibles on their auto insurance
   a. generally drive more carefully.
   b. pay lower premiums.

## Tackle the Test: Multiple-Choice Questions

1. Which of the following is true about private information?
   I. It has value.
   II. Everyone has access to it.
   III. It can distort economic decisions.
   a. I only
   b. II only
   c. III only
   d. I and III only
   e. I, II, and III
2. Due to adverse selection,
   a mutually beneficial trades go unexploited.
   b. people buy lemons rather than other fruit.
   c. sick people buy less insurance.
   d. private information is available to all.
   e. public information is available to no one.
3. When colleges use grade point averages to make admissions decisions, they are employing which strategy?
   a. signaling
   b. screening
   c. profit maximization
   d. marginal analysis
   e. adverse selection
4. Moral hazard is the result of
   a. asymmetric information.
   b. signaling.
   c. toxic waste.
   d. adverse selection.
   e. public information.
5. A deductible is used by insurance companies to
   a. allow customers to pay for insurance premiums using payroll deduction.
   b. deal with moral hazard.
   c. make public information private.
   d. compensate policyholders fully for their losses.
   e. avoid all payments to policyholders.

## Tackle the Test: Free-Response Questions

1. Identify whether each of the following situations reflects moral hazard or adverse selection. Propose a potential solution to reduce the inefficiency that each situation creates.
   a. When you buy a second-hand car, you do not know whether it is a lemon (low quality) or a plum (high quality), but the seller knows.
   b. People with dental insurance might not brush their teeth as often, knowing that if they get cavities, the insurance will pay for the fillings.
   c. A company does not know whether individual workers on an assembly line are working hard or slacking off.
   d. When making a decision about hiring you, prospective employers do not know whether you are a productive worker or not.

**Answer (8 points)**

**1 point:** Adverse selection

**1 point:** Sellers could offer a warranty with the car that pays for repair costs.

**1 point:** Moral hazard

**1 point:** The insured can be made to pay a co-payment of a certain dollar amount each time they get a filling.

**1 point:** Moral hazard

**1 point:** Pay the workers "piece rates," that is, pay them according to how much they have produced each day.

**1 point:** Adverse selection

**1 point:** Provide potential employers with references from previous employers.

2. Individuals or corporations (for example home-buyers or banks) believe that the government will "bail them out" in the event that their decisions lead to a financial collapse. This is an example of what problem created by asymmetric information? How does this situation lead to inefficiency? What is a possible remedy for the problem?


# Module 80 Indifference Curves and Consumer Choice

## What you will learn in this Module:

- Why economists use indifference curves to illustrate a person's preferences
- The importance of the marginal rate of substitution, the rate at which a consumer is just willing to substitute one good for another
- An alternative way of finding a consumer's optimal consumption bundle, using indifference curves and the budget line

## Mapping the Utility Function

Earlier we introduced the concept of a utility function, which determines a consumer's total utility, given his or her consumption bundle. Here we will extend the analysis by learning how to express total utility as a function of the consumption of two goods. In this way we will deepen our understanding of the trade-off involved when choosing the optimal consumption bundle and of how the optimal consumption bundle itself changes in response to changes in the prices of goods. In order to do that, we now turn to a different way of representing a consumer's utility function, based on the concept of *indifference curves.*

### Indifference Curves

Ingrid is a consumer who buys only two goods: housing, measured by the number of rooms in her house or apartment, and restaurant meals. How can we represent her utility function in a way that takes account of her consumption of both goods?

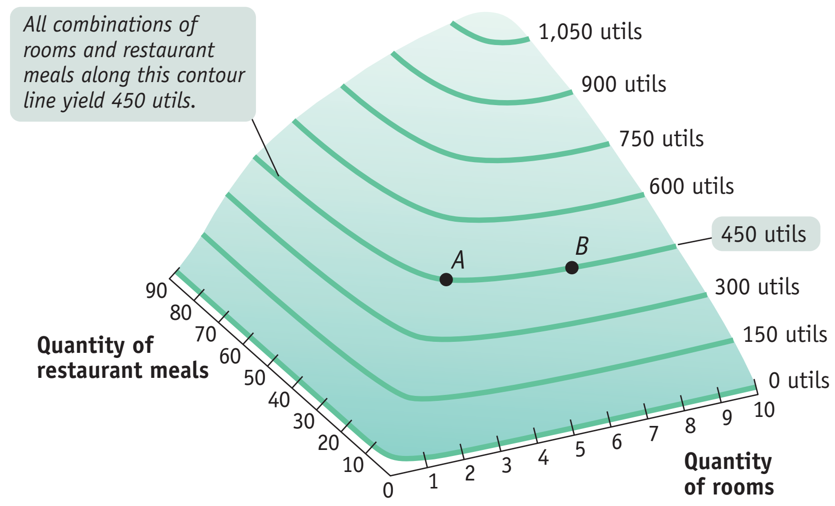
One way is to draw a three-dimensional picture. Figure 80.1 on the next page shows a three-dimensional "utility hill." The distance along the horizontal axis measures the quantity of housing Ingrid consumes in terms of the number of rooms; the distance along the vertical axis measures the number of restaurant meals she consumes. The altitude or height of the hill at each point is indicated by a contour line, along which the height of the hill is constant. For example, point *A,* which corresponds to a consumption bundle of 3 rooms and 30 restaurant meals, lies on the contour line labeled 450. So the total utility Ingrid receives from consuming 3 rooms and 30 restaurant meals is 450 utils.

A three-dimensional picture like Figure 80.1 helps us think about the relationship between consumption bundles and total utility. But anyone who has ever used a topographical map to plan a hiking trip knows that it is possible to represent a three-dimensional surface in only two dimensions. A topographical map doesn't

## figure 80.1

### Ingrid's Utility Function

The three-dimensional hill shows how Ingrid's total utility depends on her consumption of housing and restaurant meals. Point *A* corresponds to consumption of 3 rooms and 30 restaurant meals. That consumption bundle yields Ingrid 450 utils, corresponding to the height of the hill at point *A*. The lines running around the hill are contour lines, along which the height is constant. So every point on a given contour line generates the same level of utility.



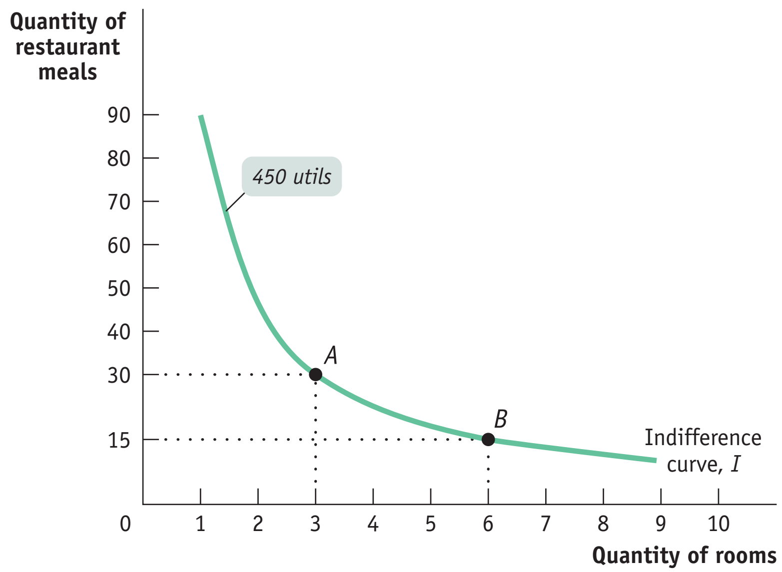

offer a three-dimensional view of the terrain; instead, it conveys information about altitude solely through the use of contour lines.

