Managerial Economics

Unit 1: Demand Theory

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OBJECTIVES

- Explain the importance of market demand in the determination of profit.
- Understand the many factors that influence demand.
  - Elasticity: Measures the percentage change in one factor given a small (marginal) percentage change in another factor
  - Demand elasticity: Measures the percentage change in quantity demanded given a small (marginal) percentage change in another factor that is related to demand
- The role of managers in controlling and predicting market demand.
  - Managers can influence demand by controlling price, advertising, product quality, and distribution strategies.

OBJECTIVES

- Role of managers (Continued)
  - Managers cannot control, but need to understand, elements of the competitive environment that influence demand.
    - ★ This includes the availability of substitute goods, their pricing, and advertising strategies employed by others.
  - Managers cannot control, but need to understand how the macroeconomic environment influences demand.
    - ★ This includes interest rates, taxes, and both local and global levels of economic activity.

How to use this chapter

- For most students almost all in this chapter should be well-known. Later on I will assume that students, indeed, know these concepts.
- I will be very quick and present only a small part.
- Students should read the chapter carefully, if they see problems.

TABLE 2.1

Market Demand Schedule for Laptops, 2008

Price per Laptop (Dollars)	Quantity Demanded (Thousands)
3,000	800
2,750	975
2,500	1,150
2,250	1,325
2,000	1,500

TABLE 02-01

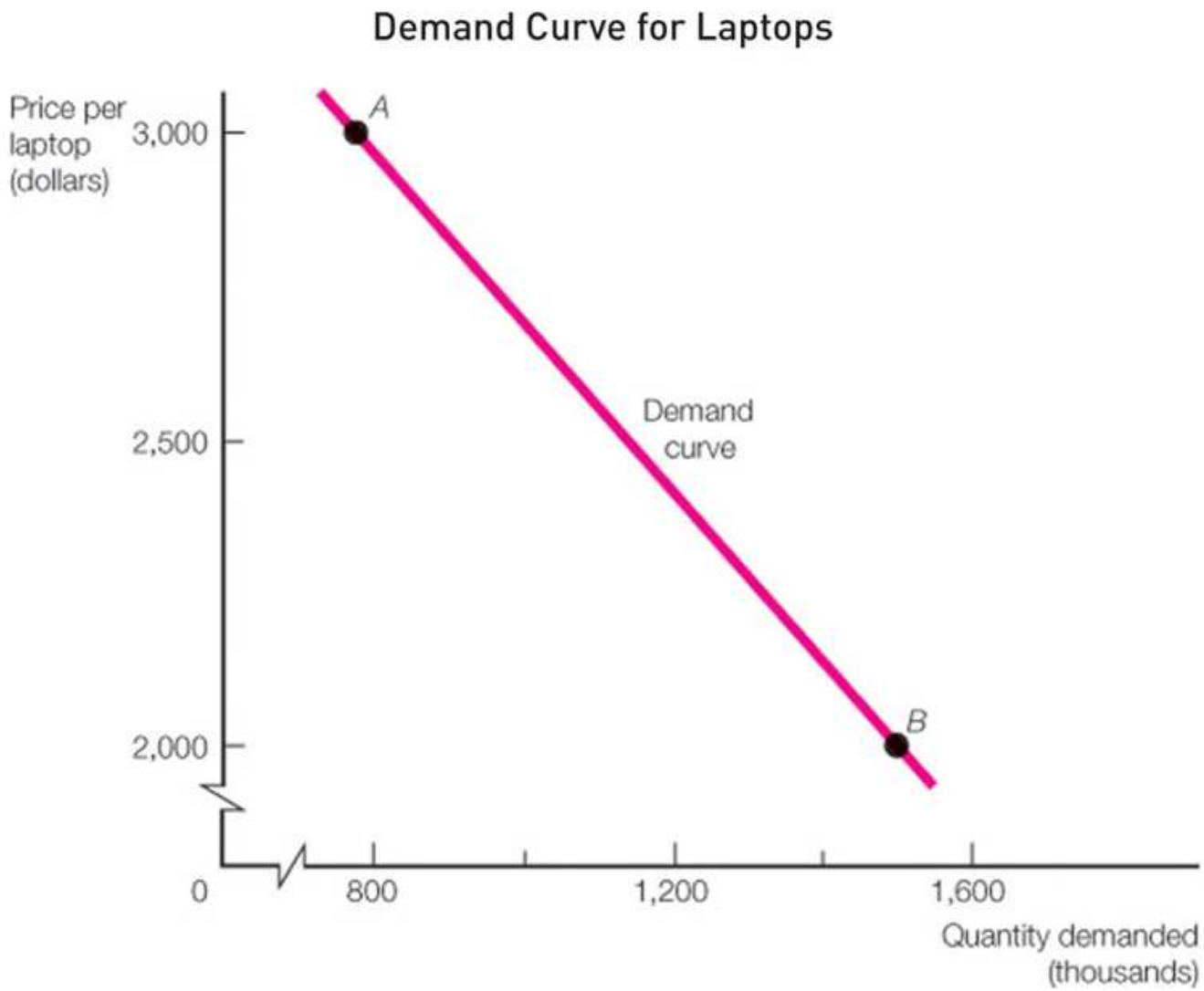


FIGURE 02-01

THE MARKET DEMAND CURVE

- Characteristics of the market demand curve
  - Quantity demanded is for output of the entire market, not of a single firm.
  - For most products and services, a higher price results in lower demand.
  - Quantity demanded is defined with regard to a particular time period.
- Determinants of the position and shape of the market demand curve
  - Consumer tastes
    - ★ Example: Increase in preference for laptop computers causes an increase in demand for laptop computers.

