

Chapter 4

Individual and Market Demand

■ Questions for Review

1. Explain the difference between each of the following terms:

a. a price consumption curve and a demand curve

The price consumption curve (*PCC*) shows the quantities of two goods a consumer will purchase as the price of one of the goods changes, while a demand curve shows the quantity of one good a consumer will purchase as the price of that good changes. The graph of the *PCC* plots the quantity of one good on the horizontal axis and the quantity of the other good on the vertical axis. The demand curve plots the quantity of the good on the horizontal axis and its price on the vertical axis.

b. an individual demand curve and a market demand curve

An individual demand curve plots the quantity demanded by one person at various prices. A market demand curve is the horizontal sum of all the individual demand curves. It plots the total quantity demanded by all consumers at various prices.

c. an Engel curve and a demand curve

An Engel curve shows the quantity of one good that will be purchased by a consumer at different income levels. The quantity of the good is plotted on the horizontal axis and the consumer's income is on the vertical axis. A demand curve is like an Engel curve except that it shows the quantity purchased at different prices instead of different income levels.

d. an income effect and a substitution effect

Both the substitution effect and income effect occur because of a change in the price of a good. The substitution effect is the change in the quantity demanded of the good due to the price change, holding the consumer's utility constant. The income effect is the change in the quantity demanded of the good due to the change in purchasing power brought about by the change in the good's price.

2. Suppose that an individual allocates his or her entire budget between two goods, food and clothing. Can both goods be inferior? Explain.

No, the goods cannot both be inferior; at least one must be a normal good. Here's why. If an individual consumes only food and clothing, then any increase in income must be spent on either food or clothing or both (recall, we assume there are no savings and more of any good is preferred to less, even if the good is an inferior good). If food is an inferior good, then as income increases, consumption of food falls. With constant prices, the extra income not spent on food must be spent on clothing. Therefore as income increases, more is spent on clothing, i.e., clothing is a normal good.

3. Explain whether the following statements are true or false:

- a. The marginal rate of substitution diminishes as an individual moves downward along the demand curve.**

True. The consumer maximizes his utility by choosing the bundle on his budget line where the price ratio is equal to the *MRS*. For goods 1 and 2, $P_1/P_2 = MRS$. As the price of good 1 falls, the consumer moves downward along the demand curve for good 1, and the price ratio (P_1/P_2) becomes smaller. Therefore, *MRS* must also become smaller, and thus *MRS* diminishes as an individual moves downward along the demand curve.

- b. The level of utility increases as an individual moves downward along the demand curve.**

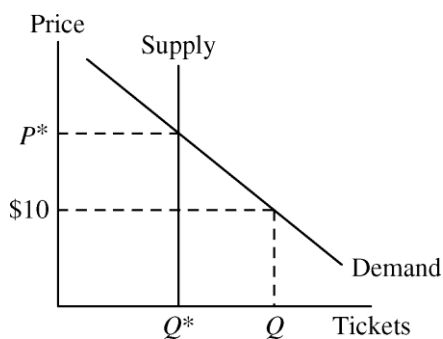
True. As the price of a good falls, the budget line pivots outward, and the consumer is able to move to a higher indifference curve.

- c. Engel curves always slope upward.**

False. If the good is an inferior good, quantity demanded decreases as income increases, and therefore the Engel curve slopes downward.

- 4. Tickets to a rock concert sell for \$10. But at that price, the demand is substantially greater than the available number of tickets. Is the value or marginal benefit of an additional ticket greater than, less than, or equal to \$10? How might you determine that value?**

The diagram below shows this situation. At a price of \$10, consumers want to purchase Q tickets, but only Q^* are available. Consumers would be willing to bid up the ticket price to P^* , where the quantity demanded equals the number of tickets available. Since utility-maximizing consumers are willing to pay more than \$10, the marginal increase in satisfaction (i.e., the value or marginal benefit of an additional ticket) is greater than \$10. One way to determine the value of an additional ticket would be to auction it off. Another possibility is to allow scalping. Since consumers are willing to pay an amount equal to the marginal benefit they derive from purchasing an additional ticket, the scalper's price equals that value.



- 5. Which of the following combinations of goods are complements and which are substitutes? Can they be either in different circumstances? Discuss.**

- a. a mathematics class and an economics class**

If the math class and the economics class do not conflict in scheduling, then the classes could be either complements or substitutes. Math is important for understanding economics, and economics can motivate mathematics, so the classes could be complements. If the classes conflict or the student has room for only one in his schedule, they are substitutes.

- b. tennis balls and a tennis racket**

Tennis balls and a tennis racket are both needed to play tennis, thus they are complements.

c. steak and lobster

Foods can both complement and substitute for each other. Steak and lobster can be substitutes, as when they are listed as separate items on a menu. However, they can also function as complements because they are often served together.

d. a plane trip and a train trip to the same destination

Two modes of transportation between the same two points are substitutes for one another.

e. bacon and eggs

Bacon and eggs are often eaten together and are complementary goods in that case. However, in relation to something else, such as pancakes, bacon and eggs can function as substitutes.

6. Suppose that a consumer spends a fixed amount of income per month on the following pairs of goods:**a. tortilla chips and salsa****b. tortilla chips and potato chips****c. movie tickets and gourmet coffee****d. travel by bus and travel by subway**

If the price of one of the goods increases, explain the effect on the quantity demanded of each of the goods. In each pair, which are likely to be complements and which are likely to be substitutes?

- a. If the price of tortilla chips increases, the consumer will demand fewer tortilla chips. Since tortilla chips and salsa are complements, the demand for salsa will drop (the demand curve will shift to the left), and the consumer will demand less salsa.
- b. If the price of tortilla chips increases, the consumer will demand fewer tortilla chips. Since tortilla chips and potato chips are substitutes, the demand for potato chips will increase (the demand curve will shift to the right), and the consumer will demand more potato chips.
- c. The consumer will demand fewer movies if the price of tickets increases. You might think the demands for movies and gourmet coffee would be independent of each other. However, because the consumer spends a fixed amount on the two, the demand for coffee will depend on whether the consumer spends more or less of her fixed budget on movies after the price increase. If the consumer's demand elasticity for movie tickets is elastic, she will spend less on movies, and therefore more of her fixed income will be available to spend on coffee. In this case, her demand for coffee increases, and she buys more gourmet coffee. The goods are substitutes in this situation. If her demand for movies is inelastic, however, she will spend more on movies after the price increase, and therefore less on coffee. In this case, she will buy less of both goods in response to the price increase for movies, so the goods are complements. Finally, if her demand for movies is unit elastic, she will spend the same amount on movies and therefore will not change her spending on coffee. In this case, the goods are unrelated, and the demand curve for coffee is unchanged.
- d. If the price of bus travel increases, the amount of bus travel demanded will fall, and the demand for subway rides will rise, because travel by bus and subway are typically substitutes. The demand curve for subway rides will shift to the right.