The same principle can be applied to the representation of a utility function. In Figure 80.2, Ingrid's consumption of rooms is measured on the horizontal axis and her consumption of restaurant meals on the vertical axis. The curve here corresponds to the contour line in Figure 80.1, drawn at a total utility of 450 utils. This curve shows all the consumption bundles that yield a total utility of 450 utils. One point on that contour line is *A,* a consumption bundle consisting of 3 rooms and 30 restaurant meals. Another point on that contour line is *B,* a consumption bundle consisting of 6 rooms but only 15 restaurant meals. Because *B* lies on the same contour line, it yields Ingrid

## figure 80.2

### An Indifference Curve

An indifference curve is a contour line along which total utility is constant. In this case, we show all the consumption bundles that yield Ingrid 450 utils. Consumption bundle *A,* consisting of 3 rooms and 30 restaurant meals, yields the same total utility as bundle *B,* consisting of 6 rooms and 15 restaurant meals. That is, Ingrid is indifferent between bundle *A* and bundle *B*.



the same total utility—450 utils—as $A$. We say that Ingrid is *indifferent* between $A$ and $B$: because bundles $A$ and $B$ yield the same total utility level, Ingrid is equally well off with either bundle.

A contour line that maps consumption bundles yielding the same amount of total utility is known as an **indifference curve.** An individual is always indifferent between any two bundles that lie on the same indifference curve. For a given consumer, there is an indifference curve corresponding to each possible level of total utility. For example, the indifference curve in Figure 80.2 shows consumption bundles that yield Ingrid 450 utils; different indifference curves would show consumption bundles that yield Ingrid 400 utils, 500 utils, and so on.

A collection of indifference curves that represents a given consumer's entire utility function, with each indifference curve corresponding to a different level of total utility, is known as an **indifference curve map.** Figure 80.3 shows three indifference curves—$I_1$, $I_2$, and $I_3$—from Ingrid's indifference curve map, as well as several consumption bundles, *A, B, C,* and *D*. The accompanying table lists each bundle, its composition of rooms and restaurant meals, and the total utility it yields. Because bundles $A$ and $B$ generate the same number of utils, 450, they lie on the same indifference curve, $I_2$.

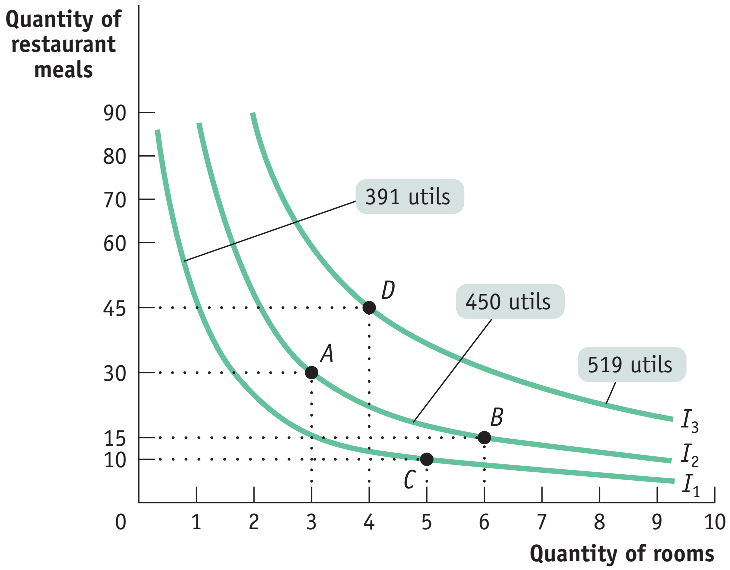
Although Ingrid is indifferent between $A$ and *B,* she is certainly not indifferent between $A$ and *C:* as you can see from the table, $C$ generates only 391 utils, a lower total utility than $A$ or *B.* So Ingrid prefers consumption bundles $A$ and $B$ to bundle *C.* This is represented by the fact that $C$ is on indifference curve $I_1$, and $I_1$ lies below $I_2$. Bundle *D,* though, generates 519 utils, a higher total utility than $A$ and *B.* It is on $I_3$, an indifference curve that lies above $I_2$. Clearly, Ingrid prefers $D$ to either $A$ or *B.* And, even more strongly, she prefers $D$ to *C.*

An **indifference curve** is a line that shows all the consumption bundles that yield the same amount of total utility for an individual.

The entire utility function of an individual can be represented by an **indifference curve map,** a collection of indifference curves in which each curve corresponds to a different total utility level.

Section 14 Appendix

**figure 80.3** An Indifference Curve Map




| Consumption bundle | Quantity of rooms | Quantity of meals | Total utility (utils) |
|---|---|---|---|
| *A* | 3 | 30 | 450 |
| *B* | 6 | 15 | 450 |
| *C* | 5 | 10 | 391 |
| *D* | 4 | 45 | 519 |

The utility function can be represented in greater detail by increasing the number of indifference curves drawn, each corresponding to a different level of total utility. In this figure bundle $C$ lies on an indifference curve corresponding to a total utility of 391 utils. As in Figure 80.2, bundles $A$ and $B$ lie on an indifference curve corresponding to a total utility of 450 utils. Bundle $D$ lies on an indifference curve corresponding to a total utility of 519 utils. Ingrid prefers any bundle on $I_2$ to any bundle on $I_1$, and she prefers any bundle on $I_3$ to any bundle on $I_2$.

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### Are Utils Useful?

In the table that accompanies Figure 80.3, we give the number of utils achieved on each of the indifference curves shown in the figure. But is this information actually needed?

The answer is no. As you will see shortly, the indifference curve map tells us all we need to know in order to find a consumer's optimal consumption bundle. That is, it's important that Ingrid has higher total utility along indifference curve $I_2$ than she does along $I_1$, but it doesn't matter *how much higher* her total utility is. In other words, we don't have to measure utils in order to understand how consumers make choices.

Economists say that consumer theory requires an *ordinal* measure of utility—one that ranks consumption bundles in terms of desirability—so that we can say that bundle *X* is better than bundle *Y*. The theory does not, however, require *cardinal* utility, which actually assigns a specific number to the total utility yielded by each bundle.

So why introduce the concept of utils at all? The answer is that it is much easier to understand the basis of rational choice by using the concept of measurable utility.

## Properties of Indifference Curves

No two individuals have the same indifference curve map because no two individuals have the same preferences. But economists believe that, regardless of the person, every indifference curve map has two general properties. These are illustrated in panel (a) of Figure 80.4.

**a.** *Indifference curves never cross.* Suppose that we tried to draw an indifference curve map like the one depicted in the left diagram in panel (a), in which two indifference curves cross at *A*. What is the total utility at *A*? Is it 100 utils or 200 utils? Indifference curves cannot cross because each consumption bundle must correspond to one unique total utility level—not, as shown at *A,* two different total utility levels.