Effect of an Increased Preference on the Market Demand Curve for Laptops

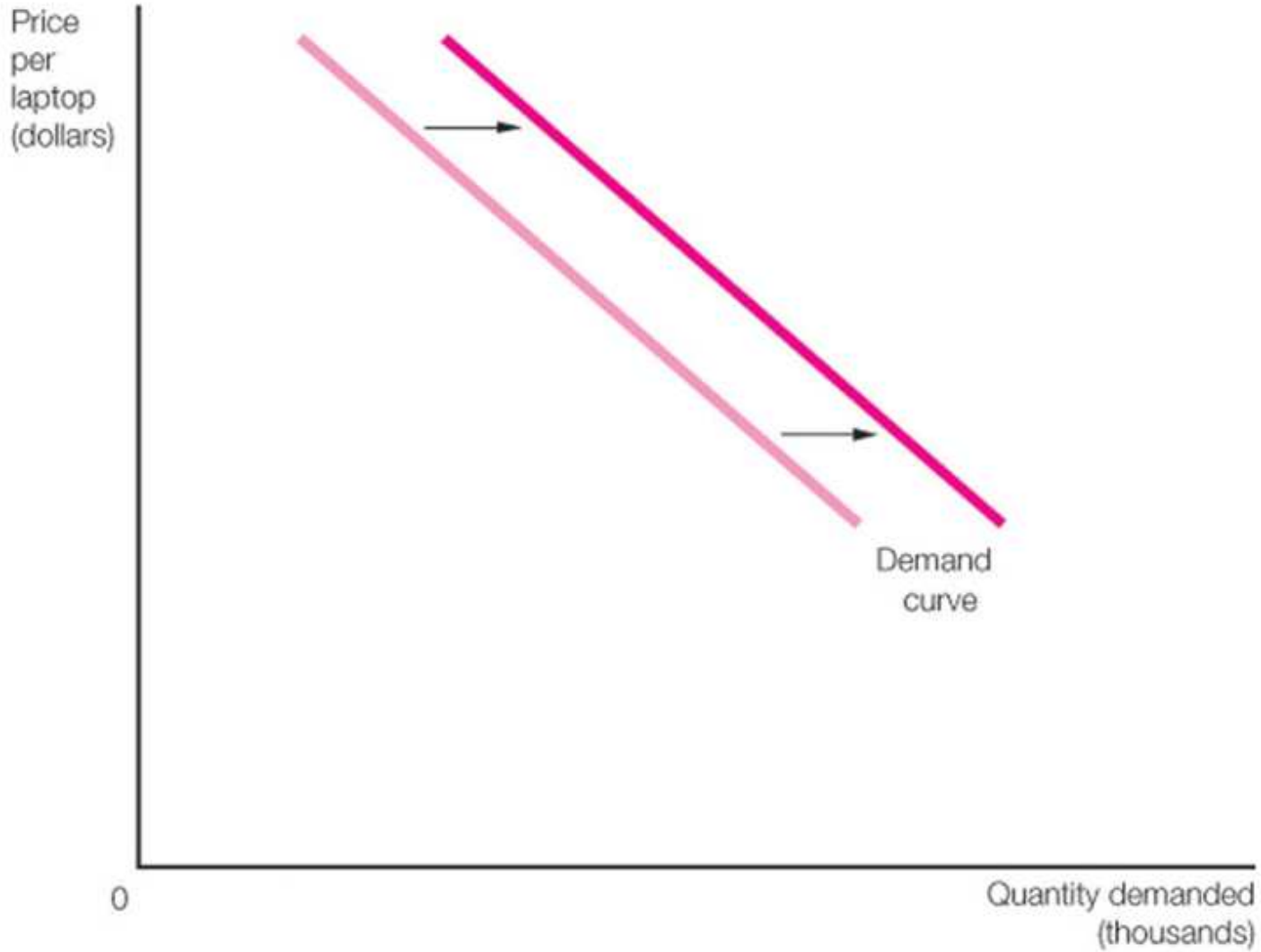


FIGURE 02-02

THE MARKET DEMAND CURVE

- Consumer income
  - Normal (superior) or inferior goods
  - Example: Increase in income causes an increase in demand for laptop computers.
  - More specific: for each given price, demand is higher
- Population size in the market

Effect of an Increase in Per Capita Income on the Market Demand Curve for Laptops

