Chapter 5

MEASUREMENT AND INTERPRETATION OF ELASTICITIES

The elasticity of demand in a market is great or small accordingly as the amount demanded increases much or little for a given fall in price, and diminishes much or little for a given rise in price.

Alfred Marshall (1842–1924)

Chapter Outline

Prices of milk rose by roughly 25 percent in May 2004 to around $4 per gallon. To what extent will higher prices affect milk-buying habits of consumers?

Chapters 3 and 4 discussed consumer response to a decline in a product's price by purchasing more of that product. In fact, economists are so sure of this inverse relationship between price and quantity demanded that it is referred to as the law of demand. In Chapter 4, we learned that the market demand curve for a commodity shifts to the right or the left when consumers respond to changes in prices and incomes.

What is left unsaid thus far is the degree of consumer responsiveness to change in prices and incomes. Estimates of the degree of responsiveness are expressed in what economists refer to as elasticities. The concept of demand elasticity was invented by British economist Alfred Marshall, the nineteenth-century pioneer of microeconomic theory. The purpose of this chapter is to discuss the measurement of specific widely used concepts of elasticities and provide actual estimates of these elasticities and their meaning to economic analyses.

Own-Price Elasticity of Demand

Economists compare the difference between the change in quantity demanded with the change in the price of a good in percentage terms. This comparison is called the **own-price elasticity of demand.**[1] The own-price elasticity

[1] The elasticity of demand is an arc elasticity that applies to discrete changes in price. When the changes approach zero, a point elasticity of demand can be defined.

of demand measures the sensitivity to changes in the price of the particular products. The own-price elasticity of demand is defined as

$$\text{own-price elasticity of demand} = \frac{\text{percentage change in quantity}}{\text{percentage change in price}} \quad (5.1)$$

The percentage change in the quantity of hamburgers demanded, for example, is equal to the change in hamburgers divided by the average quantity of hamburgers consumed during the period. The percentage change in the price of hamburgers is equal to the change in the price of hamburgers divided by the average price of hamburgers during this period.

To illustrate the calculation of this elasticity, assume that your consumption of hamburgers drops from three hamburgers to two hamburgers when the price increases from \$1.00 to \$1.25 per hamburger. The average quantity over this range would be equal to 2.5 (i.e., [2 + 3] ÷ 2), while the average price would be \$1.125 (i.e., [\$1.25 + \$1] ÷ 2). The own-price elasticity of demand in this case would be

$$\text{own-price elasticity of demand} = \frac{(Q_A - Q_B) \div ([Q_A + Q_B] \div 2)}{(P_A - P_B) \div ([P_A + P_B] \div 2)} =$$

$$\frac{(2 - 3) \div 2.5}{(\$1.25 - \$1.00) \div \$1.125} = -1.8 \quad (5.2)$$

in which Q_A and P_A represent the quantity and price after the change, and Q_B and P_B represent quantity and price before the change. Thus, a 1% fall (rise) in the price of a hamburger will increase (reduce) quantity demanded by 1.8%. Often the minus sign is ignored (i.e., we might simply say that the own-price elasticity is 1.8). The minus sign indicates that the demand curve is indeed downward sloping.

We may simplify Equation 5.2 with some algebraic manipulation:

$$\text{own-price elasticity of demand} = \frac{\Delta Q}{\Delta P} \times \frac{\bar{P}}{\bar{Q}} \quad (5.3)$$

where $\Delta Q = Q_A - Q_B$; $\Delta P = P_A - P_B$; $\bar{P} = \frac{P_A + P_B}{2}$; and $\bar{Q} = \frac{Q_A + Q_B}{2}$

This formula, given by either Equation 5.2 or 5.3, measures average price elasticity between two points on the demand curve and is technically called the **arc elasticity**. Differential calculus permits the determination of price elasticity at a specific point on the demand curve. This measure, dealing with infinitesimal changes, is called the **point elasticity**. Because demand curves slope downward to the right, the measure of own-price elasticity is always negative. The effects of a change in the price of a good on the demand for this good are summarized in Table 5.1.

When the price elasticity of demand for a good exceeds one (in absolute value), we call the response **elastic**; that is, the percentage change in quantity demanded exceeds the percentage change in price. If the price elasticity of

Table 5.1 Own-Price Elasticity of Demand

If the Own-Price Elasticity Is:	Demand Is Said to Be:	Percentage Change in Quantity Is:
Greater than one	Elastic	Greater than percentage change in price
Equal to one	Unitary elastic	Same as percentage change in price
Less than one	Inelastic	Less than percentage change in price

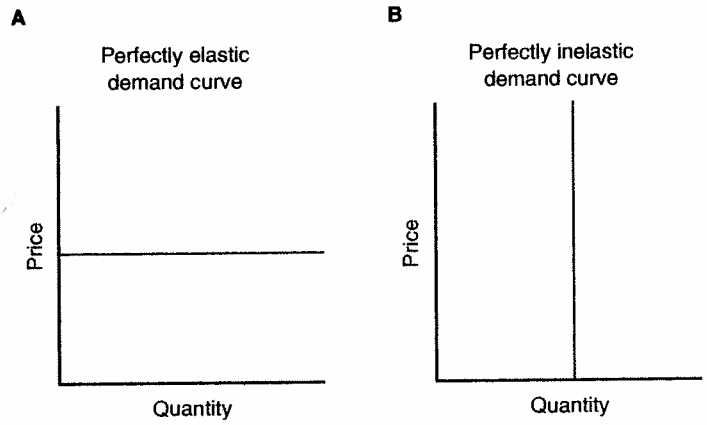


FIGURE 5.1 *A,* A perfectly elastic demand curve is parallel to the horizontal axis. *B,* A perfectly inelastic demand curve is parallel to the vertical axis.

demand is equal to one, the curve would represent a **unitary elastic** demand. When the price elasticity of demand for a good is less than one (in absolute value), the demand is called **inelastic**. The percentage change in the quantity demanded is less than the percentage change in the product price.