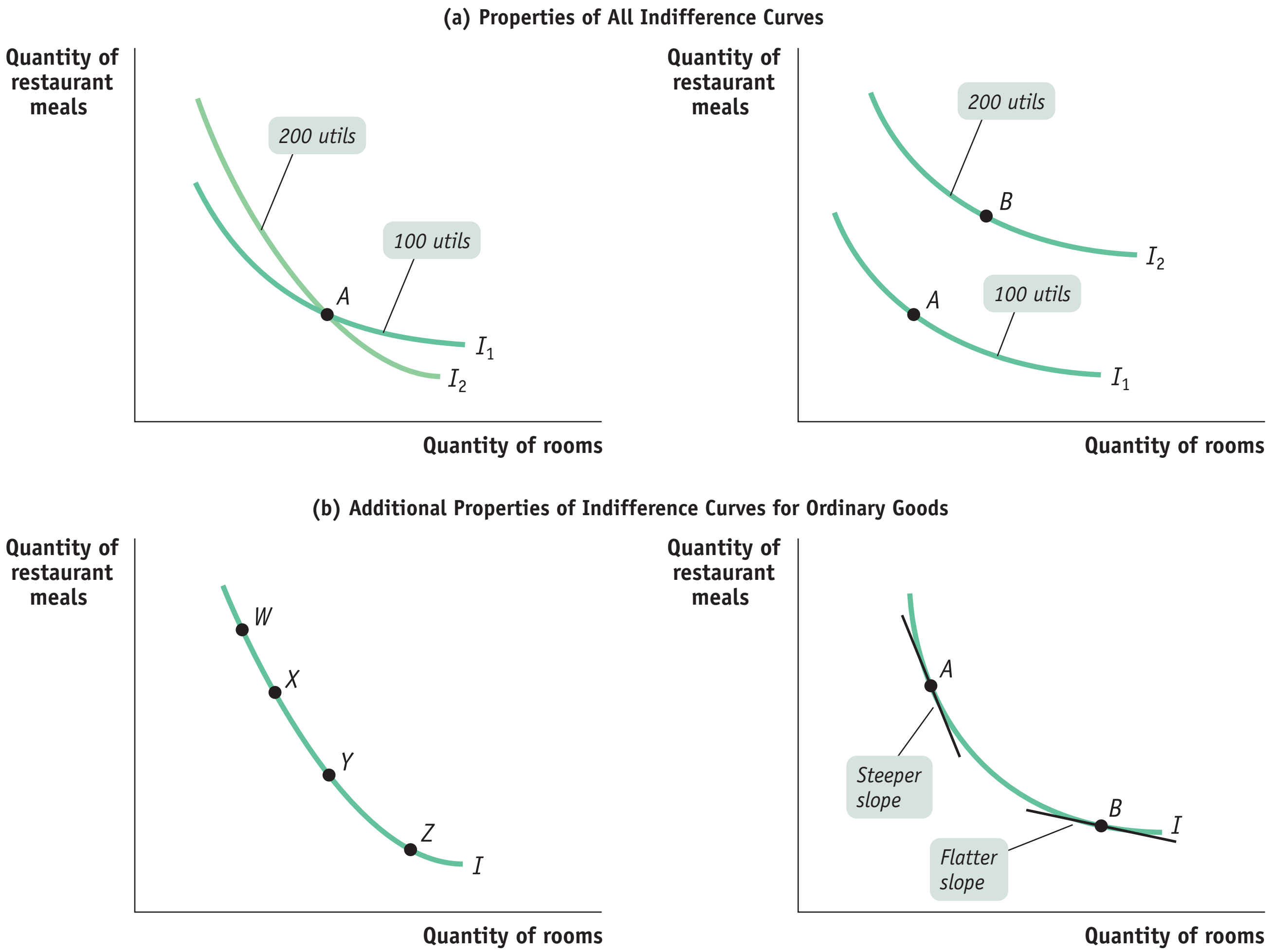
**b.** *The farther out an indifference curve lies—the farther it is from the origin—the higher the level of total utility it indicates.* The reason, illustrated in the right diagram in panel (a), is that we assume that more is better—we consider only the consumption bundles for which the consumer is not satiated. Bundle *B,* on the outer indifference curve, contains more of both goods than bundle *A* on the inner indifference curve. So *B,* because it generates a higher total utility level (200 utils), lies on a higher indifference curve than *A.*

Furthermore, economists believe that, for most goods, consumers' indifference curve maps also have two additional properties. They are illustrated in panel (b) of Figure 80.4:

**c.** *Indifference curves slope downward.* Here, too, the reason is that more is better. The left diagram in panel (b) shows four consumption bundles on the same indifference curve: *W, X, Y,* and *Z.* By definition, these consumption bundles yield the same level of total utility. But as you move along the curve to the right, from *W* to *Z,* the quantity of rooms consumed increases. The only way a person can consume more rooms without gaining utility is by giving up some restaurant meals. So the indifference curve must slope downward.

**d.** *Indifference curves have a convex shape.* The right diagram in panel (b) shows that the slope of each indifference curve changes as you move down the curve to the right: the curve gets flatter. If you move up an indifference curve to the left, the curve gets steeper. So the indifference curve is steeper at *A* than it is at *B.* When this occurs, we say that an indifference curve has a *convex* shape—it is bowed-in toward the origin. This feature arises from diminishing marginal utility, a principle we discussed in Module 51. Recall that when a consumer has diminishing marginal utility, consumption of another unit of a good generates a smaller increase in total utility than the previous unit consumed. Next we will examine in detail how diminishing marginal utility gives rise to convex-shaped indifference curves.

**figure 80.4** Properties of Indifference Curves




Panel (a) represents two general properties that all indifference curves share. The left diagram shows why indifference curves cannot cross: if they did, a consumption bundle such as *A* would yield both 100 and 200 utils, a contradiction. The right diagram of panel (a) shows that indifference curves that are farther out yield higher total utility: bundle *B,* which contains more of both goods than bundle *A,* yields higher total utility. Panel (b) depicts two additional properties of indifference curves for ordinary goods. The left diagram of panel (b) shows that indifference curves slope downward: as you move down the curve from bundle *W* to bundle *Z,* consumption of rooms increases. To keep total utility constant, this must be offset by a reduction in quantity of restaurant meals. The right diagram of panel (b) shows a convex-shaped indifference curve. The slope of the indifference curve gets flatter as you move down the curve to the right, a feature arising from diminishing marginal utility.

Goods that satisfy all four properties of indifference curve maps are called *ordinary goods*. The vast majority of goods in any consumer's utility function fall into this category. Below we will define ordinary goods more precisely and see the key role that diminishing marginal utility plays for them.

## Indifference Curves and Consumer Choice

Above we used indifference curves to represent the preferences of Ingrid, whose consumption bundles consist of rooms and restaurant meals. Our next step is to show how to use Ingrid's indifference curve map to find her utility-maximizing consumption bundle, given her budget constraint, which arises because she must choose a consumption bundle that costs no more than her total income.

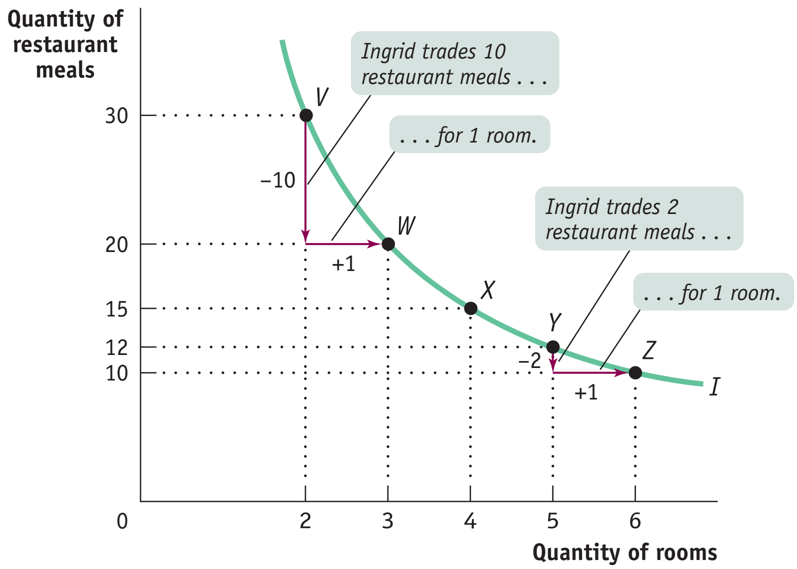
It's important to understand how our analysis here relates to what we did in Module 51. We are not offering a new theory of consumer behavior in this module—consumers are assumed to maximize total utility as before. In particular, we know that consumers will follow the *optimal consumption rule*: the optimal consumption bundle lies on the budget line, and the marginal utility per dollar is the same for every good in the bundle.

But as we'll see shortly, we can derive this optimal consumer behavior in a somewhat different way—a way that yields deeper insights into consumer choice.

## The Marginal Rate of Substitution

The first element of our approach is a new concept, the *marginal rate of substitution.* The essence of this concept is illustrated in Figure 80.5.

**figure 80.5** **The Changing Slope of an Indifference Curve**




| Consumption bundle | Quantity of rooms | Quantity of restaurant meals |
|---|---|---|
| *V* | 2 | 30 |
| *W* | 3 | 20 |
| *X* | 4 | 15 |
| *Y* | 5 | 12 |
| *Z* | 6 | 10 |

This indifference curve is downward sloping and convex, implying that restaurant meals and rooms are ordinary goods for Ingrid. As Ingrid moves down her indifference curve from *V* to *Z,* she trades reduced consumption of restaurant meals for increased consumption of housing. However, the terms of that trade-off change. As she moves from *V* to *W,* she is willing to give up 10 restaurant meals in return for 1 more room. As her consumption of rooms rises and her consumption of restaurant meals falls, she is willing to give up fewer restaurant meals in return for each additional room. The flattening of the slope as you move from left to right arises from diminishing marginal utility.