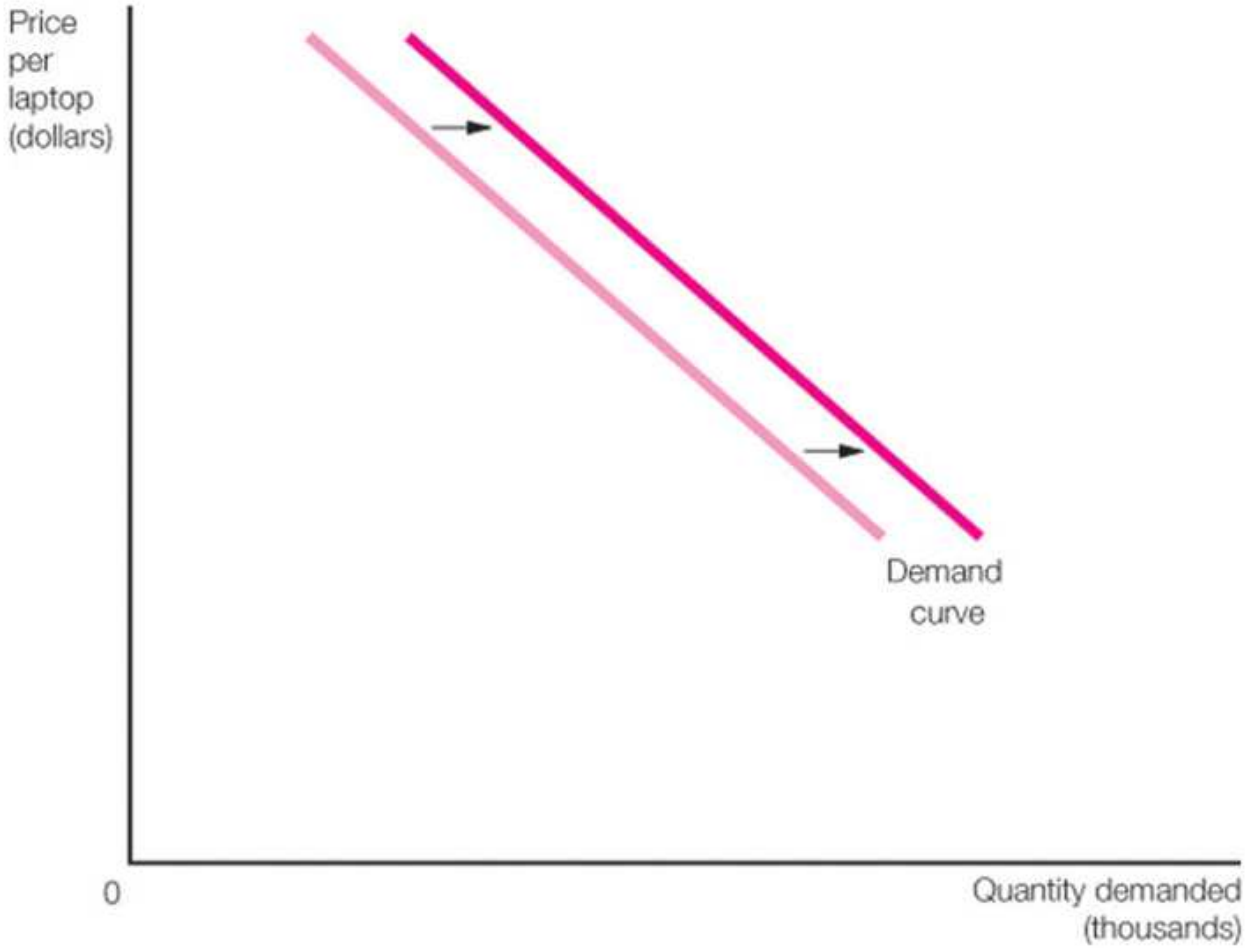


FIGURE 02-03

INDUSTRY AND FIRM DEMAND FUNCTIONS

- Market demand function: The relationship between the quantity demanded and the various factors that influence this quantity
  - Quantity of X (Q) = f(factors)
  - Factors include
    - ★ price of X
    - ★ incomes of consumers
    - ★ tastes of consumers
    - ★ prices of other goods
    - ★ population
    - ★ advertising expenditures

INDUSTRY AND FIRM DEMAND FUNCTIONS

- Example: $Q = b_1 P + b_2 I + b_3 S + b_4 A$
  - Assumes that population is constant and that the demand function is linear
  - P = price of laptops
  - I = per capita disposable income
  - S = average price of software
  - A = amount spent on advertising
  - b_1, b_2, b_3 and b_4 are parameters that are estimated using statistical methods

INDUSTRY AND FIRM DEMAND FUNCTIONS

- Interpretation of Parameters:
  - $Q = b_1 P + b_2 I + b_3 S + b_4 A$
  - E.g. b_1: if Price changes by one unit, quantity demanded changes by b_1 units under the condition that all other variables (i.e. price of Software) are held constant
  - Example:
    - $Q = -700P + 200I - 500S + 0.01A$

The firm's demand curve

- Negative slope with regard to price
  - Slope may not be the same as that of the market demand curve.
- Represents a portion of market demand
  - Market share
  - Responds to same market and macroeconomic factors as the market demand curve
- Directly related to the prices of substitute goods provided by competitors
  - Increase in competitor's price will cause a increase in a firm's demand.

THE OWN-PRICE ELASTICITY OF DEMAND

- The price elasticity of a demand function is the percentage change in quantity demanded in response to a 1 percent increase in price.
- Typically negative
- Price elasticity generally is different at different prices and on different markets.

$$\eta = (\frac{P}{Q})\frac{\Delta Q}{\Delta P}$$

THE OWN-PRICE ELASTICITY OF DEMAND

- Own-price elasticity of demand (Continued)
  - Price elasticity demand is symbolized by η.
  - $0 \geq \eta \geq -\infty$
    - ★ When $|\eta| > 1$, demand is elastic.
    - ★ When $|\eta| < 1$, demand is inelastic.
    - ★ When $|\eta| = 1$, demand is unitary.

THE OWN-PRICE ELASTICITY OF DEMAND

- Some extreme cases:
  - When $\eta = 0$, demand is perfectly inelastic and the demand curve is vertical.
    - ★ Quantity demanded is the same at all prices.
  - When $\eta = -\infty$, demand is perfectly elastic and the demand curve is horizontal.
    - ★ Price is the same for all quantities demanded.
    - ★ If price rises, quantity demanded falls to zero.
    - ★ If price falls, quantity demanded increases without limit.
    - ★
    - ★ What market is this?