7. Which of the following events would cause a movement *along* the demand curve for U.S. produced clothing, and which would cause a *shift* in the demand curve?**a. the removal of quotas on the importation of foreign clothes**

The removal of quotas will allow U.S. consumers to buy more foreign clothing. Because foreign produced goods are substitutes for domestically produced goods, the removal of quotas will result in a decrease in demand (a shift to the left) for U.S. produced clothes. There could be a smaller secondary effect also. When the quotas are removed, the total supply (foreign plus domestic) of clothing will increase, causing clothing prices to fall. The drop in clothing prices will lead consumers to buy more U.S. produced clothing, which is a movement along the demand curve.

b. an increase in the income of U.S. citizens

When income rises, expenditures on normal goods such as clothing increase, causing the demand curve to shift out to the right.

c. a cut in the industry's costs of producing domestic clothes that is passed on to the market in the form of lower prices

A cut in an industry's costs will shift the supply curve out. The equilibrium price will fall and quantity demanded will increase. This is a movement along the demand curve.

8. For which of the following goods is a price increase likely to lead to a substantial income (as well as substitution) effect?

a. salt

Small income effect, small substitution effect: The amount of income that is spent on salt is very small, so the income effect is small. Because there are few substitutes for salt, consumers will not readily substitute away from it, and the substitution effect is therefore small.

b. housing

Large income effect, small substitution effect: The amount of income spent on housing is relatively large for most consumers. If the price of housing rises, real income is reduced substantially, leading to a large income effect. However, there are no really close substitutes for housing, so the substitution effect is small.

c. theater tickets

Small income effect, large substitution effect: The amount of income spent on theater tickets is usually relatively small, so the income effect is small. The substitution effect is large because there are many good substitutes such as movies, TV shows, bowling, dancing and other forms of entertainment.

d. food

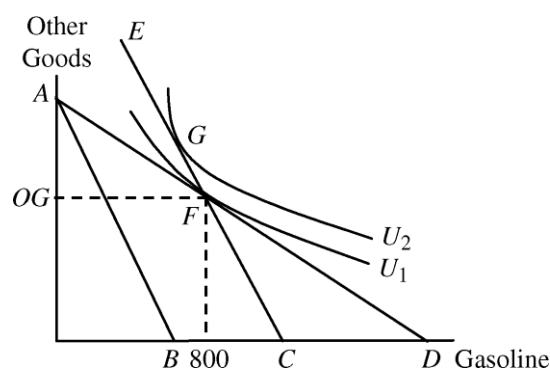
Large income effect, virtually no substitution effect: As with housing, the amount of income spent on food is relatively large for most consumers, so the income effect is large. Although consumers can substitute out of particular foods, they cannot substitute out of food in general, so the substitution effect is essentially zero.

9. Suppose that the average household in a state consumes 800 gallons of gasoline per year. A 20-cent gasoline tax is introduced, coupled with a \$160 annual tax rebate per household. Will the household be better or worse off under the new program?

If the household does not change its consumption of gasoline, it will be unaffected by the tax-rebate program, because the household pays $(\$0.20)(800) = \160 in taxes and receives \$160 as an annual tax rebate. The two effects cancel each other out. However, the utility maximization model predicts that the household will not continue to purchase 800 gallons of gasoline but rather will reduce its gasoline consumption because of the substitution effect. As a result, it will be better off after the tax and rebate program. The diagram shows this situation. The original budget line is AD , and the household maximizes its utility at point F where the budget line is tangent to indifference curve U_1 .

At F , the household consumes 800 gallons of gasoline and OG of other goods. The 20-cent increase in price brought about by the tax pivots the budget line to AB (which is exaggerated to make the diagram clearer). Then the \$160 rebate shifts the budget line out in a parallel fashion to EC where the household is again able to purchase its original bundle of goods containing 800 gallons of gasoline. However, the new budget line intersects indifference curve U_1 and is not tangent to it. Therefore,

point F cannot be the new utility maximizing bundle of goods. The new budget line is tangent to a higher indifference curve, U_2 at point G . Point G is therefore the new utility maximizing bundle, and the household consumes less gasoline (because G is to the left of F) and is better off because it is on a higher indifference curve.



10. Which of the following three groups is likely to have the most, and which the least, price-elastic demand for membership in the Association of Business Economists?

a. students

The major differences among the groups are the level of income and commitment to a career in business economics. We know that demand will be more price-elastic (all else equal) if a good's consumption constitutes a large percentage of an individual's income, because the income effect will be large. Also demand is less elastic the more the good is seen as a necessity. For students, membership in the Association is likely to represent a larger percentage of income than for the other two groups, and students are less likely to see membership as critical for their success. Thus, their demand will be the most price-elastic.

b. junior executives

The level of income for junior executives will be larger than for students but smaller than for senior executives. They will see membership as important but perhaps not as important as for senior executives. Therefore, their demand will be less price-elastic than students but more elastic than senior executives.

c. senior executives

The high earnings among senior executives and the high importance they place on membership will result in the least elastic demand for membership.

11. Explain which of the following items in each pair is more price elastic.

a. The demand for a specific brand of toothpaste and the demand for toothpaste in general

The demand for a specific brand is more elastic because the consumer can easily switch to another brand if the price goes up. It is not so easy to switch to a different tooth brushing agent (baking soda?).

b. The demand for gasoline in the short run and the demand for gasoline in the long run

Demand in the long run is more elastic since consumers have more time to adjust to a change in price. For example, consumers can buy more fuel efficient vehicles, move closer to work or school, organize car pools, etc.