If the demand curve were perfectly flat, or horizontal, it would represent a **perfectly elastic demand**. If the demand curve were perpendicular to the horizontal axis, or completely vertical, it would represent a **perfectly inelastic demand** (see Figure 5.1, *A* and *B*).

Along the demand curve, the elasticity may be changing. Consider the case of the linear demand curve for a hypothetical product illustrated in Figure 5.2. The demand response by the consumer is elastic along the upper portion of the curve. We see this from the elasticities, calculated using Equation 5.1, that are presented in column 6 of Table 5.2. The demand response is unitary elastic at the midpoint of this curve, inelastic to the right of this point, and elastic to the left of this point.

Why does this elasticity change along a linear demand curve, although the change in quantity divided by the change in price is constant? The ratio of price to quantity is continuously changing as we move down the demand curve. In fact, the ratio of price to quantity approaches zero when price approaches zero. Therefore, in the case of a linear demand curve, we can conclude that the own-price elasticity of demand falls (rises) when the product price falls (rises). Note that the elasticity is different at each point on a linear (straight-line) demand curve, but the slope of the linear demand curve is constant.

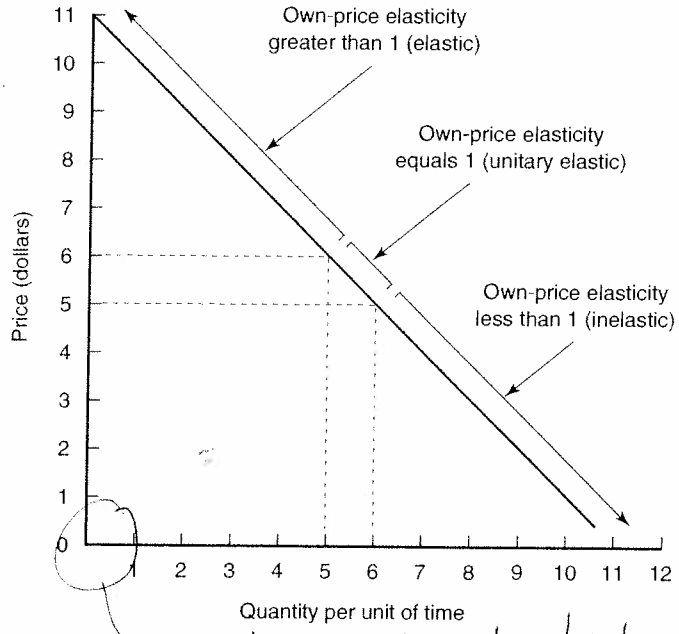


FIGURE 5.2 Graphical illustration of consumption expenditures and the own-price elasticity data given in Table 5.2.

Table 5.2 Consumption Expenditures and the Own-Price Elasticity

(1) Price	(2) Quantity Demanded	(3) Total Expenditure, (1) × (2)	(4) Percentage Change in Quantity, % Δ (2)	(5) Percentage Change in Price, % Δ (1)	(6) Own-Price Elasticity, (4) ÷ (5)
$11	0	$0			
			+ 1/0.5	−1/10.5	−21.00
10	1	10			
			+ 1/1.5	−1/9.5	−6.33
9	2	18			
			+ 1/2.5	−1/8.5	−3.40
8	3	24			
			+ 1/3.5	−1/7.5	−2.14
7	4	28			
			+ 1/4.5	−1/6.5	−1.44
6	5	30			
			+ 1/5.5	−1/5.5	−1.00
5	6	30			
			+ 1/6.5	−1/4.5	−0.69
4	7	28			
			+ 1/7.5	−1/3.5	−0.47
3	8	24			
			+ 1/8.5	−1/2.5	−0.29
2	9	18			
			+ 1/9.5	−1/1.5	−0.14
1	10	10			

The own-price elasticity of demand measures the percentage change in the quantity demanded of a good given a 1% change in price. This measure is negative, reflective of the law of demand. If this elasticity is greater than one, the demand for a good is termed elastic; if this elasticity is less than one, the demand for a good is said to be inelastic.

With elastic demand, the percentage change in quantity will be greater than the percentage change in price; thus, consumer expenditures rise when prices fall. The opposite conclusion holds for a price rise; expenditures will fall when price increases. When the elasticity is one, the percentage change in quantity will be equal to the percentage change in price. There would be no change in consumer expenditures when price changes. The percentage change in quantity will be less than the percentage change in price if demand is inelastic; thus, consumer expenditures fall when price falls.