Demand Curves with Zero and Infinite Price Elasticities of Demand

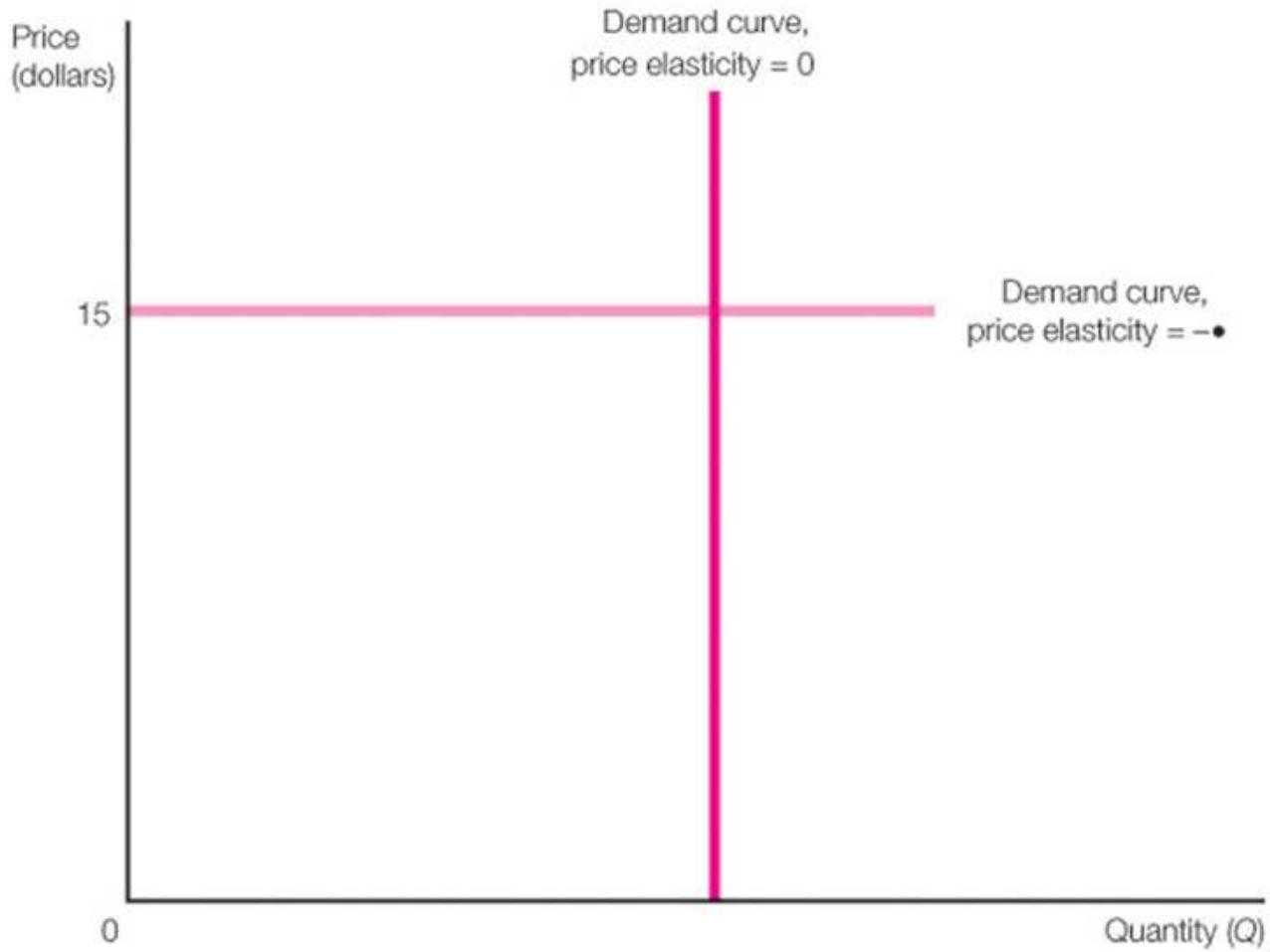


FIGURE 02-05

Looks simple, but...

- this is the most important insight of this lecture:
  - Typically demand curve is downward sloping
  - That means, we are in a market, which is not fully competitive
  - If this were not the case (i.e perfect competition), everything would be boring:
    - ★ Marketing, pricing, ... would make no sense

THE OWN-PRICE ELASTICITY OF DEMAND

- Example: linear demand curves
  - The slope of a linear demand curve is constant.
  - price elasticity will differ depending on price.
    - ★ At the midpoint of a linear demand curve, $\eta = -1$, with η approaching zero as price approaches the vertical intercept.
    - ★ At prices above the midpoint, demand is elastic, with η approaching negative infinity as price approaches zero.
    - ★ At prices below the midpoint, demand is inelastic.

Values of the Price Elasticity of Demand at Various Points along a Linear Demand Curve

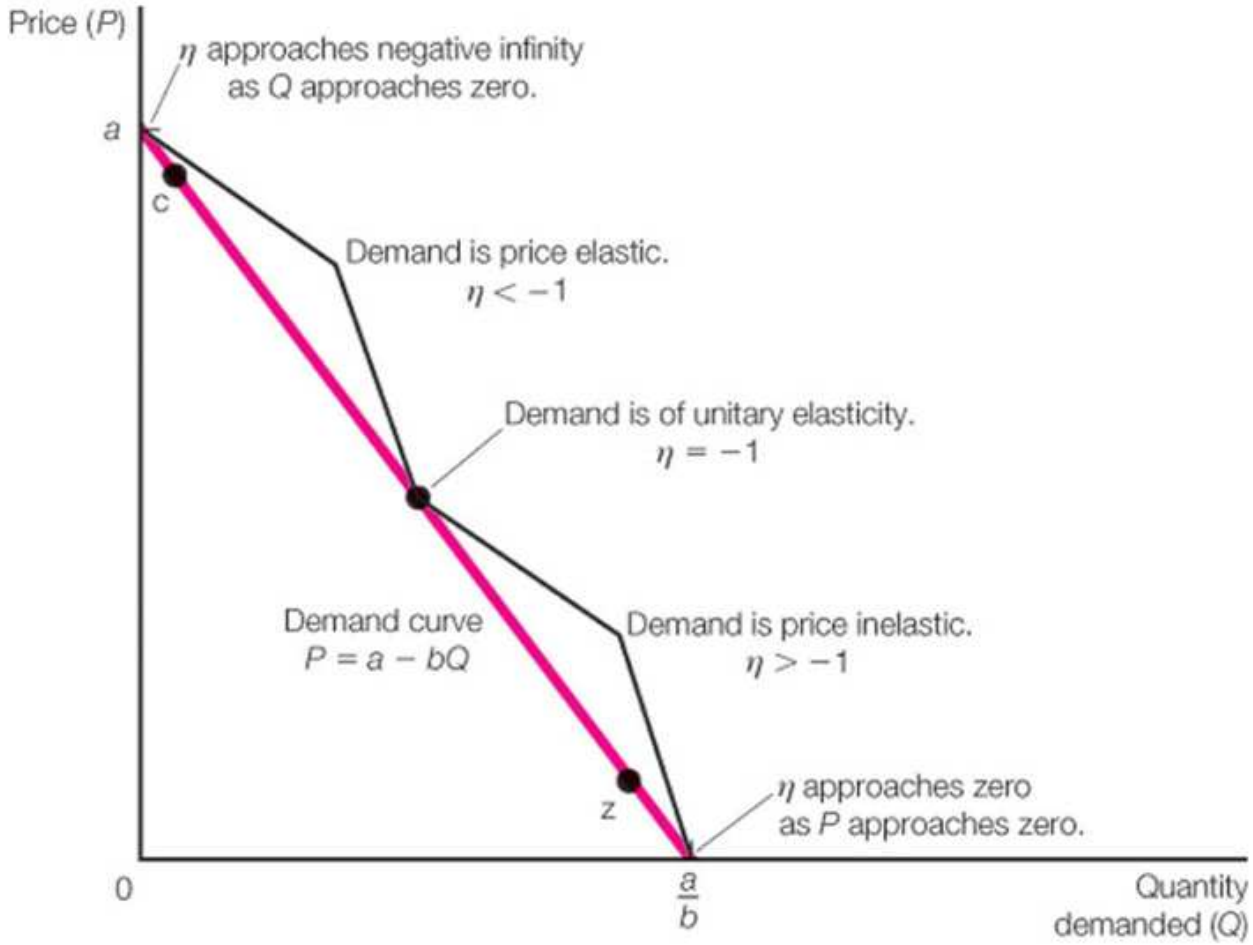


FIGURE 02-06

Knowing the elasticity

- Every manager must know elasticity of demand for main products
- How can we do that?
- Very easy to calculate