12. Explain the difference between a positive and a negative network externality and give an example of each.

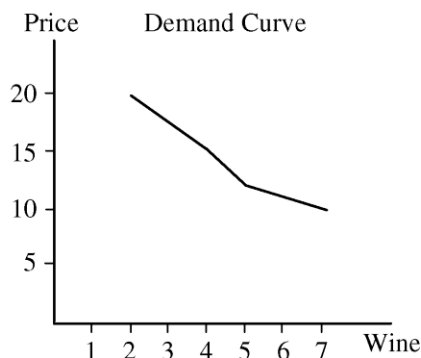
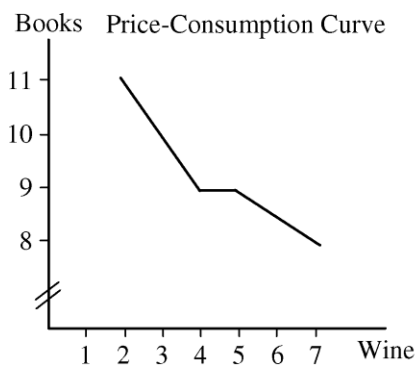
A positive network externality exists if one individual's demand increases in response to the purchase of the good by other consumers. Fads are an example of a positive network externality. For example, each individual's demand for baggy pants increases as more other individuals begin to wear baggy pants. This is also called a bandwagon effect. Another example of a positive network externality occurs with communications equipment such as telephones. A telephone is more desirable when there are a large number of other phone owners to whom one can talk. A negative network externality exists if the quantity demanded by one individual decreases in response to the purchase of the good by other consumers. In this case the individual prefers to be different from other individuals. As more people adopt a particular style or purchase a particular type of good, this individual will reduce his demand for the good. Goods like designer clothing can have negative network externalities, as some people would not want to wear the same clothes that many other people are wearing. This is also known as the snob effect. Another example of a negative network externality is road congestion. As more people use a road, the more congested it becomes, and the less valuable it is to each driver. Some people will drive on the road less often (i.e., demand less road services) when it becomes overly congested.

■ Exercises

1. An individual sets aside a certain amount of his income per month to spend on his two hobbies, collecting wine and collecting books. Given the information below, illustrate both the price-consumption curve associated with changes in the price of wine and the demand curve for wine.

Price Wine	Price Book	Quantity Wine	Quantity Book	Budget
\$10	\$10	7	8	\$150
\$12	\$10	5	9	\$150
\$15	\$10	4	9	\$150
\$20	\$10	2	11	\$150

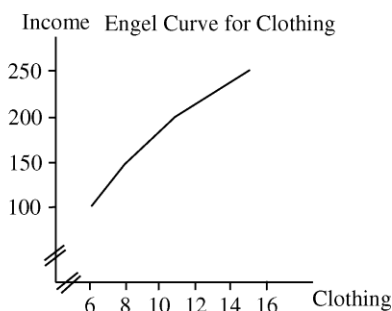
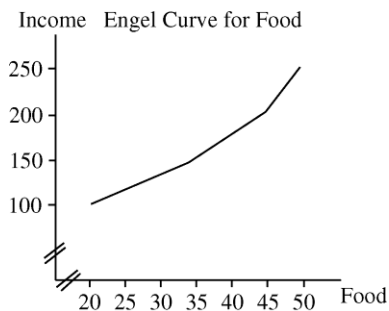
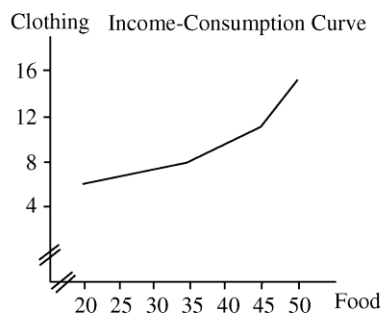
The price-consumption curve connects each of the four optimal bundles given in the table, while the demand curve plots the optimal quantity of wine against the price of wine in each of the four cases. See the diagrams below.



2. An individual consumes two goods, clothing and food. Given the information below, illustrate both the income-consumption curve and the Engel curve for clothing and food.

Price Clothing	Price Food	Quantity Clothing	Quantity Food	Income
\$10	\$2	6	20	\$100
\$10	\$2	8	35	\$150
\$10	\$2	11	45	\$200
\$10	\$2	15	50	\$250

The income-consumption curve connects each of the four optimal bundles given in the table above. As the individual's income increases, the budget line shifts out and the optimal bundles change. The Engel curve for each good illustrates the relationship between the quantity consumed and income (on the vertical axis). Both Engel curves are upward sloping, so both goods are normal.

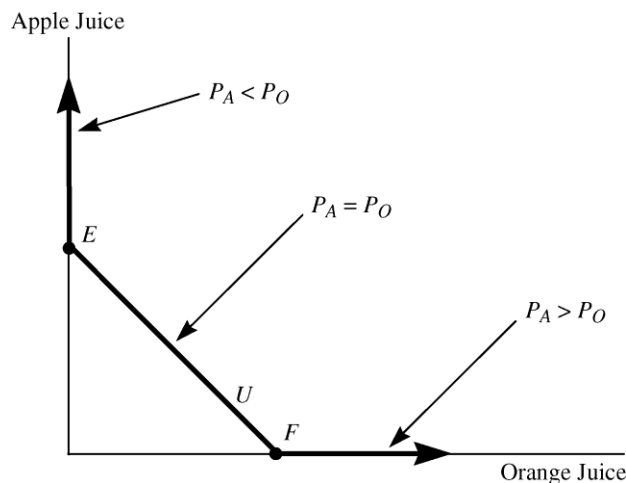


3. Jane always gets twice as much utility from an extra ballet ticket as she does from an extra basketball ticket, regardless of how many tickets of either type she has. Draw Jane's income-consumption curve and her Engel curve for ballet tickets.

Ballet tickets and basketball tickets are perfect substitutes for Jane. Therefore, she will consume either all ballet tickets or all basketball tickets, depending on the two prices. As long as ballet tickets are less than twice the price of basketball tickets, she will choose all ballet. If ballet tickets are more than twice the price of basketball tickets, she will choose all basketball. This can be determined by comparing the marginal utility per dollar for each type of ticket, where her marginal utility from another ballet ticket is 2 times her marginal utility from another basketball ticket regardless of the number of tickets she has. Her income-consumption curve will then lie along the axis of the good that she chooses. As income increases and the budget line shifts out, she will buy more of the chosen good and none of the other good. Her Engel curve for the good chosen is an upward-sloping straight line, with the number of tickets equal to her income divided by the price of the ticket. For the good not chosen, her Engel curve lies on the vertical (income) axis because she will never purchase any of those tickets regardless of how large her income becomes.