Note that in Table 5.2 total expenditures made by the consumer would be \$18 if the price were equal to \$9. Total expenditure would be \$28 if the price fell to \$7. Total expenditures would have risen by \$10 (i.e., \$28 − \$18) if the price were to fall by \$2 (i.e., \$9 − \$7). This relationship will always hold whenever the change in price takes place in the elastic portion of the demand curve. If the price were to fall from \$4 to \$2, total expenditures would fall by \$10 (i.e., \$28 − \$18). This change in total expenditures takes place in the inelastic portion of the demand curve. The opposite conclusion holds for a price rise; a rise in price raises (lowers) expenditure if demand is inelastic (elastic).

■ INCOME ELASTICITY OF DEMAND

As noted earlier, it is useful to assess the effects of changes in income on changes in quantity demanded in percentage terms. This measure is called the **income elasticity** of demand. The income elasticity of demand measures the sensitivity to changes in income. The income elasticity of demand is defined as

$$\begin{matrix}\text{income}\\ \text{elasticity}\\ \text{of demand}\end{matrix} = \frac{\text{percentage change in quantity}}{\text{percentage change in income}} \tag{5.4}$$

Consequently, the income elasticity demand is a measure of the responsiveness of the quantity of a good purchased due to changes in income, all other factors constant. In Figure 4.5, the income elasticity of demand for hamburgers over the segment AB of the Engel curve for hamburgers is equal to

$$\begin{matrix}\text{income}\\ \text{elasticity}\\ \text{of demand}\end{matrix} = \frac{(Q_A - Q_B) \div ([Q_A + Q_B] \div 2)}{(I_A - I_B) \div ([I_A + I_B] \div 2)} =$$

$$\frac{(2 - 3) \div ([2 + 3] \div 2)}{(5 - 6) \div ([5 - 6] \div 2)} = -2.20 \tag{5.5}$$

The income elasticity of demand measures the percentage change in the quantity demanded of a good given a 1% change in income. If this elasticity is negative, the good in question is classified as an inferior good. If this measure is positive but less than one, the good in question is labeled a normal good. If this measure is greater than one, the good in question is labeled a luxury or superior good.

Therefore, a 1% increase in income leads to a 2.2% increase in the demand for hamburgers. An income elasticity greater than one implies that a 1% increase in income will cause consumption to rise more than 1%. Goods with an elasticity greater than one are called luxuries by economists. When the income elasticity is less than one but greater than zero, the good is called a **necessity**, or a **normal good**. When the income elasticity is negative, the good is referred to as an **inferior good**, which is not the same as poor quality or defective (see Table 5.3). In the example of hamburgers over the line segment AB in Figure 4.5, hamburgers are classified as a necessity. Most foods are necessities, and most nonfood products, such as furniture, a physician's services, and recreation, are considered **luxuries**.

Table 5.3 Income Elasticity Classifications

If the Income Elasticity Is:	The Good Is Classified As:
Greater than one	A luxury and a normal good
Less than one but greater than zero	A necessity and a normal good
Less than zero	An inferior good

Again, we may simplify Equation 5.5 as follows:

$$\text{income elasticity of demand} = \frac{\Delta Q}{\Delta I} \times \frac{\bar{I}}{\bar{Q}} \tag{5.6}$$

where $\Delta Q = Q_A - Q_B$; $\Delta I = I_A - I_B$; $\bar{I} = \frac{I_A + I_B}{2}$; and $\bar{Q} = \frac{Q_A + Q_B}{2}$

According to Tomek and Robinson (1981), "The income elasticity for food in the aggregate, as well as for many individual products, is thought to decrease as incomes increase." Income elasticities will typically change over different income levels, and this change can be positive or negative. When incomes rise, *ceteris paribus*, demand increases for foods such as beef, poultry, shellfish, fresh fruits, and vegetables, but decreases for other foods such as sugar, processed milk, potatoes, eggs, and breakfast cereal (see Blaylock and Smallwood, 1986). In the domestic market, most foods have small, positive income elasticities. Consequently, large increases in income are necessary to generate substantial increases in consumption.

■ Cross-Price Elasticity of Demand

We can measure the effects of changes in the price of tacos on the demand for hamburgers by calculating the **cross-price elasticity** of demand as

$$\text{cross-price elasticity of demand} = \frac{\text{percentage change in quantity of hamburgers}}{\text{percentage change in price of tacos}} \tag{5.7}$$

$$= \frac{(Q_{HA} - Q_{HB}) \div ([Q_{HA} + Q_{HB}] \div 2)}{(P_{TA} - P_{TB}) \div ([P_{TA} + P_{TB}] \div 2)} \tag{5.8}$$

in which Q_H refers to the quantity demanded of hamburgers and P_T refers to the price of tacos. This elasticity measures the relative responsiveness of the consumption of hamburgers to the price of tacos. Once again, we may simplify Equation 5.8:

$$\text{cross-price elasticity of demand} = \frac{\Delta Q_H}{\Delta P_T} \times \frac{\bar{P}_T}{\bar{Q}_H}, \text{ where} \tag{5.9}$$

$$\Delta Q_H = Q_{HA} - Q_{HB}; \Delta P_T = P_{TA} - P_{TB}; \bar{P}_T = \frac{P_{TA} + P_{TB}}{2};$$

$$\text{and } \bar{Q}_H = \frac{Q_{HA} + Q_{HB}}{2}$$

Table 5.4 Cross-Price Elasticity Classifications

If the Cross-Price Elasticity Is:	The Goods Are Classified As:
Positive	Substitutes
Negative	Complements
Zero	Independent

The cross-price elasticity of demand measures the change in the quantity demanded for one good in light of a 1% change in the price of another good. If this elasticity is positive, the goods in question are classified as substitutes. If this elasticity is negative, the goods in question are classified as complements. If this elasticity is equal to zero, the goods in question are classified as independent.

