Managerial Economics

EIGHTH EDITION

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Lecture Notes

1. Introduction

- Objectives
  - ➢ To provide a guide to making good managerial decisions
  - ➢ To use formal models to analyze the effects of managerial decisions on measures of a firm's success
- Managerial Economics versus Microeconomics
  - ➢ Managerial economics differs from microeconomics in that microeconomics focuses on description and prediction while managerial economics is prescriptive.
  - ➢ Managerial economics prescribes behavior, whereas microeconomics describes the environment.
  - ➢ Managerial economics is an integrative course that brings the various functional areas of business together in a single analytical framework.
  - ➢ Managerial economics exhibits economies of scope by integrating material from other disciplines and thereby reinforcing and enhancing understanding of those subjects.

2. The Theory of the Firm

- Managerial Objective
  - ➢ To make choices that will increase the value of the firm
  - ➢ Managers in profit-oriented organizations try to increase the net present value of expected future cash flows.
  - ➢ The value of the firm is defined as the present value of future profits:

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- ➢ Present value of expected future profits $= \dfrac{\pi_1}{1+i} + \dfrac{\pi_2}{(1+i)^2} + \cdots + \dfrac{\pi_n}{(1+i)^n}$
- ➢ More compactly, we write:
- ➢ Present value of expected future profits $= \displaystyle\sum_{t=1}^{n} \dfrac{\pi_t}{(1+i)^t}$
- ➢ Given that profit = total revenue − total cost, then we write:
- ➢ Present value of expected future profits $= \displaystyle\sum_{t=1}^{n} \dfrac{TR_t - TC_t}{(1+i)^t}$
- ➢ Notation
  - ∗ π_t Profit in time t = Total Revenue in time t − Total Cost in time t
  - ∗ i Interest rate
  - ∗ n Number of time periods
  - ∗ TR_t Total Revenue in time t
  - ∗ TC_t Total Cost in time t
- • Managerial Choices
  - ➢ Influence total revenue by managing demand
  - ➢ Influence total cost by managing production
  - ➢ Influence the relevant interest rate by managing finances and risk
- • Managerial Constraints
  - ➢ Environmental and antitrust laws
  - ➢ Resource scarcity
  - ➢ Legal or contractual limitations

STRATEGY SESSION:
Bono Sees Red, and Corporate Profits See Black

DISCUSSION QUESTIONS

1. How can a firm assess the benefits and costs of cause marketing?
2. What other examples of cause marketing can you identify?

3. What Is Profit?

- • Two Measures of Profit
  - ➢ *Accounting profit*
    - ∗ Historical costs, legal compliance, reporting requirements
    - ∗ The accountant is concerned with controlling the firm's day-to-day operations, detecting fraud and embezzlement, satisfying tax and other laws, and producing records for various interested groups
  - ➢ *Economic profit*
    - ∗ Market value; opportunity, or implicit cost

∗ The economist is concerned with decision making, rational choice among strategies
∗ A more useful measure for managerial decision making

4. Reasons for the Existence of Profit

- Profit
  ➢ Measures the quality of managers' decision-making skills
  ➢ Encourages good management decisions by linkage with incentives
- Sources of Profit: Three profit-generating areas
  ➢ Innovation: Producing products that are better than existing products in terms of functionality, technology, and style
  ➢ Risk taking: Future outcomes and their likelihoods are unknown, as are the reactions of rivals.
  ➢ Market power: Managers also earn profit by exploiting market inefficiencies. Common tactics include
    ∗ building barriers to entry
    ∗ employing sophisticated pricing strategies
    ∗ diversification efforts
    ∗ making good strategic production decisions

5. Managerial Interests and the Principal–Agent Problem

- Principal–Agent Problem
  ➢ The interests of a firm's owners and those of its managers may differ, unless the manager is the owner.
  ➢ Separation of ownership and control
    ∗ The principals are the owners. They want managers to maximize the value of the firm.
    ∗ The agents are the managers. They want more compensation and less accountability. Because the firm's owners find it difficult to adequately distinguish between actions that maximize profits and those that do not, managers have incentives to enrich themselves.
    ∗ The divergence in goals is the principal–agent problem.
    ∗ To deal with this problem, owners (the principals) often use contracts to converge their preferences and those of their agents.
    ∗ *Moral hazard* exists when a person behaves differently when he or she is not subject to the risks associated with his or her behavior.
    ∗ Managers who do not maximize the value of the firm may do so because they do not suffer as a result of their behavior.

