Note: In Chapter 20 (Chapter 7 in the micro split), we used marginal utility analysis to develop the demand curve of an individual. At a more advanced level, economists often rely on a more formal technique—indifference curve analysis—to present this material. This more formal analysis is presented here.

WHAT ARE INDIFFERENCE CURVES?

There are two elements in every choice: (1) preferences (the desirability of various goods) and (2) opportunities (the attainability of various goods). The indifference curve relates to the former: the preferences of an individual. It separates better (more preferred by this individual) bundles of goods from inferior (less preferred) bundles, providing a diagrammatic picture of how an individual ranks alternative consumption bundles.

To illustrate indifference curves, we begin with the title character from the classic Robinson Crusoe, by Daniel Defoe, published in 1719 and thought to be the first English novel. Crusoe was shipwrecked on a desert island. In Exhibit A-1, we assume that he is initially consuming eight fish and eight breadfruit per week (point A). This initial bundle provides him with a certain level of satisfaction (utility). He would, however, be willing to trade this initial bundle for certain other consumption alternatives if the opportunity presented itself. Because he likes both fish and breadfruit, he would especially like to obtain bundles to the northeast of point A in the diagram, because they represent more of both goods. However, he would also be willing to give up some breadfruit if in return he received a compensatory amount of fish. Similarly, if the terms of trade were right, he would be willing to exchange fish for breadfruit.

The trade-offs he is just willing to make—those that would make him no better and no worse off—lie along the indifference curve. Of course, he is happy to move to any bundle on a higher indifference curve.

Starting from point A (eight fish and eight breadfruit), we ask Crusoe if he is willing to trade that bundle for various other bundles. He answers “Yes” (Y), “No” (N), or “I do not care” (i). Exhibit A-1 shows the pattern of his responses. Crusoe’s “I do not care” answers indicate that the original bundle (point A) and each alternative indicated by an i are valued equally by Crusoe. These i points, when connected, form the indifference curve. This line separates the preferred bundles of fish and breadfruit from the less-valued combinations. Note that such a curve is likely to be entirely different for any two people. The preferences of individuals vary widely.

We can establish a new indifference curve for the individual by starting from any point not on the original curve and following the same procedure. If we start with a point (a consumption bundle) to the northeast of the original indifference curve, all points on the new curve will have a higher level of satisfaction for Crusoe than any on the old curve. The new curve will probably have about the same shape as the original.

CHARACTERISTICS OF INDIFFERENCE CURVES

In developing consumer theory, economists assume that the preferences of consumers exhibit certain properties. These properties enable us to make statements about the general pattern of indifference curves. What are these properties, and what do they imply about the characteristics of indifference curves?
1. More goods are preferable to fewer goods—thus, bundles on indifference curves lying farthest to the northeast of a diagram are always preferred. Assuming the consumption of only two commodities that are both desired, the individual will always prefer a bundle with more of one good (without loss of the other) to the original bundle. This means that combinations to the northeast of a point on the diagram will always be preferred to points lying to the southwest.

2. Goods are substitutable—therefore, indifference curves slope downward to the right. As we discussed in this chapter, individuals are willing to substitute one good for another. Crusoe will be willing to give up some breadfruit if he is compensated with enough fish. Stated another way, there will be some amount of additional fish such that Crusoe will stay on the same indifference curve, even though his consumption of breadfruit has declined. However, in order to remain on the same indifference curve, Crusoe must always acquire more of one good to compensate for the loss of the other. The indifference curve for goods thus will always slope downward to the right (run northwest to southeast).

3. The value a consumer puts on a good declines as he or she consumes more of it—therefore, indifference curves are always convex when viewed from below. The slope of the indifference curve represents the willingness of the individual to substitute one good for the other. Economists refer to the amount of one good that is just sufficient to compensate the consumer for the loss of a unit of the other good as the marginal rate of substitution. It is equal to the slope of the indifference curve. Reflecting the principle of diminishing marginal utility, the marginal rate of substitution of a good will decline as the good is consumed more intensively relative to other goods. Suppose Crusoe remains on the same indifference curve while continuing to expand his consumption of fish relative to breadfruit. As his consumption of fish increases (and his consumption of breadfruit declines), his valuation of fish relative to breadfruit will decline. It will take more and more units of fish to compensate for the loss of still another unit of breadfruit. The indifference curve will become flatter, reflecting the decline in the marginal rate of substitution of fish for breadfruit as Crusoe consumes more fish relative to breadfruit.

   Of course, just the opposite will happen if Crusoe’s consumption of breadfruit increases relative to that of fish—if he moves northwest along the same indifference curve. In this case, as breadfruit is consumed more intensively, Crusoe’s valuation of it will decline relative to that of fish, and the marginal rate of substitution of fish for breadfruit will rise (the indifference curve will become steeper and steeper). Therefore, because the valuation of a good declines as it is consumed more intensively, indifference curves must be convex when viewed from the origin.

4. Indifference curves are everywhere. We can construct an indifference curve starting from any point on the diagram. This simply means that any two bundles of goods can be compared by the individual.