We can distinguish among the three different effects that a change in the price of one good can have on the demand for another good (see Table 5.4). The effects of substitutes and complements are of interest to agricultural economists. For example, when the price for beef increases, what will happen to the demand for other products, such as poultry, fish, pork, fruit, and vegetables?

Commodities with large, positive (negative) cross-price elasticities are close **substitute (complementary)** commodities. Cross-price elasticities close to zero are indicative of commodities that are unrelated.

■ Other General Properties

The concept of elasticities often is a key input in making sound business decisions. To illustrate, a firm facing an inelastic demand for its product could increase price and raise revenues at the same time. The rise in price would lead to increases in profits because the higher price would reduce quantity sold, cutting total costs. In another case, top management may operate under the assumption that the brand name of its product is so strong that it could raise price without any serious impact on sales. However, if the demand for this branded product is elastic, the appropriate course of action would be to cancel the planned price increase and offer instead a price reduction, perhaps through a discount coupon.

We now focus on other properties of demand curves. The larger (smaller) the number of substitutes, the more (less) elastic the demand curve. Thus, a commodity such as salt is likely to be very inelastic, and a commodity such as Hunt's catsup is likely to be very elastic. There are several substitutes for Hunt's catsup (e.g., Heinz, Del Monte, and other brands). Aggregates are generally more inelastic than their components. The demand for food is more inelastic than the demand for hamburgers. Further, the demand for Hunt's catsup is more elastic than the demand for catsup in general. The greater the number of alternative uses a commodity has, the greater its price elasticity will be.

Another general property is the budget share of the commodity. If a good or service represents a relatively large budget share or proportion of household budgets, its demand curve will be more elastic. When expenditures for a good or service are sizable, such as for automobiles, furniture, and appliances, consumers are more sensitive to changes in their prices, *ceteris paribus*. Salt expenditures comprise a relatively small percentage of total expenditures made by a consumer. Thus, salt is not likely to exhibit a high elasticity of demand. The demand for cabbage is also inelastic by virtue of its negligible budget share. A 50% increase in the price of cabbage will have very little effect on the quantity demanded, even though there are several substitutes for cabbage. There are relatively few substitutes for housing services, and its budget share is relatively large. Consequently, the elasticity of demand for housing services is expected to be large. Houthakker and Taylor (1970) estimate that the own-

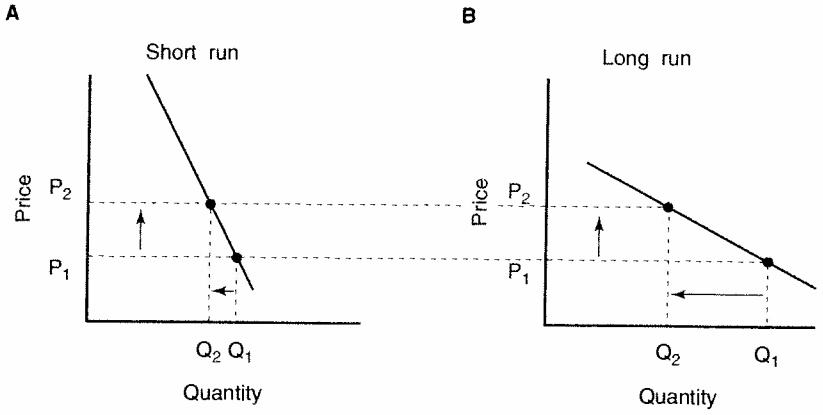


FIGURE 5.3 Consumer demand curves become more elastic (flatter) over time as consumers adjust to changing prices.

price elasticity of demand for housing is approximately equal to −1, and that the own-price elasticity of demand for cabbage is about −0.4.

Another general property of demand curves is that short-run demand is more inelastic than long-run demand. With the passage of time, consumers find that they are better able to adjust to price changes. Suppose the price of a product rises from P_1 to P_2 in Figure 5.3, *A* and *B*. In the short run, a consumer's immediate response is to reduce his or her consumption of the product only from Q_1 to Q_2 (Figure 5.3, *A*). As consumers make adjustments to their consumption habits over a longer period of time, however, they will cut back their consumption to Q_2 (Figure 5.3, *B*). During the energy crisis of the 1970s, consumers were not able to adjust their purchases of gasoline in the short run when the price of gasoline rose sharply. With the manufacturing of cars that got better gas mileage, consumers were able to adjust to higher gasoline prices by lowering gasoline consumption over the long run.

A final property of demand curves is that the price elasticity of demand for farm products is greater at the retail level than at the farm level. George Brandow, an agricultural economist at Penn State University, conducted a landmark study of selected elasticities of the demand for agricultural commodities in the United States at farm and retail levels. The differences in magnitude of the elasticities in these two markets in the food chain are primarily attributable to the relative level of prices in the two markets and to the value added to the product between these markets (see Table 5.5).