We have just seen that for most goods, consumers' indifference curves are downward sloping and convex. Figure 80.5 shows such an indifference curve. The points labeled *V, W, X, Y,* and *Z* all lie on this indifference curve—that is, they represent consumption bundles that yield Ingrid the same level of total utility. The table accompanying the figure shows the components of each of the bundles. As we move along the indifference curve from *V* to *Z,* Ingrid's consumption of housing steadily increases from 2 rooms to 6 rooms, her consumption of restaurant meals steadily decreases from 30 meals to 10 meals, and her total utility is kept constant. As we move down the indifference curve, then, Ingrid is trading more of one good for less of the other, with the *terms* of that trade-off—the ratio of additional rooms consumed to restaurant meals sacrificed—chosen to keep her total utility constant.

Notice that the quantity of restaurant meals that Ingrid is willing to give up in return for an additional room changes along the indifference curve. As we move from *V* to *W,* housing consumption rises from 2 to 3 rooms and restaurant meal consumption falls from 30 to 20—a trade-off of 10 restaurant meals for 1 additional room. But as we move from *Y* to *Z,* housing consumption rises from 5 to 6 rooms and restaurant meal consumption falls from 12 to 10, a trade-off of only 2 restaurant meals for an additional room.

To put it in terms of slope, the slope of the indifference curve between *V* and *W* is −10: the change in restaurant meal consumption, −10, divided by the change in housing consumption, 1. Similarly, the slope of the indifference curve between *Y* and *Z* is −2. So the indifference curve gets flatter as we move down it to the right—that is, it has a convex shape, one of the four properties of an indifference curve for ordinary goods.

Why does the trade-off change in this way? Let's think about it intuitively and then work through it more carefully. When Ingrid moves down her indifference curve, whether from *V* to *W* or from *Y* to *Z,* she gains utility from her additional consumption of housing but loses an equal amount of utility from her reduced consumption of restaurant meals. But at each step, the initial position from which Ingrid begins is different. At *V,* Ingrid consumes only a small quantity of rooms; because of diminishing marginal utility, her marginal utility per room at that point is high. At *V,* then, an additional room adds a lot to Ingrid's total utility. But at *V* she already consumes a large quantity of restaurant meals, so her marginal utility of restaurant meals is low at that point. This means that it takes a large reduction in her quantity of restaurant meals consumed to offset the increased utility she gets from the extra room of housing.

At *Y,* in contrast, Ingrid consumes a much larger quantity of rooms and a much smaller quantity of restaurant meals than at *V.* This means that an additional room adds fewer utils, and a restaurant meal forgone costs more utils, than at *V.* So Ingrid is willing to give up fewer restaurant meals in return for another room of housing at *Y* (where she gives up 2 meals for 1 room) than she is at *V* (where she gives up 10 meals for 1 room).

Now let's express the same idea—that the trade-off Ingrid is willing to make depends on where she is starting from—by using a little math. We do this by examining how the slope of the indifference curve changes as we move down it. Moving down the indifference curve—reducing restaurant meal consumption and increasing housing consumption—will produce two opposing effects on Ingrid's total utility: lower restaurant meal consumption will reduce her total utility, but higher housing consumption will raise her total utility. And since we are moving down the indifference curve, these two effects must exactly cancel out:

*Along the indifference curve:*

**(80-1)** (Change in total utility due to lower restaurant meal consumption) +
(Change in total utility due to higher housing consumption) = 0

or, rearranging terms,

*Along the indifference curve:*

**(80-2)** −(Change in total utility due to lower restaurant meal consumption) =
(Change in total utility due to higher housing consumption)

Let's now focus on what happens as we move only a short distance down the indifference curve, trading off a small increase in housing consumption in place of a small decrease in restaurant meal consumption. Following our notation from before, let's use $MU_R$ and $MU_M$ to represent the marginal utility of rooms and restaurant meals, respectively, and $Q_R$ and $Q_M$ to represent the changes in room and meal consumption, The **marginal rate of substitution,** or ***MRS,*** of good *R* in place of good *M* is equal to $\frac{MU_R}{MU_M}$, the ratio of the marginal utility of *R* to the marginal utility of *M.*

respectively. In general, the change in total utility caused by a small change in consumption of a good is equal to the change in consumption multiplied by the *marginal utility* of that good. This means that we can calculate the change in Ingrid's total utility generated by a change in her consumption bundle using the following equations:

**(80-3)** Change in total utility due to a change in restaurant meal consumption $= MU_M \times Q_M$

and

**(80-4)** Change in total utility due to a change in housing consumption $= MU_R \times Q_R$

So we can write Equation 80-2 in symbols as:

*Along the indifference curve:*

**(80-5)** $-MU_M \times Q_M = MU_R \times Q_R$

Note that the left-hand side of Equation 80-5 has a negative sign; it represents the loss in total utility from decreased restaurant meal consumption. This must equal the gain in total utility from increased room consumption, represented by the right-hand side of the equation.

What we want to know is how this translates into the slope of the indifference curve. To find the slope, we divide both sides of Equation 80-5 by $Q_R$, and again by $-MU_M$, in order to get the $Q_M$, $Q_R$ terms on one side and the $MU_R$, $MU_M$ terms on the other. This results in:

**(80-6)** *Along the indifference curve:* $\frac{\Delta Q_M}{\Delta Q_R} = -\frac{MU_R}{MU_M}$

The left-hand side of Equation 80-6 is the slope of the indifference curve; it is the rate at which Ingrid is willing to trade rooms (the good on the horizontal axis) for restaurant meals (the good on the vertical axis) without changing her total utility level. The right-hand side of Equation 80-6 is the negative of the ratio of the marginal utility of rooms to the marginal utility of restaurant meals—that is, the ratio of what she gains from one more room to what she gains from one more meal, with a negative sign in front.

Putting all this together, Equation 80-6 shows that, along the indifference curve, the quantity of restaurant meals Ingrid is willing to give up in return for a room, $\frac{\Delta Q_M}{\Delta Q_R}$, is exactly equal to the negative of the ratio of the marginal utility of a room to that of a meal, $-\frac{MU_R}{MU_M}$. Only when this condition is met will her total utility level remain constant as she consumes more rooms and fewer restaurant meals.

Economists have a special name for the ratio of the marginal utilities found in the right-hand side of Equation 80-6: it is called the **marginal rate of substitution,** or ***MRS,*** of rooms (the good on the horizontal axis) in place of restaurant meals (the good on the vertical axis). That's because as we slide down Ingrid's indifference curve, we are substituting more rooms for fewer restaurant meals in her consumption bundle. As we'll see shortly, the marginal rate of substitution plays an important role in finding the optimal consumption bundle.

Recall that indifference curves get flatter as you move down them to the right. The reason, as we've just discussed, is diminishing marginal utility: as Ingrid consumes more housing and fewer restaurant meals, her marginal utility from housing falls and her marginal utility from restaurant meals rises. So her marginal rate of substitution, which is equal to the negative of the slope of her indifference curve, falls as she moves down the indifference curve.

The flattening of indifference curves as you slide down them to the right—which reflects the same logic as the principle of diminishing marginal utility—is known as the principle of **diminishing marginal rate of substitution.** It says that an individual who consumes only a little bit of good *A* and a lot of good *B* will be willing to trade off a lot of good *B* in return for one more unit of good *A,* and an individual who already consumes a lot of good *A* and not much of good *B* will be less willing to make that trade-off.

We can illustrate this point by referring back to Figure 80.5. At point *V,* a bundle with a high proportion of restaurant meals to rooms, Ingrid is willing to forgo 10 restaurant meals in return for 1 room. But at point *Y,* a bundle with a low proportion of restaurant meals to rooms, she is willing to forgo only 2 restaurant meals in return for 1 room.

From this example we can see that, in Ingrid's utility function, rooms and restaurant meals possess the two additional properties that characterize ordinary goods. Ingrid requires additional rooms to compensate her for the loss of a meal, and vice versa; so her indifference curves for these two goods slope downward. And her indifference curves are convex: the slope of her indifference curve—*the negative of* the marginal rate of substitution—becomes flatter as we move down it. In fact, an indifference curve is convex only when it has a diminishing marginal rate of substitution—these two conditions are equivalent.