Calculating elasticities

- **Point estimate:** (demand function is known); calculated at a specific point of demand.
- Use statistic regression analysis $\eta = \frac{\Delta Q}{\Delta P}\frac{P}{Q}$
  - If more data are available
- **Arc elasticity:** uses average values of Q and P as reference points (if only two data points are known)

$$\eta = \frac{\Delta Q}{\Delta P}\frac{(P_1+P_2)/2}{(Q_1+Q_2)/2} = \frac{(Q_2-Q_1)}{(P_2-P_1)}\frac{(P_1+P_2)/2}{(Q_1+Q_2)/2}$$

USING THE DEMAND FUNCTION TO CALCULATE THE PRICE ELASTICITY

- Given
  - $Q = -700P + 200I - 500S + 0.01A$
  - Q = Quantity demanded of computers
  - Price = P = 3,000
  - Income = I = 13,000
  - Software = S = 400
  - Advertising = A = 50,000,000

USING THE DEMAND FUNCTION TO CALCULATE THE PRICE ELASTICITY

- Derive the demand curve
  - $Q = -700P + (200)(13000) - (500)(400) + (0.01)(50000000)$
  - $Q = 2900000 - 700P$
- Determine Q
  - $Q = 2900000 - (700)(3000) = 800000$
- $\eta = (-700)(3000/800000) = -2.62$

If you increase the price, how will your revenue react?

- Total Revenue TR=PQ
- now we increase the price
  - TR = PQ
  - dTR/dP = Q(dP/dP) + P(dQ/dP)
    - ★ Simplify
  - (1/Q)(dTR/dP) = (dP/dP) + (P/Q)(dQ/dP) = 1 + η

If you increase the price, how will your revenue react?

- (1/Q is positive): Implications:
  - If $\eta =$ -1, $dTR/dP = 0$, so total revenue is at a maximum and a change in P will have no effect on total revenue.
  - If $\eta >$ -1 (inelastic), $dTR/dP > 0$, so an increase in P will increase total revenue.
  - If $\eta <$ -1 (elastic), $dTR/dP < 0$, so an increase in P (and consequent decrease in Q) will decrease total revenue.

Recap: What are the important issues?

- Markets are not perfect; therefore pricing and advertising is important
- Know the demand curve
- Price elasticity: do not set price, where demand is inelastic
- Optimal pricing rule

Example: FUNDING PUBLIC TRANSIT

- Given
  - Price (fare) elasticity of demand for public transit in the United States is about -0.3.
  - Many public transit systems lose money.
  - Public transit systems are funded by federal, state, and local governments, all of which have budget issues.

FUNDING PUBLIC TRANSIT

- Which transit systems have the most difficult time getting public funding?
  - Revenue from sales will increase if fares are increased, because demand is inelastic.
  - Costs will likely decrease if fares are increased, because quantity demanded (ridership) will fall.
  - Managers of public transit will therefore increase fares if they do not receive enough public funds to balance their budgets.
  - Public funding seems necessary to prevent price hikes

DETERMINANTS OF OWN-PRICE ELASTICITY OF DEMAND

- Number and similarity of available substitutes
- Product price relative to a consumer's total budget
- Time period available for adjustment to a price change
  - Ex: Cell phone contracts, gasoline prices

TABLE 2.4

Own Price Elasticities of Demand, Selected Goods, and Services from Global Locations

Good/Service	Elasticity	Good/Service	Elasticity
Agricultural products		Cigarettes (U.S.)[7]	−0.107
Apples (U.S.)[1]	−1.159	Bread (U.K.)[3]	−0.26
Potatoes (U.K.)[3]	−0.13	Energy	
Oranges (U.S.)[2]	−0.62	Gasoline—short run (Canada)[8]	−0.01 to −0.2
Lettuce (U.S.)[2]	−2.58	Gasoline—long run (Canada)[8]	−0.4 to −0.8
Products from animals/fish		Transportation	
1 percent milk (U.S.)[5]	−0.54 to −0.74	Domestic cars (U.S.)[9]	−0.78
Cheese (U.K.)[3]	−1.36	European cars (U.S.)[9]	−1.09
Cheese (U.S.)[6]	−0.595	Other manufactured goods	
Meat (China)[4]	−0.06 to −0.18	Clothing and footwear (U.K./Ireland)[10]	−0.94
Beef/veal (U.K.)[3]	−1.45	Other goods (U.K./Ireland)[10]	−0.85
Manufactured agricultural products		Services	
Beer and malt beverages (U.S.)[6]	−2.83	Child care (North America)[11]	−0.570
Wine (U.K./Ireland)[7]	−1.12	Government health care (Kenya)[12]	−0.100
Wine and brandy (U.S.)[6]	−0.198		

TABLE 02-04

WHY ARE THERE MARKETS WITH LOW ELASTICITY OF DEMAND?

- Elasticity is calculated for the market (as a whole)
- What is elasticity if the firm changes the price alone?
- Competitive situation in the industry has to be taken into account
- It seems that in markets with relatively low elasticities are markets where unilateral price hikes are difficult
- Firm-specific price elasticity of demand is the one which is important for price setting!!

THE STRATEGIC USE OF THE PRICE ELASTICITY OF DEMAND

- Example: Strategic pricing of first class (η= -0.45), regular economy (η= -1.30) and excursion (η= -1.83) airline tickets between the United States and Europe
  - First class prices should be relatively high because demand is inelastic.
  - Regular economy and excursion prices should be relatively low because demand is elastic.

TABLE 2.5

Elasticities of Demand for Air Tickets between the United States and Europe

Type of Ticket	Price Elasticity	Income Elasticity
First class	−0.45	1.50
Regular economy	−1.30	1.38
Excursion	−1.83	2.37

TABLE 02-05

THE STRATEGIC USE OF THE PRICE ELASTICITY OF DEMAND

- Example: Using differentiation strategies to change the price elasticity of demand for a product
  - Differentiation strategies convince consumers that a product is unique, and therefore has fewer substitutes.
  - Role of advertising

THE STRATEGIC USE OF THE PRICE ELASTICITY OF DEMAND

- Example (Continued)
  - If consumers perceive that a product has fewer substitutes, then their price elasticity of demand for the product will decrease (become less elastic) in absolute value.
  - Differentiation strategies do not require actual differences in products, only a perceived difference.