To summarize, the determinants of the elasticity of demand for a specific commodity include

- availability of substitutes for the commodity,
- alternative uses for the commodity,
- type of market (e.g., farm level versus retail level or domestic market versus export market),
- the percentage of the budget spent on the commodity, and
- time.

Given this number of determinants, the elasticity of demand for a commodity is not a constant. Agricultural economist Fredrick Waugh stated there is no such thing as a (i.e., single) demand elasticity.

The concept of elasticity, originated by Alfred Marshall, is a key input in making sound business decisions. Determinants of the elasticity of demand of a commodity include availability of substitutes for the commodity, the type of market, the level of the marketing channel, the percentage of the budget spent on the commodity, and time.

Table 5.5 Own-Price Elasticities at the Retail and Farm Levels of the Marketing Channel

Commodity	Own-Price Elasticity of Demand	
	Retail Level	Farm Level
Turkey	−1.40	−0.92
Chicken	−1.16	−0.74
Beef	−0.95	−0.68 (cattle)
Pork	−0.75	−0.46 (hogs)
Butter	−0.85	−0.66
Cheese	−0.70	−0.53
Ice cream	−0.55	−0.11
Eggs	−0.30	−0.23
Fruit	−0.60	−0.36
Vegetables	−0.30	−0.10

Source: *Brandow GE:* Interrelationships among demand for farm products and implications for control of market supply, *University Park, Penn, 1961, Agricultural Experiment Station.*

Some Real-World Examples

Economists have estimated specific own-price, cross-price, and income elasticities of demand for various products. Own-price and income elasticities for several food products at the retail level are presented in Table 5.6. In the United States, the demand for grapes is elastic (−1.3780), the demand for bananas is inelastic (−0.4002), and the demand for oranges is unitary (−0.9996).

Own-Price Elasticities. The price elasticity of demand for farm products in the United States has been very small. Therefore, demand elasticities of most agricultural products are in the inelastic range. Increases in the output of farm commodities because of excellent weather conditions and/or increases in productivity will depress prices rather dramatically.

Consider again the definition of the own-price elasticity expressed in Equation 5.2, or the percentage change in quantity over range *AB* divided by the percentage change in price over range *AB*. Using Brandow's estimate of the own-price elasticity for farm products of −0.34, can you use this equation to defend the statement that a 1% increase in quantity coming onto the market would depress farm prices by almost 3%? (*Hint:* Given the percent change in quantity of 1 and the elasticity of −0.34, you are left with one equation and one unknown—the percent change in price—for which to solve.)

With respect to specific commodities, George and King (1971) found that the price elasticity of demand for beef at the retail level was −0.64. Thus, a 1% fall in the price of beef at the retail level would increase the demand for beef at the retail level by 0.64%. Tweeten (1970) suggests that the short-run own-price elasticity of demand for wheat and soybeans during the 1990s was −0.475 and −0.347, and the corresponding long-run elasticities for these commodities were actually elastic (−1.220 and −1.002, respectively).

Perhaps the most comprehensive study of retail price and income elasticities is the study by Huang reported in Table 5.6. This table suggests that a 1% increase in the retail price of sweeteners would have practically no effect on demand. However, a 1% increase in the retail price of grapes would decrease demand by more than 1%.

Table 5.6 Estimated Own-Price and Income Elasticities at the Retail Level

Commodity	Own-Price Elasticity	Income Elasticity
Beef and veal	−.6166	.4549
Pork	−.7297	.4427
Other meats	−1.3712	.0607
Chicken	−.5308	.3645
Turkey	−.6797	.3196
Eggs	−.1452	−.0283
Cheese	−.3319	.5927
Fluid milk	−.2588	−.2209
Evaporated and dry milk	−.8255	−.2664
Wheat flour	−.1092	−.1333
Rice	−.1467	−.3664
Potatoes	−.3688	.1586
Butter	−.1670	.0227
Margarine	−.2674	.1112
Other fats and oils	−.2191	.3691
Apples	−.2015	−.3514
Oranges	−.9996	.4866
Bananas	−.4002	−.0429
Grapes	−1.3780	.4407
Grapefruits	−.2191	.4588
Other fresh fruits	−.2357	−.3401
Lettuce	−.1371	.2344
Tomatoes	−.5584	.4619
Celery	−.2516	.1632
Onions	−.1964	.1603
Carrots	−.0388	−.1529
Cabbage	−.0385	−.3767
Other fresh vegetables	−.2102	.2837
Fruit juice	−.5612	1.1254
Canned tomatoes	−.3811	.7878
Canned peas	−.6926	.3295
Canned fruit cocktail	−.7323	.7354
Dried beans, peas, and nuts	−.1248	.5852
Other processed fruits and vegetables	−.2089	.6311
Sugar	−.0521	−.1789
Sweeteners	−.0045	−.0928
Coffee and tea	−.1868	.0937
Ice cream and other frozen dairy products	−.1212	.0111
Nonfood	−.9875	1.1873

Source: *Huang KS:* U.S. demand for food: a complete system of price and income effects, *Washington, D.C., 1985, U.S. Department of Agriculture.*

Income Elasticities. Schultze (1971) found that the income elasticity for farm products in this country during the early 1970s was only 0.08. This elasticity was shown to vary from 0.15 in Canada to 0.75 in both West Germany and France. This relatively low income elasticity in the United States suggests that a 10% increase in income would expand the demand for farm products by less than 1%. When income increases, more is spent on nonfood products in the United States than in other developed countries, all other factors held constant. Thus,