➢ Solutions
  ∗ Devise methods that lead to convergence of the interests of the firm's owners and its managers.
  ∗ *Examples:* Stock option plans or bonuses linked to profits

6. Demand and Supply: A First Look

- Market
  ➢ A group of firms and individuals that interact with each other to buy or sell a product
  ➢ Part of an economy's infrastructure
  ➢ A social institution that exists to facilitate economic exchange
  ➢ Relies on binding, enforceable contracts

STRATEGY SESSION:
Baseball Discovers the Law of Supply and Demand

DISCUSSION QUESTIONS

1. Do you see a relationship between variable pricing of baseball game tickets and odds-making on horse races?
2. How do you think real-time variable pricing would influence the practice of ticket scalping?

7. The Demand Side of a Market

- Demand Curve
  ➢ It shows managers how many units they sell at a given price, holding other possible influences constant.
  ➢ It is negatively sloped.
  ➢ It pertains to a particular period of time.
  Other influences on demand decisions include
    ∗ consumer income
    ∗ prices of substitutes and complements
    ∗ advertising expenditures
    ∗ product quality
    ∗ government fiat
- Total Revenue Function
  ➢ A firm's total revenue (*TR*) for a given time period is equal to the price charged (*P*) times the quantity sold (*Q*) during that time period.
  ➢ $TR = P \times Q$
  ➢ The demand function reflects the effect of changes in *P* on quantity demanded (*Q*) per time period and, hence, the effect of changes in *P* on *TR*.

8. The Supply Side of a Market

- Supply side is represented by a market supply curve.
  - ➢ The market supply curve shows how many units of a commodity sellers will offer at any price.
  - ➢ It is positively sloped.
  - ➢ It pertains to a particular period of time.
  - ➢ Decreases in the cost of inputs (labor, capital, land) or technological progress cause supply curves to shift to the right.

9. Equilibrium Price

- Disequilibrium
  - ➢ Price is too high.
    - ∗ Excess supply or surplus
    - ∗ Causes price to fall
  - ➢ Price is too low.
    - ∗ Excess demand or shortage
    - ∗ Causes price to rise
- Equilibrium Price
  - ➢ A situation in which quantity demanded is equal to quantity supplied
  - ➢ Price is sustainable.
  - ➢ The market is in balance because everyone who wants to purchase the good can, and every seller who wants to sell the good can.

10. Actual Price

- The price that is of interest to the manager
- *Invisible hand:* When no governmental agency is needed to induce producers to drop or increase their prices
- If the actual price is above the equilibrium price, there will be a surplus that will put downward pressure on the actual price.
- If the actual price is below the equilibrium price, there will be a shortage that will put upward pressure on the actual price.
- If the actual price is equal to the equilibrium price, then there will be neither a shortage nor a surplus and the market is said to be in equilibrium.

11. What If the Demand Curve Shifts?

- Demand and supply curves are not static. They shift in reaction to changes in the environment.
- Increase in Demand
  - ➢ Represented by a rightward or upward shift in the demand curve

➢ Result of a change that makes buyers willing to purchase a larger quantity of a good at the current price and/or to pay a higher price for the current quantity
➢ Will create a shortage and cause the equilibrium price to increase

- Decrease in Demand
  ➢ Represented by a leftward or downward shift in the demand curve
  ➢ Result of a change that makes buyers purchase a smaller quantity of a good at the current price and/or continue to buy the current quantity only if the price is reduced
  ➢ Will create a surplus and cause the equilibrium price to decrease

12. What If the Supply Curve Shifts?

- Increase in Supply
  ➢ May be caused by technological advances
  ➢ Represented by a rightward or downward shift in the supply curve
  ➢ Result of a change that makes sellers willing to offer a larger quantity of a good at the current price and/or to offer the current quantity at a lower price
  ➢ Will create a surplus and cause the equilibrium price to decrease
- Decrease in Supply
  ➢ Represented by a leftward or upward shift in the supply curve
  ➢ Result of a change that makes sellers willing to offer a smaller quantity of a good at the current price and/or to offer the current quantity at a higher price
  ➢ Will create a shortage and cause the equilibrium price to increase

STRATEGY SESSION:
Life During a Market Movement

DISCUSSION QUESTIONS

1. Several factors are mentioned as contributing to disequilibrium in global food markets. Among them are emotions (panic), government restrictions on trade, the Malthusian specter of population growth outpacing food production, slowing productivity growth in the agricultural sector, rising incomes, and the production of ethanol. Which of these are supply factors and which are demand factors? How does each influence market price?