With this information, we can define **ordinary goods,** which account for the great majority of goods in any consumer's utility function. A pair of goods are ordinary goods in a consumer's utility function if they possess two properties: the consumer requires more of one good to compensate for less of the other, and the consumer experiences a diminishing marginal rate of substitution when substituting one good for the other.

Next we will see how to determine Ingrid's optimal consumption bundle using indifference curves.

The principle of **diminishing marginal rate of substitution** states that the more of good *R* a person consumes in proportion to good *M,* the less *M* he or she is willing to substitute for another unit of *R.*

Two goods, *R* and *M,* are **ordinary goods** in a consumer's utility function when (1) the consumer requires additional units of *R* to compensate for fewer units of *M,* and vice versa; and (2) the consumer experiences a diminishing marginal rate of substitution when substituting one good for another.

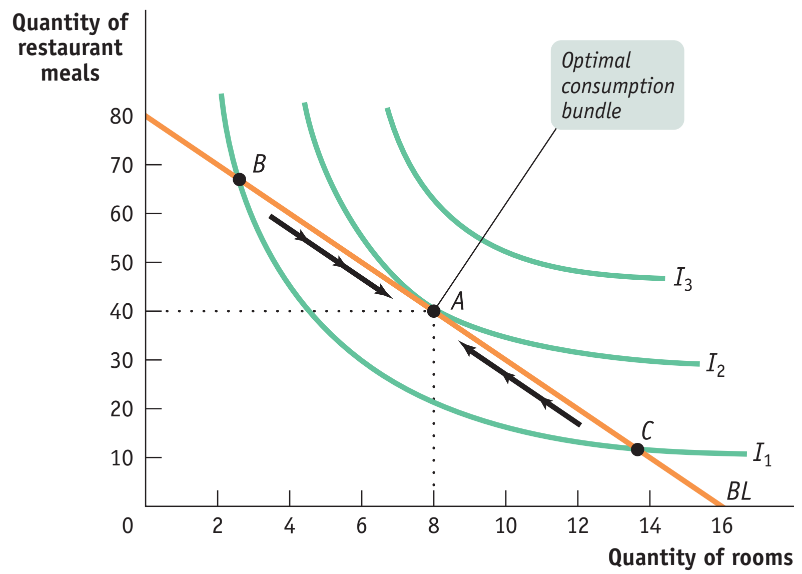
## The Tangency Condition

Now let's put some of Ingrid's indifference curves on the same diagram as her budget line to illustrate an alternative way of representing her optimal consumption choice. Figure 80.6 shows Ingrid's budget line, *BL,* when her income is \$2,400 per month,

**figure 80.6**

### The Optimal Consumption Bundle

The budget line, *BL,* shows Ingrid's possible consumption bundles, given an income of \$2,400 per month, when rooms cost \$150 per month and restaurant meals cost \$30 each. $I_1$, $I_2$, and $I_3$ are indifference curves. Consumption bundles such as *B* and *C* are not optimal because Ingrid can move to a higher indifference curve. The optimal consumption bundle is *A,* where the budget line is just tangent to the highest possible indifference curve.



The **tangency condition** between the indifference curve and the budget line holds when the indifference curve and the budget line just touch. This condition determines the optimal consumption bundle when the indifference curves have the typical convex shape.

housing costs $150 per room each month, and restaurant meals cost $30 each. What is her optimal consumption bundle?

To answer this question, we show several of Ingrid's indifference curves: $I_1$, $I_2$, and $I_3$. Ingrid would like to achieve the total utility level represented by $I_3$, the highest of the three curves, but she cannot afford to because she is constrained by her income: no consumption bundle on her budget line yields that much total utility. But she shouldn't settle for the level of total utility generated by *B,* which lies on $I_1$: there are other bundles on her budget line, such as *A,* that clearly yield higher total utility than *B.*

In fact, *A*—a consumption bundle consisting of 8 rooms and 40 restaurant meals per month—is Ingrid's optimal consumption choice. The reason is that *A* lies on the highest indifference curve Ingrid can reach given her income.

At the optimal consumption bundle *A,* Ingrid's budget line *just touches* the relevant indifference curve—the budget line is *tangent* to the indifference curve. This **tangency condition** between the indifference curve and the budget line applies to the optimal consumption bundle when the indifference curves have the typical convex shape.

To see why, let's look more closely at how we know that a consumption bundle that *doesn't* satisfy the tangency condition can't be optimal. Reexamining Figure 80.6, we can see that consumption bundles *B* and *C* are both affordable because they lie on the budget line. However, neither is optimal. Both of them lie on the indifference curve $I_1$, which cuts through the budget line at both points. But because $I_1$ cuts through the budget line, Ingrid can do better: she can move down the budget line from *B* or up the budget line from *C,* as indicated by the arrows. In each case, this allows her to get onto a higher indifference curve, $I_2$, which increases her total utility.

Ingrid cannot, however, do any better than $I_2$: any other indifference curve either cuts through her budget line or doesn't touch it at all. And the bundle that allows her to achieve $I_2$ is, of course, her optimal consumption bundle.

## The Slope of the Budget Line

Figure 80.6 shows us how to use a graph of the budget line and the indifference curves to find the optimal consumption bundle, the bundle at which the budget line and the indifference curve are tangent. But rather than rely on drawing graphs, we can determine the optimal consumption bundle by using a bit more math. As you can see from Figure 80.6, at *A,* the optimal consumption bundle, the budget line and the indifference curve have the same slope. Why? Because two curves can only be tangent to each other if they have the same slope at the point where they meet. Otherwise, they would cross each other at that point. And we know that if we are on an indifference curve that crosses the budget line (like $I_1$, in Figure 80.6), we can't be on the indifference curve that contains the optimal consumption bundle (like $I_2$).

So we can use information about the slopes of the budget line and the indifference curve to find the optimal consumption bundle. To do that, we must first analyze the slope of the budget line, a fairly straightforward task. We know that Ingrid will get the highest possible utility by spending all of her income and consuming a bundle on her budget line. So we can represent Ingrid's budget line, the consumption bundles available to her when she spends all of her income, with the equation:

$$\textbf{(80-7)} \quad (Q_R \times P_R) + (Q_M \times P_M) = N$$

where *N* stands for Ingrid's income. To find the slope of the budget line, we divide its vertical intercept (where the budget line hits the vertical axis) by its horizontal intercept (where it hits the horizontal axis) and then add a negative sign. The vertical intercept is the point at which Ingrid spends all her income on restaurant meals and none on housing (that is, $Q_R = 0$). In that case the number of restaurant meals she consumes is:

$$\textbf{(80-8)} \quad Q_M = \frac{N}{P_M} = \$2{,}400/(\$30 \text{ per meal}) = 80 \text{ meals}$$
$$= \text{Vertical intercept of budget line}$$

At the other extreme, Ingrid spends all her income on housing and none on restaurant meals (so that $Q_M = 0$). This means that at the horizontal intercept of the budget line, the number of rooms she consumes is:

$$\textbf{(80-9)} \quad Q_R = \frac{N}{P_R} = \frac{\$2{,}400}{(\$150 \text{ per room})} = 16 \text{ rooms}$$
$$= \text{Horizontal intercept of budget line}$$

The **relative price** of good $R$ in terms of good $M$ is equal to $\frac{P_R}{P_M}$, the rate at which $R$ trades for $M$ in the market.

Now we have the information needed to find the slope of the budget line. It is:

$$\textbf{(80-10)} \quad \text{Slope of budget line} = -\frac{(\text{Vertical intercept})}{(\text{Horizontal intercept})} = -\frac{\frac{N}{P_M}}{\frac{N}{P_R}} = -\frac{P_R}{P_M}$$

Notice the negative sign in Equation 80-10; it's there because the budget line slopes downward. The quantity $\frac{P_R}{P_M}$ is known as the **relative price** of rooms in terms of restaurant meals, to distinguish it from an ordinary price in terms of dollars. Because buying one more room requires Ingrid to give up the quantity $\frac{P_R}{P_M}$ of restaurant meals, or 5 meals, we can interpret the relative price $\frac{P_R}{P_M}$ as the rate at which a room trades for restaurant meals in the market; it is the price—in terms of restaurant meals—Ingrid has to "pay" to get one more room.