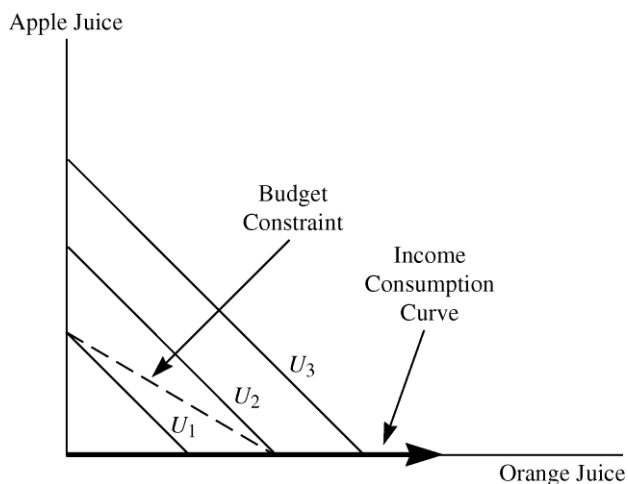
4. a. Orange juice and apple juice are known to be perfect substitutes. Draw the appropriate price-consumption curve (for a variable price of orange juice) and income-consumption curve.

We know that indifference curves for perfect substitutes are straight lines like the line EF in the price-consumption curve diagram below. In this case, the consumer always purchases the cheaper of the two goods (assuming a one-for-one tradeoff). If the price of orange juice is less than the price of apple juice, the consumer will purchase only orange juice and the price-consumption curve will lie along the orange juice axis of the graph (from point F to the right).



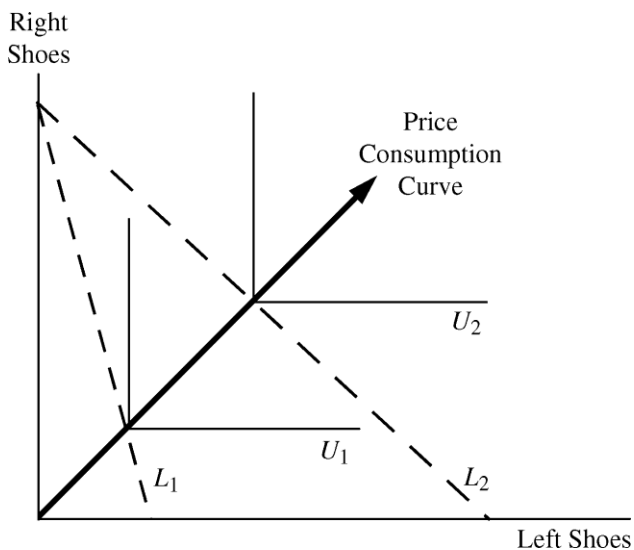
If apple juice is cheaper, the consumer will purchase only apple juice and the price-consumption curve will be on the apple juice axis (above point E). If the two goods have the same price, the consumer will be indifferent between the two; the price-consumption curve will coincide with the indifference curve (between E and F).

Assuming that the price of orange juice is less than the price of apple juice, the consumer will maximize her utility by consuming only orange juice. As income varies, only the amount of orange juice varies. Thus, the income-consumption curve will be along the orange juice axis as in the figure below. If apple juice were cheaper, the income-consumption curve would lie on the apple juice axis.

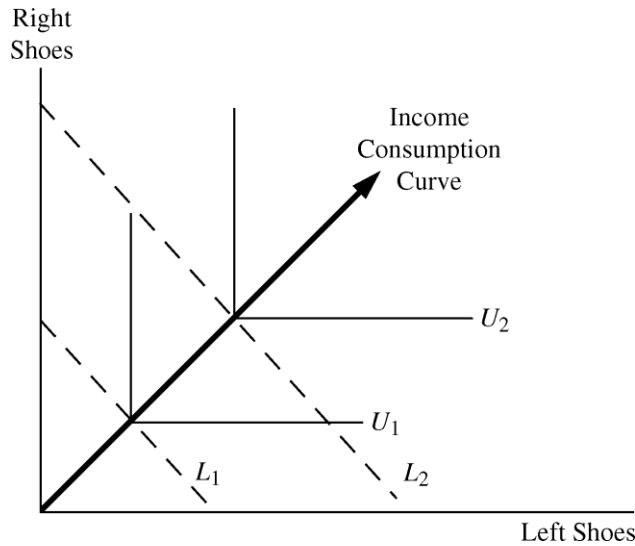


- b. Left shoes and right shoes are perfect complements. Draw the appropriate price-consumption and income-consumption curves.

For perfect complements, such as right shoes and left shoes, the indifference curves are L-shaped. The point of utility maximization occurs when the budget constraints, L_1 and L_2 touch the kink of U_1 and U_2 . See the following figure.



In the case of perfect complements, the income consumption curve is also a line through the corners of the L-shaped indifference curves. See the figure below.

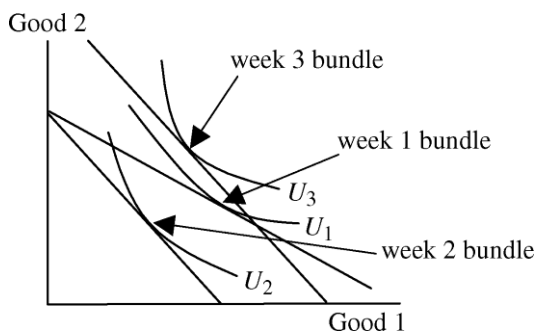


5. Each week, Bill, Mary, and Jane select the quantity of two goods, x_1 and x_2 , that they will consume in order to maximize their respective utilities. They each spend their entire weekly income on these two goods.
- a. Suppose you are given the following information about the choices that Bill makes over a three-week period:

	x_1	x_2	P_1	P_2	I
Week 1	10	20	2	1	40
Week 2	7	19	3	1	40
Week 3	8	31	3	1	55

Did Bill's utility increase or decrease between week 1 and week 2? Between week 1 and week 3? Explain using a graph to support your answer.