2. The market price for crude oil fluctuated widely during 2008. What supply and demand factors contributed to these fluctuations? Is the petroleum market subject to any of the same factors cited as influencing agricultural markets?

Chapter 1: Problem Solutions

1. A book is to be written by Britney Spears. Batman Books agrees to pay Britney $6 million for the rights to this not-yet-written memoir. According to one leading publisher, Batman Books could earn a profit of roughly $1.2 million if it sold 625,000 copies in hardcover. On the other hand, if it sold 375,000 copies, managers would lose about $1.3 million. Publishing executives stated that it was hard to sell more than 500,000 copies of a nonfiction hardcover book, and very exceptional to sell 1 million copies. Were Batman managers taking a substantial risk in publishing this book?

   SOLUTION:

   There was a substantial risk of loss. On the other hand, there was substantial opportunity for gain. Risk is often unavoidable. The appropriate balance between risk and return is what should determine managers' decisions. Successful decisions in circumstances of risk are a source of profit.

2. Some say that any self-respecting top manager joining a company does so with a front-end signing bonus. In many cases this bonus is in the seven figures. At the same time the entering manager may be given a bonus guarantee. No matter what happens to firm profit, he or she gets at least a percentage of that bonus. Do long-term bonus guarantees help to solve the principal–agent problem, or do they exacerbate it? Why?

   SOLUTION:

   An executive who spends a lifetime working for a single company or in a single industry has a poorly diversified human capital portfolio. Such an executive also often has a significant, undiversified financial investment in the form of stock options and pension plans that are used in partial substitution for current salary to align the long-term wealth of the executive with that of the shareholders. As an executive climbs the corporate ladder, the value of his or her human capital becomes more closely tied to the fortunes of the firm and industry. This lack of diversification requires a compensating risk premium. A large signing bonus may allow a risk-averse executive to make an investment, which increases the value of the firm but which the executive would otherwise avoid because of concern for his or her own personal wealth; thus the bonus may reduce the principal–agent conflict. Of course the benefits of reduced risk to the executive come at the potential cost of indifference to the wealth of the shareholders. Although a large signing bonus may help solve the incentive alignment problem, compensation that is too great and too insensitive to the fortunes of the shareholders makes the principal–agent problem worse.

3. If the interest rate is 10%, what is the present value of the Monroe Corporation's profit in the next 10 years?

Number of Years in the Future	Profit (millions of dollars)
1	8
2	10
3	12
4	14
5	15
6	16
7	17
8	15
9	13
10	10

SOLUTION:

Use formula (1.1) for $t = 1, 2, \ldots, 10$ to obtain the following table:

Number of Years in the Future	Profit (millions of dollars)	$(1 + i)^{-t}$	Present Value (millions of dollars)
1	8	0.90909	7.27272
2	10	0.82645	8.26450
3	12	0.75131	9.01572
4	14	0.68301	9.56214
5	15	0.62092	9.31380
6	16	0.56447	9.03152
7	17	0.51316	8.72372
8	15	0.46651	6.99765
9	13	0.42410	5.51330
10	10	0.38554	3.85540
		Total	77.55047

The answer is $77.55047 million.

4. Managers at Du Pont de Nemours and Company expect a profit of $2.9 billion in 2012. Does this mean that Du Pont's expected economic profit will equal $2.9 billion? Why or why not?

SOLUTION:

Economic profits differ from accounting profits because of differences in the way depreciation is measured, differences in the way revenues and costs are recognized in terms of timing, and the inclusion of the opportunity cost of owner-supplied inputs in the calculation of economic profits.

Du Pont's economic profits might well be negative if accounting profits do not exceed the risk-adjusted rate of return multiplied by the firm's equity value.

5. William Howe must decide whether to start a business renting beach umbrellas at an ocean resort during June, July, and August of next summer. He believes he can rent each umbrella to vacationers at $5 a day, and he intends to lease 50 umbrellas for the three-month period for $3,000. To operate this business, he does not have to hire anyone (but himself), and he has no expenses other than the leasing costs and a fee of $3,000 per month to rent the business location. Howe is a college student, and if he did not operate this business, he could earn $4,000 for the three-month period doing construction work.

   a. If there are 80 days during the summer when beach umbrellas are demanded and Howe rents all 50 of his umbrellas on each of these days, what will be his accounting profit for the summer?

   b. What will be his economic profit for the summer?

