ILLUSTRATION 6.2

Empirical Elasticities of Demand

When we use the appropriate data and statistical techniques, it is possible to estimate price, income, and cross-price elasticities from actual demand schedules. We have collected a sample of estimated demand elasticities from a variety of sources and present them in the accompanying table. In the chapter on empirical demand functions, we will show how to estimate actual demand elasticities.

Looking at the price elasticities presented in the table, note that the demand for some basic agricultural products such as butter, chicken, pork, and eggs is inelastic. Fruit, for which consumers can find many substitutes, has a much more elastic demand than chicken, pork, or eggs. Whether ground into hamburger or cut into steaks, beef is usually more expensive than the other two basic meats, chicken and pork. Since beef represents a larger fraction of households' grocery bill, consumers are more sensitive to change in beef prices than to changes in chicken prices. And, because steaks are more expensive than ground beef, consumers will be more sensitive to steak prices. Apparently consumers of beer, wine, and cigarettes can find few substitutes for these items since the demand elasticities are quite inelastic for all three. Demand for clothing, something most of us are unwilling to go without, is inelastic. A recent study found that buyers of dynamic random access memory (DRAM) chips are so insensitive to price changes that it estimated demand to be perfectly inelastic for DRAM chips! We do not wish to dispute the results of this study, but we suspect the demand for DRAM chips is perfectly inelastic only for a very narrow range of prices. As prices for bandwidth decline, Internet service providers (ISPs) apparently gobble up bandwidth to transmit data between different countries on fiber-optic cables. For any particular type and brand of ready-to-eat cereal, consumers can find plenty of readily available substitutes. Consequently, the demand for raisin bran cereal is rather large for both leading brands. Another factor affecting price elasticity is the length of time consumers have to adjust to a price change. For example, electricity demand is more price-responsive in the long run than in the short run. It is interesting that gasoline demand is inelastic in the short run but elastic in the long run.

Normal goods have positive income elasticities of demand (E_M), and inferior goods have negative income elasticities. Ground beef and potatoes are inferior goods since E_M is negative. Steaks are more strongly normal than chicken or pork, indicating that a given percentage increase in income causes over a fourfold (fivefold) increase in steak consumption than chicken (pork) consumption. Wine is more strongly normal than beer. The high income elasticity of demand for foreign travel indicates that consumer demand for foreign travel is quite responsive to changes in income. Life insurance is a normal good for both Japanese and Americans, but Japanese demand for life insurance is nearly twice as sensitive to changes in income as U.S. demand for life insurance.

We explained in the text that cross-price elasticities are positive for substitutes and negative for complements. All four pairs of goods in the table are substitutes ($E_{XY} > 0$). Steaks and chicken are weak substitutes, while margarine and butter seem to be rather strong substitutes. Beer and wine drinkers substitute between the two alcoholic beverages but apparently not with much enthusiasm. The extremely low cross-price elasticity of demand between Kellogg's and Post brands of raisin bran cereal suggests that buyers of Kellogg's brand possess strong brand-loyalty and are quite unwilling to switch to the Post brand.

6.7 SUMMARY

The price elasticity of demand measures the responsiveness or sensitivity of consumers to changes in the price of a good. Price elasticity is the ratio of the percentage change in quantity demanded to the percentage change in the price of the good. Over a specified price range, demand is said to be either elastic, unitary elastic, or inelastic according to whether the absolute value of the price elasticity is greater than, equal to, or less than 1, respectively.

Table of Empirical Elasticities of Demand

Price elasticities of demand (E):	
Butter	−0.24
Chicken	−0.30
Pork	−0.77
Eggs	−0.26
Beef (ground)	−1.01
Beef (steaks)	−1.15
Fruit	−3.02
Beer	−0.20
Wine	−0.67
Cigarettes	−0.51
Clothing	−0.62
Dynamic Random Access Memory (DRAM) chips	−0.0
Transnational fiber-optic bandwidth	−2.0
Kellogg's Raisin Bran	−2.06
Post Raisin Bran	−2.03
Electricity (short run)	−0.28
Electricity (long run)	−0.90
Gasoline (short run)	−0.43
Gasoline (long run)	−1.50
Income elasticities of demand (E_M):	
Beef (ground)	−0.19
Beef (steaks)	1.87
Chicken	0.42
Pork	0.34
Potatoes	−0.81
Beer	0.76
Wine	1.72
Life insurance in Japan	2.99
Life insurance in United States	1.65
Cross-price elasticities of demand (E_{XR}):	
Beef (steaks) and chicken	0.24
Margarine and butter	1.53
Beer and wine	0.56
Kellogg's Raisin Bran and Post Raisin Bran	0.01