Bill's utility fell between weeks 1 and 2 because he consumed less of both goods in week 2. Between weeks 1 and 2 the price of good 1 rose and his income remained constant. The budget line pivoted inward and he moved from U_1 to a lower indifference curve, U_2 , as shown in the diagram. Between week 1 and week 3 his utility rose. The increase in income more than compensated him for the rise in the price of good 1. Since the price of good 1 rose by \$1, he would need an extra \$10 to afford the same bundle of goods he chose in week 1. This can be found by multiplying week 1 quantities times week 2 prices. However, his income went up by \$15, so his budget line shifted out beyond his week 1 bundle. Therefore, his original bundle lies within his new budget set as shown in the diagram, and his new week 3 bundle is on the higher indifference curve U_3 .

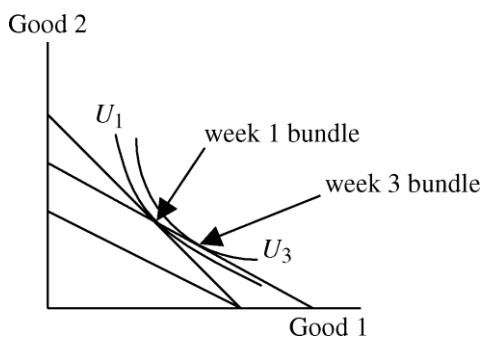


b. Now consider the following information about the choices that Mary makes:

	x_1	x_2	P_1	P_2	I
Week 1	10	20	2	1	40
Week 2	6	14	2	2	40
Week 3	20	10	2	2	60

Did Mary's utility increase or decrease between week 1 and week 3? Does Mary consider both goods to be normal goods? Explain.

Mary's utility went up. To afford the week 1 bundle at the new prices, she would need an extra \$20, which is exactly what happened to her income. However, since she could have chosen the original bundle at the new prices and income but did not, she must have found a bundle that left her slightly better off. In the graph to the right, the week 1 bundle is at the point where the week 1 budget line is tangent to indifference curve U_1 , which is also the intersection of the week 1 and week 3 budget lines. The week 3 bundle is somewhere on the week 3 budget line that lies above the week 1 indifference curve. This bundle will be on a higher indifference curve, U_3 in the graph, and hence Mary's utility increased. A good is normal if more is chosen when income increases. Good 1 is normal because Mary consumed more of it when her income increased (and prices remained constant) between weeks 2 and 3. Good 2 is not normal, however, because when Mary's income increased from week 2 to week 3 (holding prices the same), she consumed less of good 2. Thus good 2 is an inferior good for Mary.



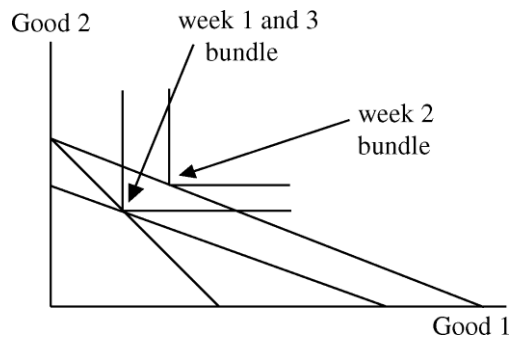
c. Finally, examine the following information about Jane's choices:

	x_1	x_2	P_1	P_2	I
Week 1	12	24	2	1	48

Week 2	16	32	1	1	48
Week 3	12	24	1	1	36

Draw a budget line-indifference curve graph that illustrates Jane's three chosen bundles. What can you say about Jane's preferences in this case? Identify the income and substitution effects that result from a change in the price of good x_1 .

In week 2, the price of good 1 drops, Jane's budget line pivots outward, and she consumes more of both goods. In week 3 the prices remain at the new levels, but Jane's income is reduced. This leads to a parallel leftward shift of her budget line and causes Jane to consume less of both goods. Notice that Jane always consumes the two goods in a fixed 1:2 ratio. This means that Jane views the two goods as perfect complements, and her indifference curves are L-shaped. Intuitively, if the two goods are complements, there is no reason to substitute one for the other during a price change, because they have to be consumed in a set ratio. Thus the substitution effect is zero. When the price ratio changes and utility is kept at the same level (as happens between weeks 1 and 3), Jane chooses the same bundle (12, 24), so the substitution effect is zero.



The income effect can be deduced from the changes between weeks 1 and 2 and also between weeks 2 and 3. Between weeks 2 and 3 the only change is the \$12 drop in income. This causes Jane to buy 4 fewer units of good 1 and 8 less units of good 2. Because prices did not change, this is purely an income effect. Between weeks 1 and 2, the price of good 1 decreased by \$1 and income remained the same. Since Jane bought 12 units of good 1 in week 1, the drop in price increased her purchasing power by $(\$1)(12) = \12 . As a result of this \$12 increase in real income, Jane bought 4 more units of good 1 and 8 more of good 2. We know there is no substitution effect, so these changes are due solely to the income effect, which is the same (but in the opposite direction) as we observed between weeks 1 and 2.

6. Two individuals, Sam and Barb, derive utility from the hours of leisure (L) they consume and from the amount of goods (G) they consume. In order to maximize utility, they need to allocate the 24 hours in the day between leisure hours and work hours. Assume that all hours not spent working are leisure hours. The price of a good is equal to \$1 and the price of leisure is equal to the hourly wage. We observe the following information about the choices that the two individuals make:

Price of G	Price of L	Sam L (hours)	Barb L (hours)	Sam G (\$)	Barb G (\$)
1	8	16	14	64	80
1	9	15	14	81	90
1	10	14	15	100	90

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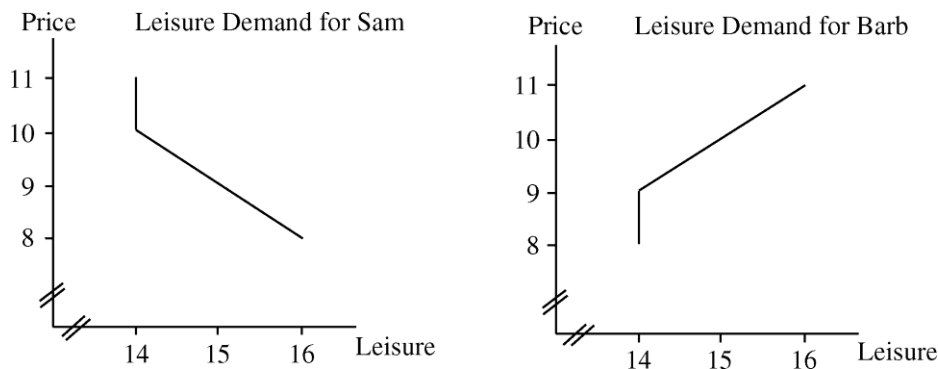
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Graphically illustrate Sam's leisure demand curve and Barb's leisure demand curve. Place price on the vertical axis and leisure on the horizontal axis. Given that they both maximize utility, how can you explain the difference in their leisure demand curves?