   SOLUTION:

   a. TR = (80 days) × (50 umbrellas) × ($5 per day) = $20,000
      TC = (3 months) × ($3,000 per month rent) + ($3,000 umbrella lease)
         = $12,000
      Accounting Profit = TR−TC = $8,000
   b. Economic Profit = Accounting Profit − Opportunity Cost
      Economic Profit = $8,000 − $4,000 = $4,000

6. On March 3, 2008, a revival of *Gypsy*, the Stephen Sondheim musical, opened at the St. James Theater in New York. Ticket prices ranged from $117 to $42 per seat. The show's weekly gross revenues, operating costs, and profit were estimated as follows, depending on whether the average ticket price was $75 or $65:

	Average Price of $75	Average Price of $65
Gross revenues	$765,000	$680,000
Operating costs	600,000	600,000
Profit	165,000	80,000

   a. With a cast of 71 people, a 30-piece orchestra, and more than 500 costumes, *Gypsy* cost more than $10 million to stage. This investment was in addition to the operating costs (such as salaries and theater rent). How many weeks would it take before the investors got their money back, according to these estimates, if the average price was $65? If it was $75?

b. George Wachtel, director of research for the League of American Theaters and Producers, has said that about one in three shows opening on Broadway in recent years has at least broken even. Were the investors in *Gypsy* taking a substantial risk?

c. According to one Broadway producer, "Broadway isn't where you make the money any more. It's where you establish the project so you can make the money. When you mount a show now, you really have to think about where it's going to play later." If so, should the profit figures here be interpreted with caution?

d. If the investors in this revival of *Gypsy* make a profit, will this profit be, at least in part, a reward for bearing risk?

SOLUTION:

a. Given a price of $75, the weekly operating profit of $165,000 would pay off the $10 million investment in 10,000/165 = 60.6 or 61 weeks. If the price is $65, it would take 10,000/80 = 125 weeks to pay off the investment. This does not provide for any return on investment, however.

b. The investors in *Gypsy* were indeed taking a substantial risk. If only one in three shows breaks even, two out of three make losses.

c. The profit figures should be interpreted with caution because they do not take into account the likelihood of profits when, and if, the show goes on the road.

d. Yes.

7. If the demand curve for wheat in the United States is

$$P = 12.4 - Q_D$$

where P is the farm price of wheat (in dollars per bushel) and Q_D is the quantity of wheat demanded (in billions of bushels), and the supply curve for wheat in the United States is

$$P = -2.6 + 2Q_S$$

where Q_S is the quantity of wheat supplied (in billions of bushels), what is the equilibrium price of wheat? What is the equilibrium quantity of wheat sold? Must the actual price equal the equilibrium price? Why or why not?

SOLUTION:

Setting demand equal to supply in equilibrium, that is, $Q_D = Q_S = Q_E$, yields

$$12.4 - Q_D = -2.6 + 2Q_S$$
$$Q_E = 15/3 = 5$$
$$P_E = 12.4 - 5 = -2.6 + (2)(5) = \$7.40$$

The actual price need not be equal to equilibrium price, although it will generally tend to move toward it because of the equilibrating effects of shortage and surplus. Factors that might prevent the actual price from equaling the equilibrium price include the cost and availability of information, transportation costs, and lack of opportunities for price-equalizing arbitrage.

8. The lumber industry was hit hard by the downturn in housing starts in 2010 and 2011. Prices plunged from $290 per thousand board feet to less than $200 per thousand board feet. Many observers believed this price decrease was caused by the slowing of new home construction because of the glut of unsold homes on the market. Was this price decrease caused by a shift in the supply or demand curve?

   SOLUTION:

   Because the demand for lumber is derived in large part from the demand for new housing construction, a decline in construction would be likely to cause the demand for lumber to fall, leading to lower lumber prices since the demand curve shifts to the left. Supply would not be affected by changes in housing construction.

9. From November 2010 to March 2011 the price of gold increased from $1,200 per ounce to over $1,800 per ounce. Newspaper articles during this period said there was little increased demand from the jewelry industry but significantly more demand from investors who were purchasing gold because of the falling dollar.
   a. Was this price increase due to a shift in the demand curve for gold, a shift in the supply curve for gold, or both?
   b. Did this price increase affect the supply curve for gold jewelry? If so, how?