TOTAL REVENUE, MARGINAL REVENUE, AND PRICE ELASTICITY

- A firm's total revenue (TR) is equal to the total amount of money consumers spend on the product in a given time period.
  - Linear demand curve: $P = a - bQ$
  - Corresponding total revenue:
    - $TR = PQ = aQ - bQ^2$

TOTAL REVENUE, MARGINAL REVENUE, AND PRICE ELASTICITY

- Marginal revenue: The incremental revenue earned from selling the n^{th} unit of output.
  - $MR = \Delta TR/\Delta Q = \Delta(aQ - bQ^2)/\Delta Q = a - 2bQ$
    - $\eta = (-1/b)[(a - bQ)/Q]$
    - If Q = a/2b, then η = -1
    - If Q $>$ a/2b, then η is inelastic
    - If Q $<$ a/2b, then η is elastic

TOTAL REVENUE, MARGINAL REVENUE, AND PRICE ELASTICITY

- Marginal revenue (Continued)
  - $MR = \Delta TR/\Delta Q = \Delta(PQ)/\Delta Q =$
    $= P(\Delta Q/\Delta Q) + Q(\Delta P/\Delta Q) =$
    $= P[1 + (Q/P)(\Delta P/\Delta Q)]$
    - ★ so $MR = P(1 + 1/\eta)$
- If product is price elastic ($\eta < -1$), marginal revenue must be positive
- Example: what is MR if price is €10 and price elasticity is -2?
  10(1+1/(-2)) = €5.
- What if product is very price elastic ($\eta = -\infty$)?

Price setting: two simple rules

- **Do not price so low that demand is price-inelastic ($\eta > -1$):**
  - Marg. Revenue is negative, i.e. by raising price, total revenue will increase and (!) costs will decrease.
- **Optimal Price:**

$$MC = MR = P(1 + \frac{1}{\eta}) \ldots \textit{pricing rule}$$
$$\Rightarrow P = MC(\frac{1}{1+1/\eta}) \ldots \textit{optimal price}$$

$\Rightarrow$ optimal price depends upon MC and price elasticity
$\Rightarrow$ The higher (the absolute value of) price elasticity, the lower the optimal price

  - Why is this so? In what market are you in?

Elasticity in Use

- Retailer: prices for the exact item may differ substantially in stores of the same chain; why?
  - Elasticity of demand is used to generate optimal prices
  - Rather than marking up cost, benchmarking or guessing, price optimization models use data mining techniques
  - Scanned transaction prices allow estimating a demand curve for each product
- Assuming that the marginal cost is equal across locations, we can equate marginal revenues:
  - $MR1 = P1[1 + (1/\mu 1)] = P2[1 + 1/\mu 2)] = MR2 = (MC)$
  - If the marginal revenue is larger in shop 2 than in shop 1, you would like to shift some sales from shop 1 to shop 2
- Two periods over time, two seats in an airplane, etc.