It is important to remember that less leisure implies more hours spent working. Sam's leisure demand curve is downward sloping. As the price of leisure (the wage) rises, he chooses to consume less leisure and thus spend more time working at a higher wage to buy more goods. Barb's leisure demand curve is upward sloping. As the price of leisure rises, she chooses to consume more leisure (and work less) since her working hours are generating more income per hour. See the leisure demand curves below.



This difference in demand can be explained by examining the income and substitution effects for the two individuals. The substitution effect measures the effect of a change in the price of leisure, keeping utility constant (the budget line rotates along the current indifference curve). Since the substitution effect is always negative, a rise in the price of leisure will cause both individuals to consume less leisure. The income effect measures the effect of the change in purchasing power brought about by the change in the price of leisure. Here, when the price of leisure (the wage) rises, there is an increase in purchasing power (the new budget line shifts outward). Assuming both individuals consider leisure to be a normal good, the increase in purchasing power will increase demand for leisure. For Sam, the reduction in leisure demand caused by the substitution effect outweighs the increase in demand for leisure caused by the income effect, so his leisure demand curve slopes downward. For Barb, her income effect is larger than her substitution effect, so her leisure demand curve slopes upward.

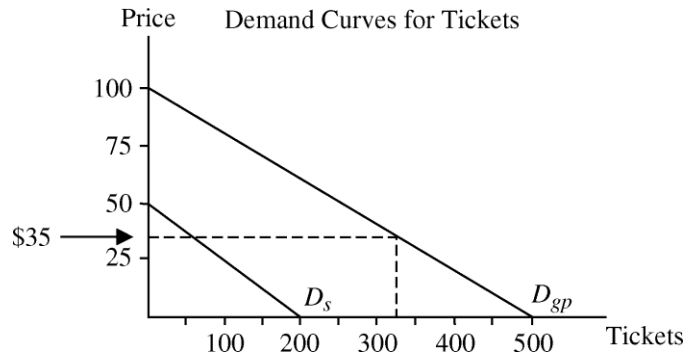
7. The director of a theater company in a small college town is considering changing the way he prices tickets. He has hired an economic consulting firm to estimate the demand for tickets. The firm has classified people who go to the theater into two groups, and has come up with two demand functions. The demand curves for the general public (Q_{gp}) and students (Q_s) are given below:

$$Q_{gp} = 500 - 5P$$

$$Q_s = 200 - 4P$$

- a. Graph the two demand curves on one graph, with P on the vertical axis and Q on the horizontal axis. If the current price of tickets is \$35, identify the quantity demanded by each group.

Both demand curves are downward sloping and linear. For the general public, D_{gp} , the vertical intercept is 100 and the horizontal intercept is 500. For the students, D_s , the vertical intercept is 50 and the horizontal intercept is 200. When the price is \$35, the general public demands $Q_{gp} = 500 - 5(35) = 325$ tickets and students demand $Q_s = 200 - 4(35) = 60$ tickets.



- b. Find the price elasticity of demand for each group at the current price and quantity.**

The elasticity for the general public is $\varepsilon_{gp} = \frac{P}{Q} \frac{\Delta Q}{\Delta P} = \frac{35}{325}(-5) = -0.54$, and the elasticity for students is $\varepsilon_s = \frac{P}{Q} \frac{\Delta Q}{\Delta P} = \frac{35}{60}(-4) = -2.33$. If the price of tickets increases by 10% then the general public will demand 5.4% fewer tickets and students will demand 23.3% fewer tickets.

- c. Is the director maximizing the revenue he collects from ticket sales by charging \$35 for each ticket? Explain.**

No, he is not maximizing revenue because neither of the calculated elasticities is equal to -1 . The general public's demand is inelastic at the current price. Thus the director could increase the price for the general public, and the quantity demanded would fall by a smaller percentage, causing revenue to increase. Since the students' demand is elastic at the current price, the director could decrease the price students pay, and their quantity demanded would increase by a larger amount in percentage terms, causing revenue to increase.

- d. What price should he charge each group if he wants to maximize revenue collected from ticket sales?**

To figure this out, use the formula for elasticity, set it equal to -1 , and solve for price and quantity. For the general public:

$$\varepsilon_{gp} = \frac{-5P}{Q} = -1$$

$$5P = Q = 500 - 5P$$

$$P = 50$$

$$Q = 250.$$

For the students:

$$\varepsilon_s = \frac{-4P}{Q} = -1$$

$$4P = Q = 200 - 4P$$

$$P = 25$$

$$Q = 100.$$

These prices generate a larger total revenue than the \$35 price. When price is \$35, revenue is $(35)(Q_{gp} + Q_s) = (35)(325 + 60) = \$13,475$. With the separate prices, revenue is $P_{gp}Q_{gp} + P_sQ_s = (50)(250) + (25)(100) = \$15,000$, which is an increase of \$1525, or 11.3%.

- 8. Judy has decided to allocate exactly \$500 to college textbooks every year, even though she knows that the prices are likely to increase by 5 to 10% per year and that she will be getting a substantial monetary gift from her grandparents next year. What is Judy's price elasticity of demand for textbooks? Income elasticity?**

Judy will spend the same amount (\$500) on textbooks even when prices increase. We know that total revenue (i.e., total spending on a good) remains constant when price changes only if demand is unit elastic. Therefore Judy's price elasticity of demand for textbooks is -1 . Her income elasticity must be zero because she does not plan to purchase more books even though she expects a large monetary gift (i.e., an increase in income).