   SOLUTION:

   a. A change in the value of the dollar causes the dollar price of globally traded commodities to change. If the value of the dollar falls, the dollar price of commodities will rise. In this case, a decline in the value of the dollar can be expected to cause the market for gold (with price measured in dollars) to experience an increase in demand and a decrease in supply and thus an increase in price. There may also have been an additional increase in demand due to expectations by investors that the dollar price of gold will continue to rise. Finally, there may have been a further supply decrease if producers, speculating that prices would rise further, withheld gold from the market.

b. Gold is an input to the production of jewelry. An increase in the price of gold would therefore be expected to reduce the supply of jewelry, resulting in higher jewelry prices.

| Demand Theory

Lecture Notes

1. Introduction

- Objectives
  - ➤ To explain the importance of market demand in managerial decision making
  - ➤ To understand the many factors that influence the demand for a product
  - ➤ To measure and analyze the sensitivity of demand to changes in factors affecting demand. The tool used for this type of sensitivity analysis is *demand elasticity.*
    - ∗ *Elasticity:* Measures the percentage change in one factor given a small (marginal) percentage change in another factor
    - ∗ *Elasticity:* Measures the sensitivity of one factor to another
    - ∗ *Demand elasticity:* Measures the percentage change in quantity demanded of a product given a small (marginal) percentage change in another factor that affects the demand for the product
  - ➤ Explain the role of managers in influencing and predicting market demand.
    - ∗ Managers can influence demand by controlling, among other things, advertising, product quality, and distribution strategies.
    - ∗ Managers cannot control, but need to understand, elements of the competitive environment that influence demand, including the availability of substitute or complement goods, their pricing, and the advertising strategies employed by their sellers.
    - ∗ Managers cannot control, but need to understand how, the macro-economic environment influences demand, including interest rates, taxes, and both local and global levels of economic activity such as the level of income in the economy.

2. The Market Demand Curve

- *Market Demand Schedule:* A table showing the total quantity of the good purchased at each price during a given time period
- *Market Demand Curve:* A plot of the market demand schedule on a graph
- *Example* (Table 2.1): Demand schedule for tablets
- It shows the total quantity of tablets demanded at each price, not the quantity demanded from a particular firm.
  - ➤ *Convention:* Price is on the vertical axis and quantity is on the horizontal axis.
  - ➤ *Example* (Figure 2.1): Demand curve for tablets
- Characteristics of the Market Demand Curve
  - ➤ Quantity demanded is for output of the entire market or the industry, not of a single firm.
  - ➤ For most products and services, the market demand curve slopes downward and to the right.
  - ➤ *Example:* The quantity of tablets demanded increases as the price of tablets falls.
  - ➤ Quantity demanded is defined with regard to a particular time period.
- Determinants of the position and shape of the market demand curve—Some of the important factors include
  - ➤ Consumer tastes or preferences
    - ∗ An increase in consumer tastes shifts the demand curve to the right.
    - ∗ A decrease in consumer tastes shifts the demand curve to the left.
  - ➤ Consumer income (or more specifically per capita disposable income)
    - ∗ Normal and inferior goods
    - ∗ *Example* (Figure 2.3): Increase in income causes an increase in demand for tablets; that is, tablets are a normal good.
  - ➤ Population size in the market

STRATEGY SESSION:
The Customer Is Always Right—Wrong!

DISCUSSION QUESTIONS

1. Like retail technology stores, clothing stores have their angels and devils. How do you think the devils prey on clothing stores, and how could their behavior be discouraged? How do you think angels could be encouraged to shop at a particular clothing store?

   Answer: Devils buy clothes, wear them, and then return them for a refund. Stores can refuse to provide refunds on returns and, instead, provide a credit for future purchases or only allow exchanges. Angels buy lots of clothes on impulse. Stores could offer quantity discounts or a "shoppers club" with special notification of sales.

2. Some electronics stores refuse to allow customers to return or exchange products, instead requiring them to deal directly with the manufacturer. What are the pros and cons of this approach with regard to the stores' objective of encouraging angels and discouraging devils?