Looking at this another way, the slope of the budget line—the negative of the relative price—tells us the opportunity cost of each good in terms of the other. The relative price illustrates the opportunity cost to an individual of consuming one more unit of one good in terms of how much of the other good in his or her consumption bundle must be forgone. This opportunity cost arises from the consumer's limited resources—his or her limited budget. It's useful to note that Equations 80-8, 80-9, and 80-10 give us all the information we need about what happens to the budget line when relative price or income changes. From Equations 80-8 and 80-9 we can see that a change in income, $N$, leads to a parallel shift of the budget line: both the vertical and horizontal intercepts will shift. That is, how far out the budget line is from the origin depends on the consumer's income. If a consumer's income rises, the budget line moves outward. If the consumer's income shrinks, the budget line shifts inward. In each case, the slope of the budget line stays the same because the relative price of one good in terms of the other does not change.

In contrast, a change in the relative price $\frac{P_R}{P_M}$ will lead to a change in the slope of the budget line. We'll analyze these changes in the budget line and how the optimal consumption bundle changes when the relative price changes or when income changes in greater detail later in the module.

## Prices and the Marginal Rate of Substitution

Now we're ready to bring together the slope of the budget line and the slope of the indifference curve to find the optimal consumption bundle. From Equation 80-6, we know that the slope of the indifference curve at any point is equal to the negative of the marginal rate of substitution:

$$\textbf{(80-11)} \quad \text{Slope of indifference curve} = -\frac{MU_R}{MU_M}$$

As we've already noted, at the optimal consumption bundle the slope of the budget line and the slope of the indifference curve are equal. We can write this formally by putting

**The relative price rule** says that at the optimal consumption bundle, the marginal rate of substitution between two goods is equal to their relative price.

Equations 80-10 and 80-11 together, which gives us the **relative price rule** for finding the optimal consumption bundle:

$$\textbf{(80-12)}\quad \textit{At the optimal consumption bundle:} -\frac{MU_R}{MU_M} = \frac{P_R}{P_M}$$

$$\text{or, } \textit{cancelling the negative signs, } \frac{MU_R}{MU_M} = \frac{P_R}{P_M}$$

That is, at the optimal consumption bundle, the marginal rate of substitution between any two goods is equal to the ratio of their prices. To put it in a more intuitive way, starting with Ingrid's optimal consumption bundle, the rate at which she would trade a room for more restaurant meals along her indifference curve, $\frac{MU_R}{MU_M}$, is equal to the rate at which rooms are traded for restaurant meals in the market, $\frac{P_R}{P_M}$.

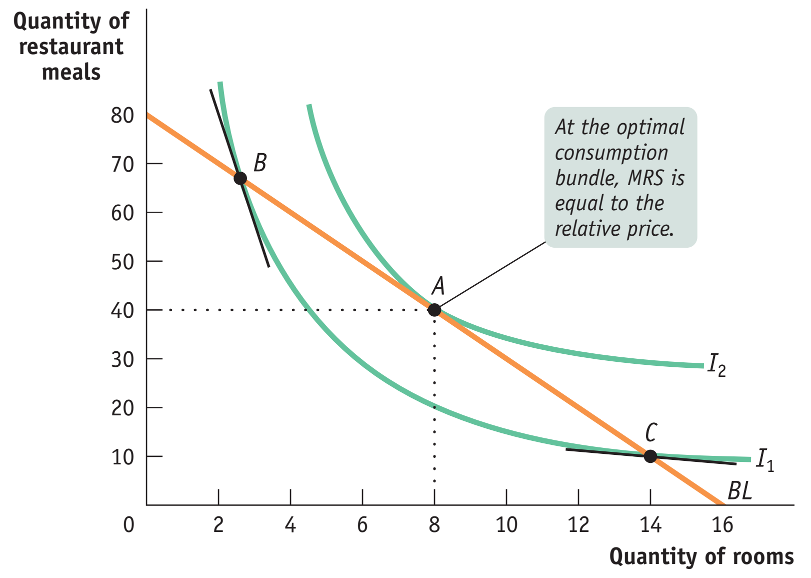
What would happen if this equality did not hold? We can see by examining Figure 80.7. There, at point *B,* the slope of the indifference curve, $-\frac{MU_R}{MU_M}$, is greater in absolute value than the slope of the budget line, $-\frac{P_R}{P_M}$. This means that, at *B,* Ingrid values an additional room in place of meals *more* than it costs her to buy an additional room and forgo some meals. As a result, Ingrid would be better off moving down her budget line toward *A,* consuming more rooms and fewer restaurant meals—and because of that, *B* could not have been her optimal bundle! Likewise, at *C,* the slope of Ingrid's indifference curve is less in absolute value than the slope of the budget line. The implication is that, at *C,* Ingrid values additional meals in place of a room *more* than it costs her to buy additional meals and forgo a room. Again, Ingrid would be better off moving along her budget line—consuming more restaurant meals and fewer rooms—until she reaches *A,* her optimal consumption bundle.

But suppose we transform the last term of Equation 80-12 in the following way: divide both sides by $P_R$ and multiply both sides by $MU_M$. Then the relative price rule becomes the optimal consumption rule:

**figure 80.7**

## Understanding the Relative Price Rule

The *relative price* of rooms in terms of restaurant meals is equal to the negative of the slope of the budget line. The *marginal rate of substitution* of rooms for restaurant meals is equal to the negative of the slope of the indifference curve. The *relative price rule* says that at the optimal consumption bundle, the marginal rate of substitution must equal the relative price. This point can be demonstrated by considering what happens when the marginal rate of substitution is not equal to the relative price. At consumption bundle *B,* the marginal rate of substitution is larger than the relative price; Ingrid can increase her total utility by moving down her budget line, *BL.* At *C,* the marginal rate of substitution is smaller than the relative price, and Ingrid can increase her total utility by moving up the budget line. Only at *A,* where the relative price rule holds, is her total utility maximized, given her budget constraint.



$$\textbf{(80-13)} \quad \textit{Optimal consumption rule: } \frac{MU_R}{P_M} = \frac{MU_M}{P_M}$$

So using either the optimal consumption rule or the relative price rule, we find the same optimal consumption bundle.

## Preferences and Choices

Now that we have seen how to represent the optimal consumption choice in an indifference curve diagram, we can turn briefly to the relationship between consumer preferences and consumer choices.

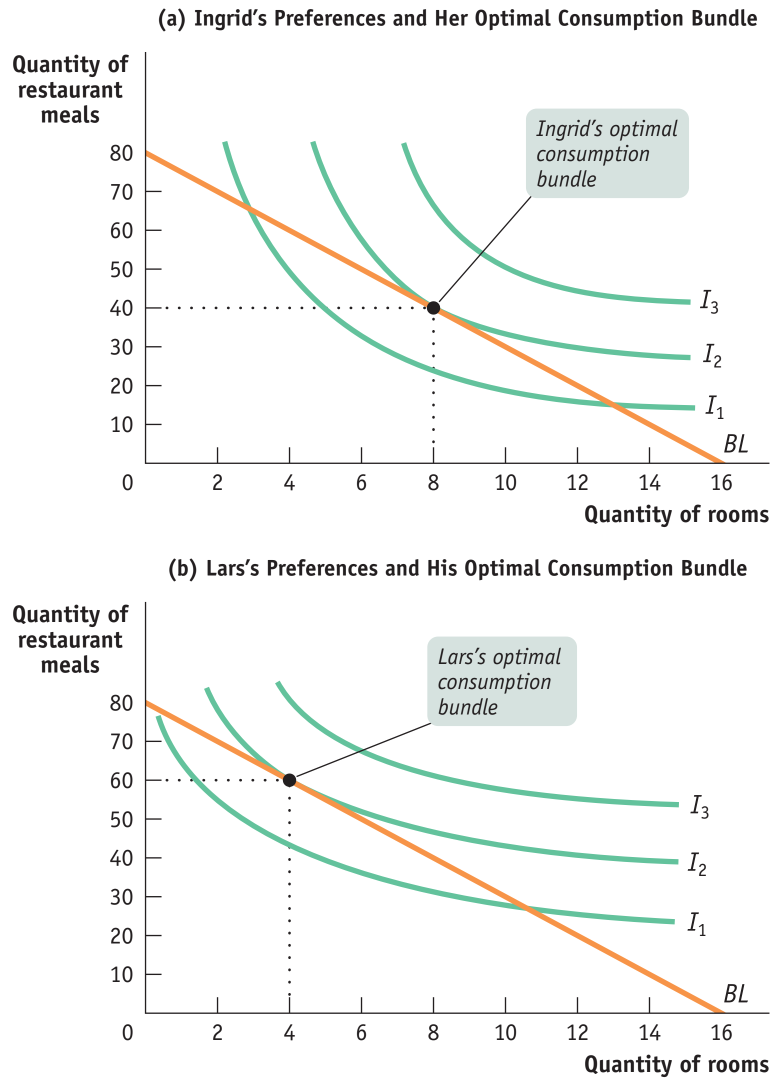
When we say that two consumers have different preferences, we mean that they have different utility functions. This in turn means that they will have indifference curve maps with different shapes. And those different maps will translate into different consumption choices, even among consumers with the same income and who face the same prices.