5. Indifference curves cannot cross—if they did, rational ordering would be violated. If indifference curves crossed, our postulate that more goods are better than fewer goods would be violated. Exhibit A-2 shows this point. The crossing of the indifference curves implies that points \( Y \) and \( Z \) are equally preferred because they both are on the same indifference curve as \( X \). Consumption bundle \( Y \), though, represents more of both fish and breadfruit than bundle \( Z \), so \( Y \) must be preferred to \( Z \). Whenever indifference curves cross, this type of internal inconsistency (irrational ranking) will arise. So, the indifference curves of an individual must not cross.

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THE CONSUMER’S PREFERRED BUNDLE

Used together with the opportunity constraint of the individual, indifference curves can be used to indicate the most preferred consumption alternatives available to an individual. The consumption opportunity constraint separates consumption bundles that are attainable from those that are unattainable.

Assuming that Crusoe could produce only for himself, his consumption opportunity constraint would look like the production possibilities curves discussed in Chapter 2. What would happen if natives from another island visited Crusoe and offered to make exchanges with him? If a barter market existed that permitted Crusoe to exchange fish for breadfruit at a specified exchange rate, his options would resemble those of the market constraint shown by Exhibit A-3. First, let us consider the case in which Crusoe inhabits a barter economy in which the current market exchange rate is two fish to one breadfruit. Suppose that, as a result of his expertise as a fisherman, Crusoe specializes in this activity and is able to bring sixteen fish to the market per week. What consumption alternatives will be open to him? Because two fish can be bartered in the market for one breadfruit, Crusoe will be able to consume sixteen fish, or eight breadfruit, or any combination on the market constraint indicated by the line between these two points. For example, if he trades two of his sixteen fish for one breadfruit, he will be able to consume a bundle consisting of fourteen fish and one breadfruit. Assuming that the set of indifference curves of Exhibit A-3 outlines Crusoe’s preferences, he will choose to consume eight fish and four breadfruit. Of course, it will be possible for Crusoe to choose many other combinations of breadfruit and fish, but none of the other attainable combinations would enable him to reach as high a level of satisfaction. Because he is able to bring only sixteen fish to the market, it would be impossible for him to attain an indifference curve higher than \( i_2 \).

Crusoe’s indifference curve and the market constraint curve will coincide (they will be tangent) at the point at which his attainable level of satisfaction is maximized. At that point (eight fish and four breadfruit), the rate at which Crusoe is
Indifference Curves Cannot Cross

If the indifference curves of an individual crossed, they would show the inconsistency pictured here. Points X and Y must be equally valued, because they are both on the same indifference curve ($i_1$). Similarly, points X and Z must be equally preferred, because they are both on the indifference curve ($i_2$). If this is true, Y and Z must also be equally preferred, because they are both equally preferred to X. However, point Y represents more of both goods than Z, so Y has to be preferred to Z. When indifference curves cross, this type of internal inconsistency always arises.

Consumer Maximization in a Barter Economy

Suppose that the set of indifference curves shown here outlines Crusoe’s preferences. The slope of the market (or budget) constraint indicates that two fish trade for one breadfruit in this barter economy. If Crusoe produces sixteen fish per week, he will trade eight fish for four breadfruit in order to move to the consumption bundle (eight fish and four breadfruit) that maximizes his level of satisfaction.

willing to exchange fish for breadfruit (as indicated by the slope of the indifference curve) will be just equal to the rate at which the market will permit him to exchange the two (the slope of the market constraint). If the two slopes differ at a point, Crusoe will always be able to find an attainable combination that will permit him to reach a higher indifference curve. He will always move down the market constraint when it is flatter than his indifference curve, and up if the market constraint is steeper.
CRUSOE IN A MONEY ECONOMY

As far as the condition for maximization of consumer satisfaction is concerned, moving from a barter economy to a money income economy changes little. Exhibit A-4 shows this point. Initially, the price of fish is $1, and the price of breadfruit is $2. The market therefore permits an exchange of two fish for one breadfruit, just as was the case in Exhibit A-3. In Exhibit A-4, we assume that Crusoe has a fixed money income of $16. At this level of income, he confronts the same market constraint (usually called a budget constraint) in an economy with money as in Exhibit A-3. Given the product prices and his income, Crusoe can choose to consume sixteen fish, or eight breadfruit, or any combination indicated by a line (the budget constraint) connecting these two points. Given his preferences, Crusoe will again choose the combination of eight fish and four breadfruit if he wishes to maximize his level of satisfaction. As was true for the barter economy, when Crusoe maximizes his satisfaction (moves to the highest attainable indifference curve), the rate at which he is willing to exchange fish for breadfruit will just equal the rate at which the market will permit him to exchange the two goods. Stated in more technical terms, when his level of satisfaction is at a maximum, Crusoe’s marginal rate of substitution of fish for breadfruit, as indicated by the slope of the indifference curve at \( E_1 \), will just equal the price ratio \( P_f/P_b \), which is also the slope of the budget constraint).