3. Industry and Firm Demand Functions

- *Market Demand Function:* The relationship between the quantity demanded of a product and the various factors that influence this quantity
  - ➢ Quantity demanded of good X: $Q = f(\text{factors}) = f(P, P\_r, I, T, N, A, \ldots)$
  - ➢ Factors include
    - ∗ price of X: P
    - ∗ incomes of consumers: I
    - ∗ tastes of consumers: T
    - ∗ prices of related goods in consumption: P_r
    - ∗ population size: N
    - ∗ advertising expenditures: A
    - ∗ general demand function:

      $$Q = f(\text{factors}) = f(P, P\_r, I, T, N, A, \text{ other factors})$$

  - ➢ *Example* (equation 2.1): A *linear* demand function:

    $$Q = b_1 P + b_2 I + b_3 S + b_4 A$$

    - ∗ Assumes that population is constant
    - ∗ P = price of tablets
    - ∗ 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, namely, *regression analysis.*
  - ➢ *Parameters:* Constant or variable terms used in the function that helps managers determine the specific form of the function but not its general nature
    - ∗ *Example:* $Q = -2{,}000P + 70I - 375S + 0.0001A$
  - ➢ Relationship between the market demand function and the market demand curve
    - ∗ The market demand curve shows the relationship between Q and P when all other variables are held constant at specific values.
    - ∗ The market demand function does not explicitly hold any values constant.
  - ➢ *Example* (equation 2.3): Suppose $I = 13{,}000$, $S = 400$, and $A = 50$ million. Then
  - ➢ $Q = -700P + 200(13{,}000) - 500(400) + 0.01(50{,}000{,}000)$
    That is

* $Q = 2,900,000 - 700P$ (direct demand function)

Solving for *P* in terms of *Q* gives the inverse demand function:

$P = 4,143 - 0.001429Q$ (graphed in Figure 2.4)

➢ *Example*: Shifting the demand curve
Suppose the price of software falls from $400 to $200. Then

$Q = -700P + 200(13,000) - 500(200) + 0.01(50,000,000)$
$Q = 3,000,000 - 700P$

* Solving for *P* gives

$P = 4,286 - 0.001429Q$ (graphed in Figure 2.4)

Note: Same slope; only the vertical intercept changes.

- The Firm's Demand Curve
  ➢ Negative slope with regard to own 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

4. The Own-Price Elasticity of Demand

- *Own-Price Elasticity of Demand:* More simply referred to as the price elasticity of demand, it is the concept that managers use to measure the percentage change in quantity demanded of their firm's products resulting from a 1% change in the products' own prices.
  ➢ The elasticity of a function is the percentage change in the dependent (*Y*) variable in response to a 1% change in the independent (*X*) variable.
  ➢ The price elasticity of a demand function is the percentage change in quantity demanded in response to a 1% change in price.
  ➢ Formula:

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

  ➢ Along a demand function, it is given by

$$\eta = \left(\frac{P}{Q}\right)\frac{\partial Q}{\partial P}$$

  ➢ Price elasticity of demand generally is different at different prices and on different markets.

- Terminology
  - ➢ Price elasticity of demand is symbolized by the Greek letter eta (η) (not a general convention).
  - ➢ *Fact:* $0 \geq \eta \geq -\infty$. That is, price elasticity of demand is always non-positive.
  - ➢ When $|\eta| > 1$, demand is elastic.
  - ➢ When $|\eta| < 1$, demand is inelastic.
  - ➢ When $|\eta| = 1$ or $\eta = -1$, demand is unitary.

Limiting 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.
- Linear Demand Curves
  - ➢ The slope of a linear demand curve is constant.
  - ➢ If the demand curve is neither vertical nor horizontal, the price elasticity will vary depending on price level.
    - ∗ 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 quantity approaches zero or as price approaches the vertical intercept.
    - ∗ At prices below the midpoint, demand is inelastic, with η approaching 0 as price approaching 0.
  - ➢ Given a demand curve defined as $P = a - bQ$, the price elasticity of demand is: $\eta = \left(\dfrac{-1}{b} \right) \dfrac{a - bQ}{Q} = -P / (a - P)$

5. Point and Arc Elasticities

- The point price elasticity formula should be used when working with an estimated demand curve or when the change in price is very small. It is written as

$$\eta = \left(\frac{P}{Q} \right) \frac{\partial Q}{\partial P}$$

  - ➢ Calculated value of price elasticity for small changes in prices will differ depending on whether P and Q are the starting values or the ending values after the price change. The change will be small if the change is small.

  * *Example:* $P_1 = 99.95$, $P_2 = 100.00$, $Q_1 = 20,002$, and $Q_2 = 20,000$

  * $\eta = [(20,002 - 20,000)/(99.95 - 100)][99.95/20,002] = -0.1999$

  * $\eta = [(20,000 - 20,002)/(100 - 99.95)][100/200,000] = -0.22$

 ➤ If the price change is large, then the direction of change will influence the calculated elasticity.