To see this, suppose that Ingrid's friend Lars also consumes only housing and restaurant meals. However, Lars has a stronger preference for restaurant meals and a weaker preference for housing. This difference in preferences is shown in Figure 80.8,

**figure 80.8**

### Differences in Preferences

Ingrid and Lars have different preferences, reflected in the different shapes of their indifference curve maps. So they will choose different consumption bundles even when they have the same possible choices. Each has an income of $2,400 per month and faces prices of $30 per meal and $150 per room. Panel (a) shows Ingrid's consumption choice: 8 rooms and 40 restaurant meals. Panel (b) shows Lars's choice: even though he has the same budget line, he consumes fewer rooms and more restaurant meals.



which shows *two* sets of indifference curves: panel (a) shows Ingrid's preferences and panel (b) shows Lars's preferences. Note the difference in their shapes.

Suppose, as before, that rooms cost $150 per month and restaurant meals cost $30. Let's also assume that both Ingrid and Lars have incomes of $2,400 per month, giving them identical budget lines. Nonetheless, because they have different preferences, they will make different consumption choices, as shown in Figure 80.8. Ingrid will choose 8 rooms and 40 restaurant meals; Lars will choose 4 rooms and 60 restaurant meals.

## Module 80 AP Review

*Solutions appear at the back of the book.*

### Check Your Understanding

1. The accompanying table shows Samantha's preferences for consumption bundles composed of chocolate kisses and licorice drops.

| *Consumption bundle* | *Quantity of chocolate kisses* | *Quantity of licorice drops* | *Total utility (utils)* |
|---|---|---|---|
| A | 1 | 3 | 6 |
| B | 2 | 3 | 10 |
| C | 3 | 1 | 6 |
| D | 2 | 1 | 4 |

   a. With chocolate kisses on the horizontal axis and licorice drops on the vertical axis, draw hypothetical indifference curves for Samantha and locate the bundles on the curves. Assume that both items are ordinary goods.
   b. Suppose you don't know the number of utils provided by each bundle. Assuming that more is better, predict Samantha's ranking of each of the four bundles to the extent possible. Explain your answer.

2. On the left diagram in panel (a) of Figure 80.4, draw a point *B* anywhere on the 200-util indifference curve and a point *C* anywhere on the 100-util indifference curve (but *not* at the same location as point *A*). By comparing the utils generated by bundles *A* and *B* and those generated by bundles *A* and *C*, explain why indifference curves cannot cross.

3. Lucinda and Kyle each consume 3 comic books and 6 video games. Lucinda's marginal rate of substitution of books for games is 2 and Kyle's is 5.
   a. For each person, find another consumption bundle that yields the same total utility as the current bundle. Who is less willing to trade games for books? In a diagram with books on the horizontal axis and games on the vertical axis, how would this be reflected in differences in the slopes of their indifference curves at their current consumption bundles?
   b. Find the relative price of books in terms of games at which Lucinda's current bundle is optimal. Is Kyle's bundle optimal given this relative price? If not, how should Kyle rearrange his consumption?

### Tackle the Test: Multiple-Choice Questions

1. Which of the following is true along an individual's indifference curve for ordinary goods?
   a. The slope is constant.
   b. Total utility changes.
   c. The individual is indifferent between any two points.
   d The slope is equal to the ratio of the prices of the consumption bundles.
   e. The individual doesn't care if utility is maximized.

2. Which of the following is/are true of indifference curves for ordinary goods?
   I. They cannot intersect.
   II. They have a negative slope.
   III. They are convex.
   a. I only
   b. II only
   c. III only
   d. I and II only
   e. I, II, and III

3. Moving from left to right along an indifference curve, which of the following increases?
   a. The marginal utility of the vertical axis good
   b. The marginal utility of the horizontal axis good
   c. The absolute value of the slope
   d. The marginal rate of substitution
   e. The demand for the vertical axis good

4. If the quantity of good $X$ is measured on the horizontal axis and the quantity of good $Y$ is measured on the vertical axis, the marginal rate of substitution is equal to
   a. $\frac{\Delta Q_X}{\Delta Q_Y}$.
   b. $\frac{MU_X}{MU_Y}$.
   c. $\frac{P_X}{P_Y}$.
   d. the ratio of the slope of the budget line and the slope of the indifference curve.
   e. 1 at the optimal level of consumption.

5. If the quantity of good $X$ is again measured on the horizontal axis and the quantity of good $Y$ is measured on the vertical axis, which of the following is true? The optimal consumption bundle is found where
   a. $\frac{MU_X}{MU_Y} = \frac{P_X}{P_Y}$.
   b. the slope of the indifference curve equals the slope of the budget line.
   c. the indifference curve is tangent to the budget line.
   d. $\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y}$.
   e. all of the above are true.

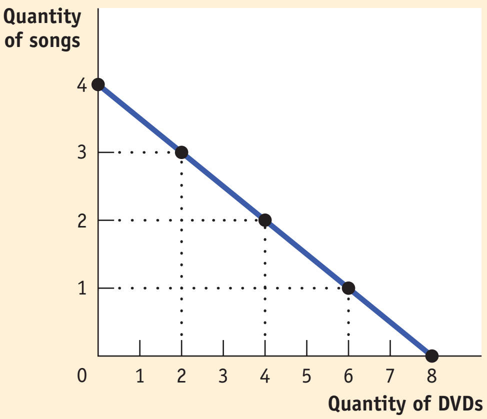
## Tackle the Test: Free-Response Questions

1. Each of the combinations of iPod song downloads and DVD rentals shown in the table below give Kathleen an equal level of utility.

| *Quantity of songs* | *Quantity of DVDs* |
|---|---|
| 0 | 8 |
| 1 | 6 |
| 2 | 4 |
| 3 | 2 |
| 4 | 0 |

   a. Graph Kathleen's indifference curve.
   b. Economists believe that the individual indifference curves for ordinary goods exhibit what two properties?
   c. Does Kathleen's indifference curve exhibit the two properties from part b? Explain.

**Answer (8 points)**




**1 point:** Axes labeled "Quantity of songs" and "Quantity of DVDs"

**1 point:** Correctly plotted indifference curve points

**1 point:** Negative slope

**1 point:** Convex shape

**1 point:** Negative slope—yes

**1 point:** As *more* DVDs are rented, there must be *fewer* song downloads to give Kathleen the same level of utility as before. This trade-off of more of one good for less of another gives the indifference curve a negative slope.

**1 point:** Convex shape—no

**1 point:** The indifference curve is a straight line with a constant slope, rather than being a convex line with a slope that decreases in absolute value from left to right.

2. Kathleen has \$20 to spend on iPod song downloads and DVD rentals each week. The price of an iPod song download is \$2 and the price of a DVD rental is \$5.
   a. Graph Kathleen's budget line.
   b. Suppose all of Kathleen's indifference curves have the same shape and slope as the one in Question 1. How many song downloads and DVD rentals will Kathleen purchase to maximize her utility? Explain.