Table 5.7 Matrix of Own-Price and Cross-Price Elasticities of Demand for Spaghetti Sauces*

Item	Prego	Ragu	Classico	Hunt's	Newman's Own	Private Label
Prego	−2.5502	.8103	.0523	.3918	.1542	.1386
Ragu	.5100	−2.0610	.1773	.1381	.0750	.0448
Classico	.2747	.9938	−2.6361	.1432	.2496	.4194
Hunt's	1.0293	.5349	.0752	−2.7541	−.0605	−.0316
Newman's Own	1.0829	.9066	.5487	−.0861	−3.4785	.3562
Private Label	.6874	.4368	.6430	−.0111	.2469	−2.8038

*Values along the diagonal = own-price elasticities; other values = cross-price elasticities

Source: *Capps, Jr., O, S Seo, and JP Nichols, On the estimation of advertising effects for branded products: an application to spaghetti sauces,* Journal of Agricultural and Applied Economics *29, 2 (December 1997): 291–302.*

a substantial increase in consumer income would not necessarily lead to appreciable changes in the consumption of food products.

The income elasticities for major individual food items are reported in Table 5.6. This table suggests that eggs, rice, fluid milk, and other selected products are inferior goods; beef, veal, pork, chicken, and cheese are normal goods; and fruit juice is a luxury good.

Cross-Price Elasticities. Consider the elasticities estimated by Capps, Seo, and Nichols for various spaghetti sauces reported in Table 5.7. The numbers along the diagonal in this table are own-price elasticities. The remaining elasticities are cross-price elasticities. The cross-price elasticity for Prego with respect to the price of Ragu is 0.8103. Thus, a 1% increase in the price of Ragu would have a large effect on the quantity of Prego demanded (i.e., Ragu spaghetti sauce is a very close substitute for Prego). According to Capps and associates, most spaghetti sauces are substitutes for each other. As well, the own-price elasticities are in the elastic range.

■ Applicability of Demand Elasticities

Estimates of own-price, cross-price, and income elasticity of demand have a variety of applications. They can be found in policy debates, wage contract negotiations, and trade negotiations at the macroeconomic level.

Applicability to Policymakers. One of the means the U.S. Secretary of Agriculture has historically had to support farm prices and incomes of farmers is to change the percentage of land that farmers must set aside or idle if they are to receive federal farm program benefits.[2] The secretary, for example, could increase the amount of wheat land idled (i.e., increase set-aside requirements) if surplus production was expected to increase stocks and depress wheat prices and income. This policy action would lower current production and eventually lead to higher wheat prices and incomes. Importantly, if the demand curve was highly inelastic (i.e., the demand curve is very steep), a relatively small amount of land would need to be idled to achieve a specific price level. The less inelastic

[2] The historical features of federal government farm programs and how they have historically affected the levels of production, farm commodity prices, farm incomes, and other aspects of the nation's food and fiber industry will be discussed in subsequent chapters.

Table 5.8 Own-Price Elasticity and Impacts of Supply Change on Farm Revenues

If the Own-Price Elasticity Is:	Increase in Supply Will:	Decrease in Supply Will:
Elastic	Increase revenue	Decrease revenue
Unitary elastic	No change in revenue	No change in revenue
Inelastic	Decrease revenue	Increase revenue

the demand curve, the more land the secretary would have to idle to achieve a specific price objective. Policymakers should not idle land if demand is elastic, because this action would cause revenue to fall.

Applicability to Farmers. The Secretary of Agriculture's actions have historically had a direct impact on farmers. If the own-price elasticity of demand for wheat is less than one in absolute value (i.e., inelastic), actions taken to limit the quantity coming into the market will have the desired effect of raising wheat prices by a greater percentage than the cutback in quantity, thus raising the revenue of wheat farmers. If the own-price elasticity of demand for wheat is greater than one in absolute value (i.e., elastic), and the federal government takes actions to limit the quantity coming onto the market to support farm prices and incomes, the opposite will happen. Here we get the undesired outcome of a drop in revenue accruing to farmers (see Table 5.8).

Applicability to Consumers. Another obvious application of the own-price elasticity is predicting what a change in price will mean for consumer expenditures. In Table 5.1, we saw that consumer expenditures fell when the own-price elasticity of demand declined. In the wake of inelastic demands, increases in supply will, *ceteris paribus*, lower the cost of food and fiber products to consumers.

According to Table 5.6, apples at the retail level have a highly inelastic own-price elasticity of −0.2015. Therefore, a plentiful crop of apples should mean much cheaper apple and apple product prices for consumers. A hard freeze in apple-producing areas would mean substantially higher prices for consumers. Specifically, a 10% increase (decrease) in the quantity of apples will lead to a nearly 50% decrease (increase) in the price of apples.

Applicability to Input Manufacturers. Estimates of demand elasticities also can guide farm input manufacturer and supplier decisions by indicating the potential degree to which their market might change because of the derived nature of the demand for farm inputs. These manufacturers and suppliers depend upon a healthy farm input demand to promote the growth of their businesses. Given an inelastic demand for farm products, policies that idle land to support prices at a specific level also mean that input purchases will decline by a smaller amount than would occur if the farm level own-price elasticity of demand were more elastic.