Sources: For price, cross-price, and income elasticities for agricultural products, see Dale Heien, "The Structure of Food Demand: Interrelatedness and Duality," *American Journal of Agricultural Economics*, May 1982; and K. S. Huang, "A Complete System of U.S. Demand for Food," *Technical Bulletin* No. 1821, Economic Research Service, U.S. Department of Agriculture, Sept. 1993. For cigarettes price elasticity, see Frank Chaloupka, "Rational Addictive Behavior and Cigarette Smoking," *Journal of Political Economy*, Aug. 1991. For clothing price elasticities, see Richard Blundell, Panos Pashardes, and Guglielmo Weber, "What Do We Learn about Consumer Demand Patterns from Micro Data," *American Economic Review*, June 1993. For alcohol elasticities, see Jon Nelson, "Broadcast Advertising and U.S. Demand for Alcoholic Beverages," *Southern Economic Journal*, Apr. 1999. For cereal elasticities, see A. Nevo, "Mergers with Differentiated Products: The Case of the Ready to Eat Cereals Industry," *RAND Journal of Economics*, Autumn 2000. For short-run and long-run gasoline and electricity elasticities, see Robert Archibald and Robert Gillingham, "An Analysis of Short-Run Consumer Demand for Gasoline Using Household Survey Data," *Review of Economics and Statistics*, Nov. 1980; and Chris King and Sanjoy Chatterjee, "Predicting California Demand Response: How Do Customers React to Hourly Prices?" *Public Utilities Fortnightly* 141, no. 13 (July 1, 2003). For income elasticity of demand for electricity, see Cheng Hsiao and Dean Mountain, "Estimating the Short-Run Income Elasticity of Demand for Electricity by Using Cross-Sectional Categorized Data," *Journal of the American Statistical Association*, June 1985. For the price elasticity of fiber-optic bandwidth, see the editorial "Fear of Fiber-Optic Glut May be Misguided," *Lightwave* 17, no. 9 (Aug. 2000). Life insurance elasticities can be found in Dai I. Chi, "Japan: Life, But Not as We Know It," *Euromoney*, Oct. 1998. For the price elasticity of DRAM chips, see Jim Handy, "Has the Market Perked Up Yet?" *Electronics Times*, June 5, 2000.

An extremely important relation in economic analysis relates the change in total revenue (due to a change in price) and the price elasticity of demand. If demand is elastic for a given change in price, an increase in price causes total revenue to fall. A decrease in price causes total revenue to rise if demand is elastic over the price range. If demand is inelastic for a given price change, an increase in price causes total revenue to rise, while a decrease in price causes total revenue to fall.

Several factors affect the price elasticity of demand. The most important of these is the availability of close substitutes. The better and more numerous the substitutes

for a good, the more elastic the demand for the good. Demand elasticity is directly related to the percentage of the consumers' budgets spent on the good. Also, the longer the time period that consumers have to adjust to price changes, the more responsive they will be, and the more elastic is demand.

Calculating price elasticity of demand can be accomplished by multiplying the slope of demand ($\Delta Q/\Delta P$) by the ratio of price divided by quantity (P/Q):

$$E = \frac{\%\Delta Q}{\%\Delta P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

Elasticity can be measured either (1) over an interval (or arc) along demand or (2) at a specific point on the demand curve, depending on the length of demand over which E is measured. If the change in price is relatively small (large), then a point (interval) measure is usually chosen.

In general, the price elasticity of demand varies along a demand curve. For linear demand curves, price and $|E|$ vary directly: The higher (lower) the price, the more (less) elastic is demand. For a curvilinear demand, there is no general rule about the relation between price and elasticity, except for the special case of $Q = aP^b$, which has a constant price elasticity (equal to b) for all prices.

Two other important elasticities are income elasticity (E_M), which measures the responsiveness of quantity purchased to changes in income, and cross-price elasticity (E_{XR}), which measures the responsiveness of quantity purchased to changes in the price of related goods (substitutes or complements). In the case of income elasticity, the elasticity measure is positive if the good is normal; negative if the good is inferior. In the case of cross-price elasticity, the elasticity measure is positive if the two goods are substitutes; negative if they are complements.

Now that we have presented the theory of consumer demand, we will show you in the next chapter how to use real-world data to estimate demand functions and forecast future demand conditions. You will use the techniques of regression analysis to estimate empirical demand equations that can be used in managerial decision making.

TECHNICAL PROBLEMS

1. Moving along a demand curve, quantity demanded decreases 8 percent when price increases 10 percent.
   a. The price elasticity of demand is calculated to be _____.
   b. Given the price elasticity calculated in part *a*, demand is _____ (elastic, inelastic, unitary elastic) along this portion of the demand curve.
   c. For this interval of demand, the percentage change in quantity in absolute value is _____ (greater than, less than, equal to) the percentage change in price in absolute value.
2. Fill in the blanks:
   a. The price elasticity of demand for a firm's product is equal to −1.5 over the range of prices being considered by the firm's manager. If the manager decreases the price of the product by 6 percent, the manager predicts the quantity demanded will _____ (increase, decrease) by _____ percent.
   b. The price elasticity of demand for an industry's demand curve is equal to −1.5 for the range of prices over which supply increases. If total industry output is expected to increase by 30 percent as a result of the supply increase, managers in this industry should expect the market price of the good to _____ (increase, decrease) by _____ percent.
3. Fill in the blanks:
   a. When demand is elastic, the _____ effect dominates the _____ effect.
   b. When demand is inelastic, the _____ effect dominates the _____ effect.
   c. When demand is unitary elastic, _____ effect dominates.