## Section 14 Appendix Review

# Summary


1. **Private information** can cause inefficiency in the allocation of risk. One problem is **adverse selection,** the result of private information about the way things are. It creates the "lemons problem" in the used-car market because buyers will pay only a price that reflects the risk of purchasing a lemon (bad car), which encourages sellers of high-quality cars to drop out of the market. Adverse selection can be limited in several ways—through the **screening** of individuals, through **signaling** that people use to reveal their private information, and through the building of a **reputation.**
2. A related problem is **moral hazard:** individuals have private information about their actions, which distorts their incentives to exert effort or care when someone else bears the costs of that lack of effort or care. It limits the ability of markets to allocate risk efficiently. Insurance companies try to limit moral hazard by imposing **deductibles,** placing more risk on the insured.
3. Preferences can be represented by an **indifference curve map,** a series of **indifference curves.** Each curve shows all of the consumption bundles that yield a given level of total utility. Indifference curves have two general properties: they never cross and greater distance from the origin indicates higher total utility levels. The indifference curves of ordinary goods have two additional properties: they slope downward and are convex in shape.
4. The **marginal rate of substitution,** or ***MRS,*** of some good $R$ in place of some good $M$—the rate at which a consumer is willing to substitute more $R$ for less $M$—is equal to $MU_R/MU_M$ and is also equal to the negative of the slope of the indifference curve when $R$ is on the horizontal axis and $M$ is on the vertical axis. Convex indifference curves get flatter as you move to the right along the horizontal axis and steeper as you move upward along the vertical axis because of *diminishing marginal utility:* a consumer requires more and more units of $R$ to substitute for a forgone unit of $M$ as the amount of $R$ consumed rises relative to the amount of $M$ consumed.
5. Most goods are **ordinary goods,** goods for which a consumer requires additional units of some other good as compensation for giving up some of the good, and for which there is a **diminishing marginal rate of substitution.**
6. A consumer maximizes utility by moving to the highest indifference curve his or her budget constraint allows. Using the **tangency condition,** the consumer chooses the bundle at which the indifference curve just touches the budget line. At this point, the **relative price** of $R$ in terms of $M$, $P_R/P_M$ (which is equal to the negative of the slope of the budget line when $R$ is on the horizontal axis and $M$ is on the vertical axis) is equal to the marginal rate of substitution of $R$ in place of $M$, $MU_R/MU_M$ (which is equal to the negative of the slope of the indifference curve). This gives us the **relative price rule:** at the optimal consumption bundle, the relative price is equal to the marginal rate of substitution. Rearranging this equation also gives us the optimal consumption rule. Two consumers faced with the same prices and income, but with different preferences and so different indifference curve maps, will make different consumption choices.


# Key Terms


Private information, p. 782
Adverse selection, p. 783
Screening, p. 783
Signaling, p. 784
Reputation, p. 784
Moral hazard, p. 785
Deductible, p. 785
Indifference curve, p. 789
Indifference curve map, p. 789
Marginal rate of substitution (*MRS*), p. 794
Diminishing marginal rate of substitution, p. 795
Ordinary goods, p. 795
Tangency condition, p. 796
Relative price, p. 797
Relative price rule, p. 798

# Problems

**1.** You are considering buying a second-hand Volkswagen. From reading car magazines, you know that half of all Volkswagens have problems of some kind (they are "lemons") and the other half run just fine (they are "plums"). If you knew that you were getting a plum, you would be willing to pay $10,000 for it: this is how much a plum is worth to you. You would also be willing to buy a lemon, but only if its price was no more than $4,000: this is how much a lemon is worth to you. And someone who owns a plum would be willing to sell it at any price above $8,000. Someone who owns a lemon would be willing to sell it for any price above $2,000.

**a.** For now, suppose that you can immediately tell whether the car that you are being offered is a lemon or a plum. Suppose someone offers you a plum. Will there be trade?

Now suppose that the seller has private information about the car she is selling: the seller knows whether she has a lemon or a plum. But when the seller offers you a Volkswagen, you do not know whether it is a lemon or a plum. So this is a situation of adverse selection.

**b.** Since you do not know whether you are being offered a plum or a lemon, you base your decision on the expected value to you of a Volkswagen, assuming you are just as likely to buy a lemon as a plum. Calculate this expected value.

**c.** Suppose, from driving the car, the seller knows she has a plum. However, you don't know whether this particular car is a lemon or a plum, so the most you are willing to pay is your expected value. Will there be trade?

**2.** You own a company that produces chairs, and you are thinking about hiring one more employee. Each chair produced gives you revenue of $10. There are two potential employees, Fred Ast and Sylvia Low. Fred is a fast worker who produces ten chairs per day, creating revenue for you of $100. Fred knows that he is fast and so will work for you only if you pay him more than $80 per day. Sylvia is a slow worker who produces only five chairs per day, creating revenue for you of $50. Sylvia knows that she is slow and so will work for you if you pay her more than $40 per day. Although Sylvia knows she is slow and Fred knows he is fast, you do not know who is fast and who is slow. So this is a situation of adverse selection.

**a.** Since you do not know which type of worker you will get, you think about what the expected value of your revenue will be if you hire one of the two. What is that expected value?

**b.** Suppose you offered to pay a daily wage equal to the expected revenue you calculated in part a. Whom would you be able to hire: Fred, or Sylvia, or both, or neither?

**c.** If you knew whether a worker were fast or slow, which one would you prefer to hire and why? Can you devise a compensation scheme to guarantee that you employ only the type of worker you prefer?

**3.** For each of the following situations, draw a diagram containing three of Isabella's indifference curves.

**a.** For Isabella, cars and tires are perfect complements, but in a ratio of 1:4; that is, for each car, Isabella wants exactly four tires. Be sure to label and number the axes of your diagram. Place tires on the horizontal axis and cars on the vertical axis.

**b.** Isabella gets utility only from her caffeine intake. She can consume Valley Dew or cola, and Valley Dew contains twice as much caffeine as cola. Be sure to label and number the axes of your diagram. Place cola on the horizontal axis and Valley Dew on the vertical axis.

**c.** Isabella gets utility from consuming two goods: leisure time and income. Both have diminishing marginal utility. Be sure to label the axes of your diagram. Place leisure on the horizontal axis and income on the vertical axis.

**d.** Isabella can consume two goods: skis and bindings. For each ski she wants exactly one binding. Be sure to label and number the axes of your diagram. Place bindings on the horizontal axis and skis on the vertical axis.

**e.** Isabella gets utility from consuming soda. But she gets no utility from consuming water: any more, or any less, water leaves her total utility level unchanged. Be sure to label the axes of your diagram. Place water on the horizontal axis and soda on the vertical axis.

**4.** Use the four properties of indifference curves for ordinary goods illustrated in Figure 80.4 to answer the following questions.

**a.** Can you rank the following two bundles? If so, which property of indifference curves helps you rank them?

Bundle *A:* 2 movie tickets and 3 cafeteria meals
Bundle *B:* 4 movie tickets and 8 cafeteria meals

**b.** Can you rank the following two bundles? If so, which property of indifference curves helps you rank them?

Bundle *A:* 2 movie tickets and 3 cafeteria meals
Bundle *B:* 4 movie tickets and 3 cafeteria meals

**c.** Can you rank the following two bundles? If so, which property of indifference curves helps you rank them?

Bundle *A:* 12 videos and 4 bags of chips
Bundle *B:* 5 videos and 10 bags of chips

**d.** Suppose you are indifferent between the following two bundles:

Bundle *A:* 10 breakfasts and 4 dinners
Bundle *B:* 4 breakfasts and 10 dinners

Now compare bundle *A* and the following bundle:
Bundle *C:* 7 breakfasts and 7 dinners

Can you rank bundle *A* and bundle *C*? If so, which property of indifference curves helps you rank them? (*Hint:* It may help if you draw this, placing dinners on the horizontal axis and breakfasts on the vertical axis. And remember that breakfasts and dinners are ordinary goods.)