Relationship between Price Elasticity, Marginal Revenue, and Total Revenue

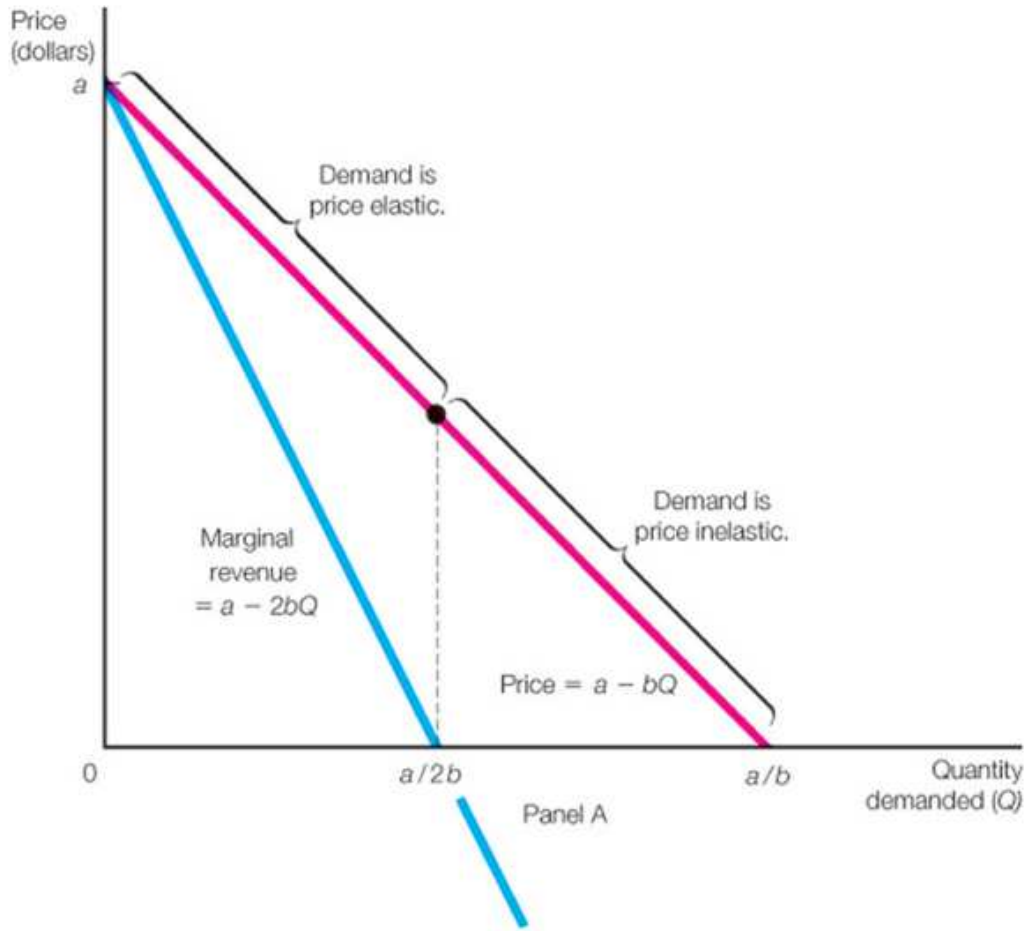


FIGURE 02-07a

Relationship between Price Elasticity, Marginal Revenue, and Total Revenue

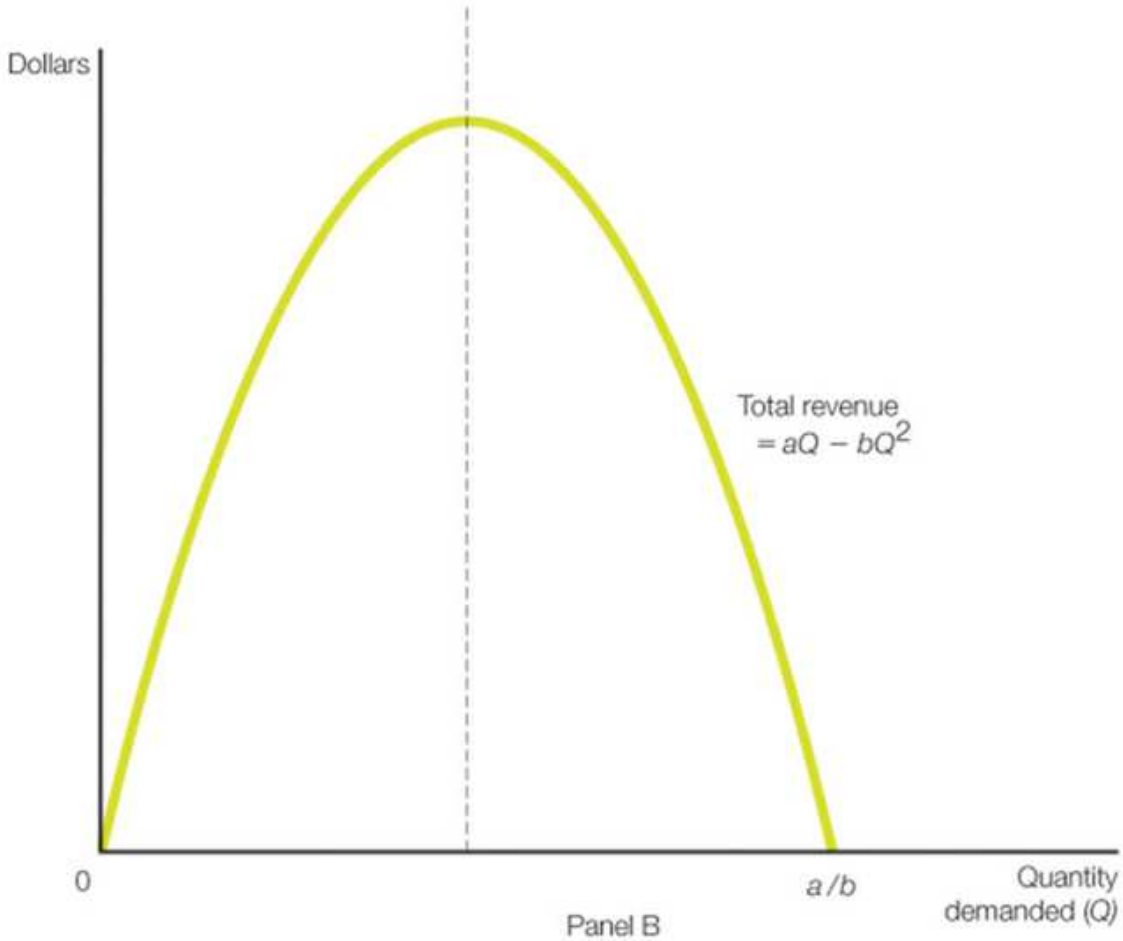
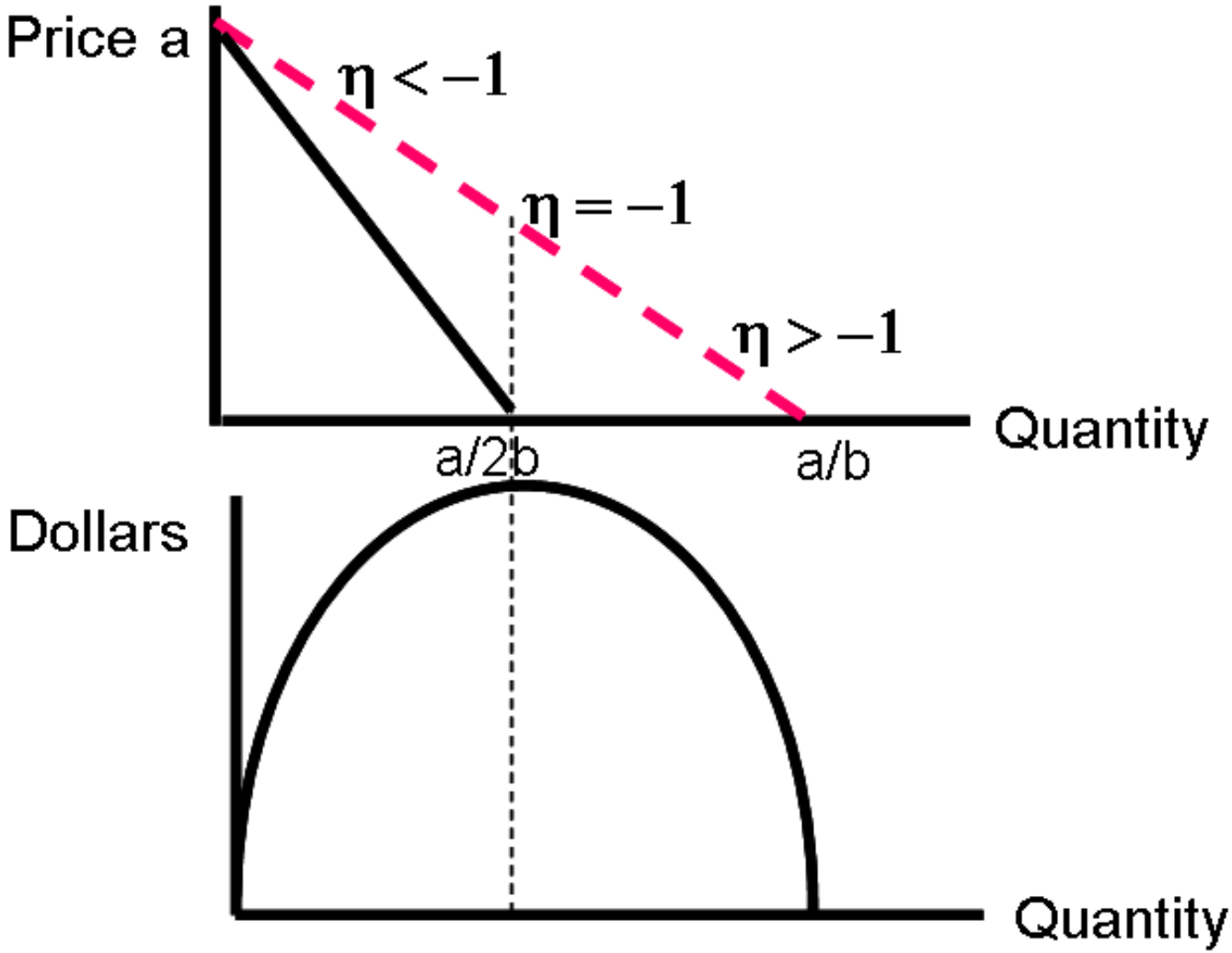