- 9. The ACME Corporation determines that at current prices the demand for its computer chips has a price elasticity of -2 in the short run, while the price elasticity for its disk drives is -1 .**

- a. If the corporation decides to raise the price of both products by 10%, what will happen to its sales? To its sales revenue?**

We know the formula for the elasticity of demand is:

$$E_p = \frac{\% \Delta Q}{\% \Delta P}.$$

For computer chips, $E_p = -2$, so $-2 = \% \Delta Q / 10$, and therefore $\% \Delta Q = -2(10) = -20$. Thus a 10% increase in price will reduce the quantity sold by 20%. For disk drives, $E_p = -1$, so a 10% increase in price will reduce sales by 10%.

Sales revenue will decrease for computer chips because demand is elastic and price has increased. We can estimate the change in revenue as follows. Revenue is equal to price times quantity sold. Let $TR_1 = P_1Q_1$ be revenue before the price change and $TR_2 = P_2Q_2$ be revenue after the price change. Therefore

$$\Delta TR = P_2Q_2 - P_1Q_1$$

$$\Delta TR = (1.1P_1)(0.8Q_1) - P_1Q_1 = -0.12P_1Q_1, \text{ or a 12\% decline.}$$

Sales revenue for disk drives will remain unchanged because demand elasticity is -1 .

- b. Can you tell from the available information which product will generate the most revenue? If yes, why? If not, what additional information do you need?**

No. Although we know the elasticities of demand, we do not know the prices or quantities sold, so we cannot calculate the revenue for either product. We need to know the prices of chips and disk drives and how many of each ACME sells.

- 10. By observing an individual's behavior in the situations outlined below, determine the relevant income elasticities of demand for each good (i.e., whether it is normal or inferior). If you cannot determine the income elasticity, what additional information do you need?**

- a. Bill spends all his income on books and coffee. He finds \$20 while rummaging through a used paperback bin at the bookstore. He immediately buys a new hardcover book of poetry.**

Books are a normal good since his consumption of books increases with income. Coffee is a neutral good since consumption of coffee stayed the same when income increased.

- b. Bill loses \$10 he was going to use to buy a double espresso. He decides to sell his new book at a discount to a friend and use the money to buy coffee.**

When Bill's income decreased by \$10 he decided to own fewer books, so books are a normal good. Coffee appears to be a neutral good because Bill's purchase of the double espresso did not change as his income changed.

- c. **Being bohemian becomes the latest teen fad. As a result, coffee and book prices rise by 25%. Bill lowers his consumption of both goods by the same percentage.**

Books and coffee are both normal goods because Bill's response to a decline in real income is to decrease consumption of both goods. In addition, the income elasticities for both goods are the same because Bill reduces consumption of both by the same percentage.

- d. **Bill drops out of art school and gets an M.B.A. instead. He stops reading books and drinking coffee. Now he reads *The Wall Street Journal* and drinks bottled mineral water.**

His tastes have changed completely, and we do not know how he would respond to price and income changes. We need to observe how his consumption of the *WSJ* and bottled water change as his income changes.

11. **Suppose the income elasticity of demand for food is 0.5 and the price elasticity of demand is -1.0 . Suppose also that Felicia spends \$10,000 a year on food, the price of food is \$2, and that her income is \$25,000.**

- a. **If a sales tax on food caused the price of food to increase to \$2.50, what would happen to her consumption of food? (Hint: Because a large price change is involved, you should assume that the price elasticity measures an arc elasticity, rather than a point elasticity.)**

The arc elasticity formula is:

$$E_p = \left(\frac{\Delta Q}{\Delta P} \right) \left(\frac{(P_1 + P_2)/2}{(Q_1 + Q_2)/2} \right).$$

We know that $E_p = -1$, $P_1 = 2$, $P_2 = 2.50$ (so $\Delta P = 0.50$), and $Q_1 = 5000$ units (because Felicia spends \$10,000 and each unit of food costs \$2). We also know that Q_2 , the new quantity, is $Q_2 = Q_1 + \Delta Q$. Thus, if there is no change in income, we may solve for ΔQ :

$$-1 = \left(\frac{\Delta Q}{0.5} \right) \left(\frac{(2 + 2.5)/2}{(5000 + (5000 + \Delta Q))/2} \right).$$

By cross-multiplying and rearranging terms, we find that $\Delta Q = -1000$. This means that she decreases her consumption of food from 5000 to 4000 units. As a check, recall that total spending should remain the same because the price elasticity is -1 . After the price change, Felicia spends $(\$2.50)(4000) = \$10,000$, which is the same as she spent before the price change.

- b. **Suppose that Felicia gets a tax rebate of \$2500 to ease the effect of the sales tax. What would her consumption of food be now?**

A tax rebate of \$2500 is an income increase of \$2500. To calculate the response of demand to the tax rebate, use the definition of the arc elasticity of income.

$$E_I = \left(\frac{\Delta Q}{\Delta I} \right) \left(\frac{(I_1 + I_2)/2}{(Q_1 + Q_2)/2} \right).$$

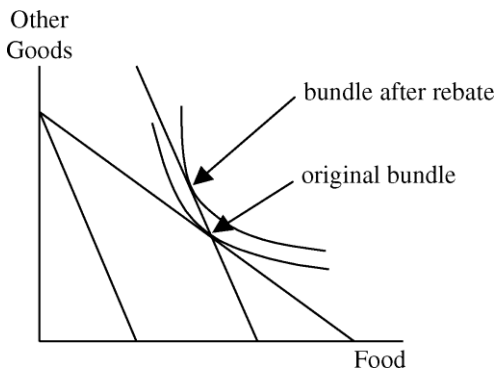
We know that $E_I = 0.5$, $I_1 = 25,000$, $\Delta I = 2500$ (so $I_2 = 27,500$), and $Q_1 = 4000$ (from the answer to 11a). Assuming no change in price, we solve for ΔQ .

$$0.5 = \left(\frac{\Delta Q}{2500} \right) \left(\frac{(25,000 + 27,500)/2}{(4000 + (4000 + \Delta Q))/2} \right).$$

By cross-multiplying and rearranging terms, we find that $\Delta Q = 195$ (approximately). This means that she increases her consumption of food from 4000 to 4195 units.