What will happen if the price of fish increases? Exhibit A-4 also answers this question. Because the price of breadfruit and Crusoe’s money income are constant, a higher fish price will have two effects. First, it will make Crusoe poorer, even though his money income will be unchanged. His budget constraint will turn clockwise around point \( A \), illustrating that his consumption options are now more limited—that is, his real income has declined. Second, the budget line will be steeper, indicating that a larger number of breadfruit must now be sacrificed to obtain an additional unit of fish. It will no longer be possible for Crusoe to attain indifference curve \( i_2 \). The best he can do is indifference curve \( i_1 \), which he can attain by choosing the bundle of five fish and three breadfruit.

Using the information supplied by Exhibit A-4, we can now locate two points on Crusoe’s demand curve for fish. When the price of fish was $1, Crusoe chose eight fish; when the price rose to $2, Crusoe reduced his consumption to five (see Exhibit A-5). Of course, other points on Crusoe’s demand curve could also be located if we considered other prices for fish.

The demand curve of Exhibit A-5 is constructed on the assumption that the price of breadfruit remains $2 and that Crusoe’s money income remains constant at $16. If either of these factors were to change, the entire demand curve for fish, shown by Exhibit A-5, would shift.

The indifference curve is a useful way to show how a person with a fixed budget chooses between two goods.

### Exhibit A-4

**Consumer Maximization in a Money Economy**

Suppose that Crusoe’s income is $16 per day, the price of fish \( P_f \) is $1, and the price of breadfruit \( P_b \) is $2. Thus, Crusoe confronts exactly the same price ratio and budget constraint as in Exhibit A-3. Assuming that his preferences are unchanged, he will again maximize his satisfaction by choosing to consume eight fish and four breadfruit. What will happen if the price of fish rises to $2? Crusoe’s consumption opportunities will be reduced. His budget constraint will turn clockwise around point \( A \), reflecting the higher price of fish. His fish consumption will decline to five units. (Note: Because Crusoe’s real income has been reduced, his consumption of breadfruit will also decline.)
In the real world, of course, people have hundreds, or even thousands, of goods to choose from, and the doubling of only one price usually has a small impact on a person’s overall consumption and satisfaction possibilities. In our simple example, the twofold increase in the price of fish makes Crusoe much worse off, because he spends a large portion of his budget on the item.

**INCOME AND SUBSTITUTION EFFECTS OF A PRICE CHANGE**

In the text, we indicated that when the price of a product rises, the amount consumed will change as a result of both an income effect and a substitution effect. Indifference curve analysis can be used to separate these two effects. Exhibit A-6 is similar to Exhibit A-4. Both exhibits show Crusoe’s response to an increase in the price of fish from $1 to $2 when money income ($16) and the price of breadfruit ($2) are held constant. Exhibit A-6, however, breaks down his total response into the substitution effect and the income effect. The reduction in the consumption of fish solely because of the substitution (price) effect, holding Crusoe’s real income (level of utility) constant, can be found by constructing a line tangent to Crusoe’s original indifference curve (i₁), and having a slope indicating the higher price of fish. This line (the broken line in Exhibit A-6), which is parallel to Crusoe’s actual budget constraint (the line containing point E₂), reflects the higher price of fish. It is tangent to the original indifference curve i₁, so Crusoe’s real income is held constant. As this line indicates,
Crusoe’s consumption of fish would fall from eight to seven, due strictly to the fact that fish are now more expensive. This move from $E_1$ to $F$ is a pure substitution effect.

Real income, though, has actually been reduced. As a result, Crusoe will be unable to attain point $F$ on indifference curve $i_2$. The best he can attain is point $E_2$, which decreases his consumption of fish by another two units to five. Because the broken line containing $F$ and the budget constraint containing $E_2$ are parallel, the relative price of fish and breadfruit is held constant as Crusoe moves from $F$ to $E_2$. This move from $F$ to $E_2$ is thus a pure income effect. (Note: Because the consumption of both goods drops in this move, when income falls but the prices do not change, both goods must be normal goods.) This reduction in the consumption of fish (and breadfruit) in the move from $F$ to $E_2$ is due entirely to the decline in Crusoe’s real income.

Indifference curve analysis highlights the assumptions and considerations that enter into consumer decisions. The logic of the proof that there is an inverse relationship between the price and the amount demanded is both elegant and reassuring. It is elegant because of the internal consistency of the logic and the precision of the analysis. It is reassuring because it conforms with our expectations, which are based on the central postulate of economics—that incentives matter in a predictable way.

**Indifference curve**
A curve, convex from below, that separates the consumption bundles that are more preferred by an individual from those that are less preferred. The points on the curve represent combinations of goods that are equally preferred by the individual.

**Marginal rate of substitution**
The change in the consumption level of one good that is just sufficient to offset a unit change in the consumption of another good without causing a shift to another indifference curve. At any point on an indifference curve, it will be equal to the slope of the curve at that point.

**Consumption opportunity constraint**
The constraint that separates consumption bundles that are attainable from those that are unattainable. In a money-income economy, this is usually a budget constraint.

**Budget constraint**
The constraint that separates the bundles of goods that the consumer can purchase from those that cannot be purchased, given a limited income and the prices of the products.