  * *Example:* $P_1 = 5$, $P_2 = 4$, $Q_1 = 3$, and $Q_2 = 40$

  * $\eta = [(40 - 3)/(4 - 5)][5/3] = -61.67$

  * $\eta = [(3 - 40)/(5 - 4)][4/40] = -3.70$

 ➤ This problem is corrected by using the arc or midpoint formula.

- *Recommendation:* The midpoint or arc elasticity formula should be used to estimate the price elasticity of demand from a demand schedule where price differences are not very small. It is given by

$$\eta = \left(\frac{\Delta Q}{\Delta P}\right)\left(\frac{P_1 + P_2}{Q_1 + Q_2}\right)$$

 ➤ *Example:* $P_1 = 5$, $P_2 = 4$, $Q_1 = 3$, and $Q_2 = 40$

 ➤ $\eta = [(40 - 3)/(4 - 5)][(5 + 4)/(3 + 40)] = -7.74$

6. Using the Demand Function to Calculate the Price Elasticity of Demand

Whenever the demand function is specified, one usually uses the point price elasticity of demand.

- *Example:* Given

 ➤ $Q = -700P + 200I - 500S + 0.01A$

 ➤ $Q =$ Quantity demanded of tablet computers

 ➤ Price $= P = 3,000$

 ➤ Income $= I = 13,000$

 ➤ Software $= S = 400$

 ➤ Advertising $= A = 50,000,000$

- Derive the demand curve

 ➤ $Q = -700P + (200)(13,000) - (500)(400) + (0.01)(50,000,000)$

 ➤ $Q = 2,900,000 - 700P$

- Determine Q

 ➤ $Q = 2,900,000 - (700)(3,000) = 800,000.$

  We have $\dfrac{\partial Q}{\partial P} = -700$. Thus

- $\eta = (-700)(3,000/800,000) = -2.62$

- For $P = 2,000$, $Q = 2,900,000 - (700)(2,000) = 1,500,000$, so $\eta = (-700)(2,000/1,500,000) = -0.93$

7. The Effect of Price Elasticity on the Firm's Revenue

- Derivation of relationship between marginal revenue ($\Delta TR/\Delta Q$ or dTR/dQ) and the price elasticity of demand
  - ➢ Total revenue: $TR = PQ$
  - ➢ Consider quantity as a function of price: $Q = f(P)$. Then, differentiating TR with respect to P, using the product rule for derivative, gives

$$dTR/dP = Q(dP/dP) + P(dQ/dP)$$

  Dividing by Q gives

$$(1/Q)(dTR/dP) = (dP/dP) + (P/Q)(dQ/dP) = 1 + \eta$$

- $1/Q$ is positive.
- *Implications:*
  - ➢ *Case 1:* If $\eta = -1$, that is, unitary elastic demand, then $1 + \eta = 0$, and $dTR/dP = 0$, so total revenue is at a maximum and a change in P will have no effect on total revenue.
  - ➢ *Case 2:* If $\eta > -1$ (inelastic demand), then $1 + \eta > 0$ and $dTR/dP > 0$, so an increase in P (and consequent decrease in Q) will increase total revenue.
  - ➢ *Case 3:* If $\eta < -1$ (elastic demand), then $1 + \eta < 0$, and $dTR/dP < 0$, so an increase in P (and consequent decrease in Q) will reduce total revenue.
  - ➢ *To summarize:*
- If the price elasticity is unitary, any price change will cause an equal and opposite percentage change in quantity demanded. Total revenue will remain constant.
- If the price elasticity is in the inelastic range, then a 1% change in P will cause less than a 1% change in quantity in the opposite direction. Therefore, total revenue will change in the same direction as price.
- If the price elasticity is in the inelastic range, then a 1% change in P will cause more than a 1% change in quantity in the opposite direction. Therefore, total revenue will change in the opposite direction from price.

PROBLEM SOLVED:
Price Elasticity of Demand: Philip Morris

DISCUSSION QUESTIONS

1. The decline in total revenue from cigarette sales in 1993 is attributed to Philip Morris's cut in the price of cigarettes. Are there other factors that might have contributed to this decline in revenue?

   Answer: The price elasticity of demand assumes that "all other things" are held constant. Changes in taxes, consumer income, or attitudes toward

tobacco during this period might have reduced demand, while the price cut increased quantity demanded. If this was the case, then the true price elasticity would likely be closer to −1.