FIGURE 02-07b

Total revenue, marginal revenue and price elasticity (the same on one slide)



Demand and MR

Total Revenue

THE INCOME ELASTICITY OF DEMAND

- Income elasticity of demand (η_I): The percentage change in quantity demanded (Q) resulting from a 1 percent increase in consumers' income (I).
  - Income can be defined as aggregate consumer income or as per capita income, depending on circumstances.
  - $\eta_I = (\frac{\Delta Q}{\Delta I})(\frac{I}{Q})$

THE INCOME ELASTICITY OF DEMAND

- Income elasticity of demand (Continued)
  - $\eta_I > 0$ for normal goods.
    - ★ On average, goods are normal, since increases in aggregate income are associated with increases in aggregate consumer spending.
  - $\eta_I < 0$ for inferior goods.

THE INCOME ELASTICITY OF DEMAND

- Strategic management and the income elasticity of demand
  - The demand for a product with a large income elasticity of demand will vary widely with changes in income caused by economic growth and recessions.
  - Portfolio decision: use products with both high and low income elasticity to reduce risk for business downturn

THE INCOME ELASTICITY OF DEMAND

- Strategic management (Continued)
  - Managers can lessen the impact of economic changes on such products by limiting fixed costs so that changes in production capacity can be made quickly.
  - Managers can forecast demand for products using the income elasticity of demand combined with forecasts of aggregate income.

TABLE 2.6

Income Elasticity of Demand, Selected Commodities, Global

Good	Elasticity
Agricultural products	
Grain (China)[1]	−0.12 to +0.15
Potatoes (U.K.)[2]	−0.32
Potatoes (U.S.)[3]	+0.15
Oranges (U.S.)[3]	+0.83
Apples (U.S.)[3]	+1.32
Lettuce (U.S.)[3]	+0.88
Animal products	
Meat (China)[1]	+0.1 to +1.2
Milk (U.K.)[2]	+0.05
Milk (U.S.)[3]	+0.50
Cream (U.S.)[3]	+1.72
Eggs (U.K.)[2]	−0.21
Eggs (U.S.)[3]	+0.57
Processed food products	
Bread (U.K.)[2]	−0.17
Other cereal products (U.K.)[2]	+0.18
Automobiles	
Domestic cars (U.S.)[4]	+1.62
European cars (U.S.)[4]	+1.93
Asian cars (U.S.)[4]	+1.65

TABLE 02-06

CROSS-PRICE ELASTICITIES OF DEMAND

- Cross-Price elasticity of demand (η_{XY}): The percentage change in quantity demanded of one good (Q_X) resulting from a 1 percent increase in the price of a related good (P_Y)
- Cross-Price elasticity of demand (Continued)
  - $\eta_{XY} = (\frac{\Delta Q_X}{\Delta P_Y})(\frac{P_Y}{Q_X})$
  - $\eta_{XY} > 0$ if the two products are substitutes.
    - ★ Example: Wheat and corn
  - $\eta_{XY} < 0$ if the two products are complements.
    - ★ Example: Computers and computer software

CROSS-PRICE ELASTICITIES OF DEMAND

- Strategic management
  - Managers can use information about the cross-price elasticity of demand to predict the effect of competitors' pricing strategies on the demand for their product.
  - Antitrust authorities use the cross-price elasticity of demand to determine the likely effect of mergers on the degree of competition in an industry.

CROSS-PRICE ELASTICITIES OF DEMAND

- Strategic management
  - Antitrust authorities (Continued)
    - ★ A high cross-price elasticity, indicating that two goods are strong substitutes, suggests that a merger would significantly reduce competition in the industry.
    - ★ A low cross-price elasticity, indicating that two goods are strong complements, suggests that a merger might give the merged firm excessive control over the supply chain.

THE ADVERTISING ELASTICITY OF DEMAND

- Advertising elasticity of demand (η_A): The percentage change in quantity demanded (Q) resulting from a 1 percent increase in advertising expenditure (A)
  - $\eta_A = (\frac{\Delta Q}{\Delta A})(\frac{A}{Q})$
  - Example Calculation
    - ★ Given: $Q = 500 - 0.5P + 0.01I + 0.82A$ *and* $A/Q = 2$
    - ★ $\eta_A = 0.82(2) = 1.64$

TABLE 2.7

Cross-Price Elasticity of Demand, Selected Pairs of Commodities, Global

Change of Price of Good	Change of Quantity of Good	Cross-Price Elasticity
European/Asian cars	U.S. domestic cars	+0.28[1]
European/U.S. domestic cars	Asian cars	+0.61[1]
U.S. domestic/Asian cars	European cars	+0.76[1]
Australian public transit	Australian auto ownership	+0.1 to +0.3[2]
Irish coal	Irish natural gas	+0.4[3]
Irish coal	Irish oil	+0.7[3]
Kenyan government-provided health care	Mission- or private sector–provided health care in Kenya	+0.023[4]
U.S. durum wheat	U.S. hard red spring wheat	+0.04[5]
U.S. hard red winter wheat	U.S. white wheat	+1.80[5]
U.K. beef/veal	U.K. pork	0.00[6]
U.K. mutton/lamb	U.K. beef/veal	+0.25[6]

TABLE 02-07