A good example of the derived relationship between farm production and the level of farm input use is the effect the federal government's payment-in-kind (PIK) program in 1983 had upon input demand. This program made income support payments to farmers denominated in bushels of wheat, corn, and other surplus commodities rather than in dollars. This policy action dramatically reduced production and the sales of manufactured inputs to farmers in 1983.

Applicability to Food Processors and Trade Firms. We can also draw conclusions about the impacts changing market conditions have on food processing firms and wholesale and retail trade firms based on published own-price, cross-price, and income elasticities. Table 5.5 shows that vegetables have an inelastic own-price elasticity of demand at the retail level. Thus, an increase in vegetable production will decrease the retail price of vegetables and, *ceteris paribus*, will increase the quantity of vegetables purchased. But the revenue received by retail food businesses will fall because the percentage drop in retail prices will exceed the percentage increase in vegetable consumption. The price elasticity of demand for farm products is greater at the retail level than at the farm level.

Continuing with the example of the inelastic own-price elasticity of demand for vegetables at the retail level, the demand for vegetables at the wholesale level will be even more inelastic. Thus, changes in vegetable production not only affect the revenue received by retailers, but also wholesalers and food processors. Most food products have an income elasticity substantially less than one, and some are negative (an inferior good) (Table 5.6). Thus, a rapid growth in consumer income nationwide will not necessarily translate into a market expansion in the demand for food products. Note the income elasticity for nonfood goods and services at the bottom of this table is greater than one.

Summary

The major points made in the chapter may be summarized as follows:

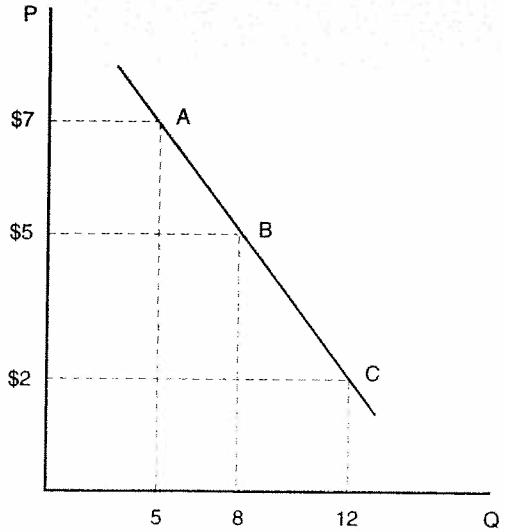
1. The own-price elasticity of demand measures the percentage change in the quantity demanded for a good given a 1% change in price. If this elasticity is greater than one, demand is said to be elastic (i.e., the percentage change in quantity exceeds the percentage change in price). If this elasticity is less than one, demand is said to be inelastic (i.e., quantity changes by a smaller percentage than price). If this elasticity is equal to one, demand is said to be unitary elastic (i.e., quantity changes by the same percentage as price).
2. The income elasticity of demand measures the percentage change in the quantity demanded for a good given a 1% change in income. When the income elasticity of demand is between zero and one, the good is classified as a normal good; when this elasticity exceeds one, the good is classified as a luxury or superior good. When the income elasticity of demand is negative, the good is classified as an inferior good.
3. If demand is inelastic, a rise (reduction) in price will lead to increased (decreased) consumer expenditures. If demand is elastic, a rise (reduction) in price will lead to a reduction (increase) in consumer expenditures. Finally, if demand is unitary elastic, expenditures are unchanged as price changes.
4. A cross-price elasticity measures the change in the demand for one good in light of a 1% change in the price of another good. If this elasticity is positive (negative), the two goods are said to be substitutes (complements). If this elasticity is equal to zero, the two goods are independent in demand.
5. Determinants of the elasticity of demand of a commodity include availability of substitutes for the commodity, alternative uses for the commodity, type of market (e.g., farm level versus retail level or domestic market versus export market), the percentage of the budget spent on the commodity, and time.

Key Terms

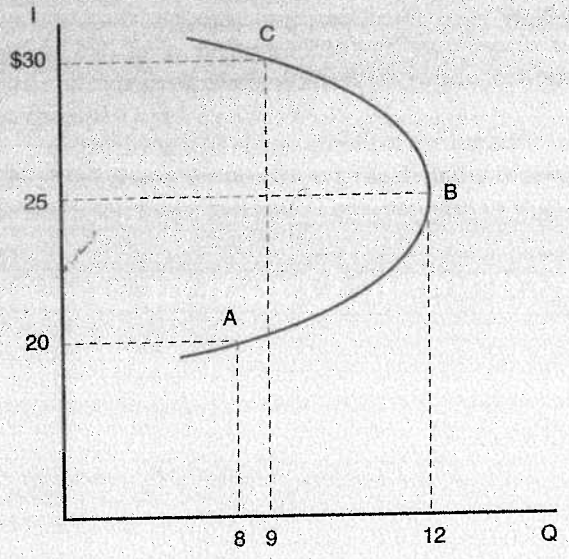
Arc elasticity
Cross-price elasticity
Elastic
Income elasticity
Inelastic
Inferior good
Luxuries
Necessity
Normal good
Own-price elasticity of demand
Perfectly elastic demand
Perfectly inelastic demand
Point elasticity
Substitute (complementary)
Unitary elastic