- c. **Is she better or worse off when given a rebate equal to the sales tax payments? Draw a graph and explain.**

Felicia is better off after the rebate. The amount of the rebate is enough to allow her to purchase her original bundle of food and other goods. Recall that originally she consumed 5000 units of food. When the price went up by fifty cents per unit, she needed an extra $(5000)(\$0.50) = \2500 to afford the same quantity of food without reducing the quantity of the other goods consumed. This is the exact amount of the rebate. However, she did not choose to return to her original bundle. We can therefore infer that she found a better bundle that gave her a higher level of utility. In the graph below, when the price of food increases, the budget line pivots inward. When the rebate is given, this new budget line shifts out to the right in a parallel fashion. The bundle after the rebate is on that part of the new budget line that was previously unaffordable, and that lies above the original indifference curve. It is on a higher indifference curve, so Felicia is better off after the rebate.



12. You run a small business and would like to predict what will happen to the quantity demanded for your product if you raise your price. While you do not know the exact demand curve for your product, you do know that in the first year you charged \$45 and sold 1200 units and that in the second year you charged \$30 and sold 1800 units.

- a. **If you plan to raise your price by 10%, what would be a reasonable estimate of what will happen to quantity demanded in percentage terms?**

We must first find the price elasticity of demand. Because the price and quantity changes are large in percentage terms, it is best to use the arc elasticity measure. $E_P = (\Delta Q / \Delta P) \times (\text{average } P / \text{average } Q) = (600 / -15) \times (37.50 / 1500) = -1$. With an elasticity of -1 , a 10% increase in price will lead to a 10% decrease in quantity.

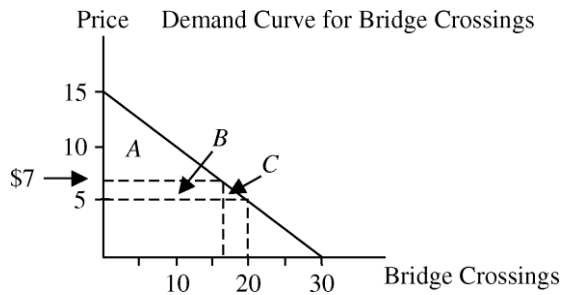
- b. **If you raise your price by 10%, will revenue increase or decrease?**

When elasticity is -1 , revenue will remain constant if price is increased.

13. Suppose you are in charge of a toll bridge that costs essentially nothing to operate. The demand for bridge crossings Q is given by $P = 15 - \frac{1}{2}Q$.

- a. **Draw the demand curve for bridge crossings.**

The demand curve is linear and downward sloping. The vertical intercept is 15 and the horizontal intercept is 30.



- b. How many people would cross the bridge if there were no toll?**

At a price of zero, $0 = 15 - (1/2)Q$, so $Q = 30$. The quantity demanded would be 30.

- c. What is the loss of consumer surplus associated with a bridge toll of \$5?**

If the toll is \$5 then the quantity demanded is 20. The lost consumer surplus is the difference between the consumer surplus when price is zero and the consumer surplus when price is \$5. When the toll is zero, consumer surplus is the entire area under the demand curve, which is $(1/2)(30)(15) = 225$. When $P = 5$, consumer surplus is area $A + B + C$ in the graph above. The base of this triangle is 20 and the height is 10, so consumer surplus $= (1/2)(20)(10) = 100$. The loss of consumer surplus is therefore $\$225 - 100 = \125 .

- d. The toll-bridge operator is considering an increase in the toll to \$7. At this higher price, how many people would cross the bridge? Would the toll-bridge revenue increase or decrease? What does your answer tell you about the elasticity of demand?**

At a toll of \$7, the quantity demanded would be 16. The initial toll revenue was $\$5(20) = \100 . The new toll revenue is $\$7(16) = \112 , so revenue increases by \$12. Since the revenue goes up when the toll is increased, demand is inelastic (the 40% increase in price outweighs the 20% decline in quantity demanded).

- e. Find the lost consumer surplus associated with the increase in the price of the toll from \$5 to \$7.**

The lost consumer surplus is area $B + C$ in the graph above. Thus, the loss in consumer surplus is $(16) \times (7 - 5) + (1/2) \times (20 - 16) \times (7 - 5) = \36 .

- 14. Vera has decided to upgrade the operating system on her new PC. She hears that the new Linux operating system is technologically superior to Windows and substantially lower in price. However, when she asks her friends, it turns out they all use PCs with Windows. They agree that Linux is more appealing but add that they see relatively few copies of Linux on sale at local stores. Vera chooses Windows. Can you explain her decision?**

Vera is influenced by a positive network externality (not a bandwagon effect). When she hears that there are limited software choices that are compatible with Linux and that none of her friends use Linux, she decides to go with Windows. If she had not been interested in acquiring much software and did not think she would need to get advice from her friends, she might have purchased Linux.

- 15. Suppose that you are the consultant to an agricultural cooperative that is deciding whether members should cut their production of cotton in half next year. The cooperative wants your advice as to whether this action will increase members' revenues. Knowing that cotton (C) and**

soybeans (S) both compete for agricultural land in the South, you estimate the demand for cotton to be $C = 3.5 - 1.0P_C + 0.25P_S + 0.50I$, where P_C is the price of cotton, P_S the price of soybeans, and I income. Should you support or oppose the plan? Is there any additional information that would help you to provide a definitive answer?

If production of cotton is cut in half, then the price of cotton will increase, given that the equation above shows that demand is downward sloping (since the sign on P_C is negative). With price increasing and quantity demanded decreasing, revenue could go either way. It depends on whether demand is elastic or inelastic. If demand is elastic, a decrease in production and an increase in price would decrease revenue. If demand is inelastic, a decrease in production and an increase in price would increase revenue. You need a lot of information before you can give a definitive answer. First, you must know the current prices for cotton and soybeans plus the level of income; then you can calculate the quantity of cotton demanded, C . Next, you have to cut C in half and determine the effect that will have on the price of cotton, assuming that income and the price of soybeans are not affected (which is a big assumption). Then you can calculate the original revenue and the new revenue to see whether this action increases members' revenues or not.