Testing Your Economic Quotient

1. If McDonald's launches a successful ad campaign for Big Macs, what will happen to Big Mac demand? Draw a graph to show this effect. What other determinants for demand are there?
2. Mabel Cranford only eats syrup with pancakes.
   - **a.** What is the technical name for this relationship between syrup and pancakes?
   - **b.** Suppose the price of pancakes goes up.
     - **i.** Represent the effect of this price increase on Mabel's pancake demand curve.
     - **ii.** Represent the effect of this price increase on Mabel's syrup demand curve.
   - **c.** What can we say about the cross-price elasticity between syrup and pancakes for Mabel Cranford?
3. Based on the graph below, estimate the own-price elasticity between points *A* and *B* and the own-price elasticity between points *B* and *C*. Are they elastic or inelastic? Why are the elasticities different? To increase revenue, at least in the short run, would you recommend a price increase or a price decrease?



4. The Dixie Chicken currently sells 1,500 burger platters per month for $3.50 and the own-price elasticity for this platter has been estimated to be −1.3. If the Chicken raises prices by 70 cents, how many platters will be sold?
5. Calculate the income elasticity from the following graph between points *A* and *B* and between points *B* and *C*. Define as specifically as possible the type of good represented by each income elasticity.



6. The cross-price elasticity for hamburger demand with respect to the price of hamburger buns is −.6. If the price of hamburger buns rises by 5% *ceteris paribus*, what change will occur for hamburger consumption? What is the relationship of these goods? Why?
7. Assume that a retailer sells 1,000 six-packs of Pepsi per day at a price of $3/six-pack. You, as an economic analyst, estimate that the cross-price elasticity between Pepsi and Coca-Cola is .7. If the retailer raises the price of Coca-Cola by 5%, how would sales of Pepsi be affected, *ceteris paribus?* Why?
8. You read in the Bryan-College Station Eagle that Texas A&M expects the price of tuition to rise by 3% for this coming fall semester. As well, Texas A&M expects the number of admission applications to drop by 2% because of this tuition hike. Assuming all other factors held constant, you conclude that the own-price elasticity of demand for applications to Texas A&M is equal to _____.
9. The concept of price elasticity of demand was originated by _____.

For questions 10 through 15, circle the correct answer.

10. Suppose that the own-price elasticity for Schweppes ginger ale is −1.25. In order for Cadbury Schweppes to increase total revenue, at least in the short run, it would be advisable to

    a. do nothing.
    b. lower the price of the ginger ale.
    c. raise the price of the ginger ale.
    d. can't tell; insufficient information.

11. Generally speaking, which of the following is true?

    a. The own-price elasticity at the retail level of the marketing channel is greater than the own-price elasticity at the farm level.
    b. The greater the number of substitutes of a commodity, the greater the own-price elasticity.
    c. The own-price elasticity is more inelastic in the short run than in the long run.
    d. All of the above.

12. If the own-price elasticity is equal to $-.8$, then

a. a 1% change in quantity demanded gives rise to a $-.8$% change in price.
b. a 10% increase in price gives rise to an 8% decrease in quantity demanded.
c. a 1% increase in price leads to an 8% decrease in quantity demanded.
d. none of the above.

13. If the own-price elasticity for a good is -1, then the demand for the good is said to be

a. elastic.
b. inelastic.
c. unitary elastic.
d. none of the above.

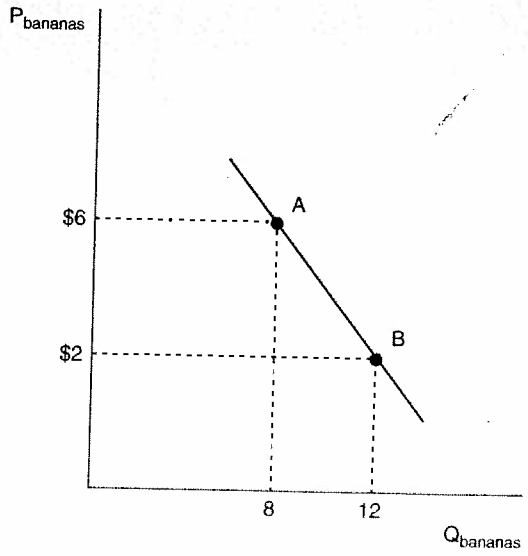
14. Assume that a retailer sells 1,000 six-packs of Pepsi per day at a price of \$3/six-pack. You, as an economic analyst, estimate that the cross-price elasticity between Pepsi and Coca-Cola is .6. If the retailer raises the price of Coca-Cola by 5%, how would sales of Pepsi be affected, *ceteris paribus?*

a. Sales of Pepsi would rise by 3 units.
b. Sales of Pepsi would rise by 30 units.
c. Sales of Pepsi would fall by 30 units.
d. None of the above.

15. From question 14, we may conclude that

a. Pepsi and Coca-Cola are complements.
b. Pepsi and Coca-Cola are substitutes.
c. Pepsi and Coca-Cola are independent.
d. can't tell; insufficient information.

16. Consider the following demand function for bananas.



Calculate the own-price elasticity of demand.

17. **a.** If the cross-price elasticity between two goods is positive, then the goods are _____.

b. If the income elasticity for pork is .5, then pork is what kind of good? _____

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