8. Funding Public Transit

- Given
  - ➢ Price (fare) elasticity of demand for public transit in the United States is estimated to be about −0.3.
  - *Facts:*
  - ➢ All public transit systems in the United States lose money.
  - ➢ Public transit systems are funded by federal, state, and local governments, all of which have budget issues.
- 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.
  - ➢ Implication: Managers of public transit will therefore increase fares if they do not receive enough public funds to balance their budgets.

9. Determinants of the Own-Price Elasticity of Demand

- Number and Similarity of Available Substitutes
  Fact: A product with many close substitutes generally has elastic demand.
- Product's Price Relative to a Consumer's Total Budget
  - ➢ *Facts:*
    - ∗ Products for which the typical consumer spends only a very small fraction of her income are quite elastic.
      - ◦ *Examples:* Thimbles, rubber bands, salt
    - ∗ Products that command a larger percentage of the consumer's total budget tend to be more price elastic.
      - ◦ *Examples:* Kitchen appliances, automobiles
- Time Period Available for Adjustment to a Price Change
  - ➢ *Fact:* For nondurable goods, demand is likely to be more elastic over a long period relative to a short period.
  - ➢ *Rationale:* The longer the time period, the easier it is for consumers to substitute one good for another.

10. The Strategic Use of the Price Elasticity of Demand

- Managers can change the price elasticity of demand for their products.
- A Useful Tool: *Product differentiation*

- Differentiation strategies convince consumers the product is unique; hence it has fewer substitutes.
- *Caution:* Differentiation is not effective if consumers do not perceive it.
- *Example:* Strategic pricing of first-class ($\eta = -0.45$), regular economy ($\eta = -1.30$), and excursion ($\eta = -1.83$) 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.
  - ➢ 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.

STRATEGY SESSION:
Elasticity in Use

DISCUSSION QUESTIONS

1. Suppose that a manufacturer sells a product through an upscale boutique and, with a different brand name, through a discount retailer. The elasticity of demand at the boutique is −1.2, and at the discount retailer it is −2.6. If the optimal price at the boutique is $85, what price ($P_D$) should be charged at the discount retailer?

   Answer: $85(1 − 1/1.2) = P_D(1 − 1/2.6)$ so $P_D = \$23.02$

2. A consulting firm charges $250 per hour to Fortune 500 companies. The estimated elasticity of demand for consulting services is −3.1. The firm is planning to spin off a subsidiary firm that will work with smaller businesses. The estimated elasticity of demand for these firms is −7.3. What price per hour (P_S), to the nearest dollar, should be charged by the subsidiary?

   Answer: $250(1 − 1/3.1) = P_S(1 − 1/7.3)$ so $P_S = \$200$

11. 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 curve: $TR = PQ = aQ{-}bQ^2$
- *Marginal Revenue:* The incremental revenue earned from selling an additional unit of output
  - ➢ $MR = dTR/dQ = d(\,aQ{-}bQ^2)/dQ = a − 2bQ$
    - ∗ $\eta = (-1/b)[(a{-}bQ)/Q] = -a/(bQ) + 1$

* *Case 1:* If $Q = a/2b$, then $\eta = -1$, unitary elastic demand.
* *Case 2:* If $Q > a/2b$, then $\eta > -1$, and demand is inelastic.
* *Case 3:* If $Q < a/2b$, then $\eta < -1$, and demand is elastic.

➤ $MR = dTR/dQ = d(PQ)/dQ = P(dQ/dQ) + Q(dP/dQ) = P[1 + (Q/P)$ (dP/dQ). Thus $MR = P(1 + 1/\eta)$
* *Case 1:* $|\eta| > 1$ (elastic) implies $MR > 0$.
* *Case 2:* $|\eta| < 1$ (inelastic) implies $MR < 0$.
* *Case 3:* $|\eta| = 1$ (unitary elastic) implies $MR = 0$.

12. The Income Elasticity of Demand

* *Income Elasticity of Demand* (η_I): Measures the percentage change in quantity demanded (Q) resulting from a 1% change in consumer income (I)
  ➤ Income can be defined as aggregate consumer income or as per capita disposable income, depending on circumstances.
  ➤ $\eta_I = \left(\dfrac{\Delta Q}{\Delta I} \right) \left(\dfrac{I}{Q} \right)$
  ➤ For a demand function, it is given by

$$\eta = \left(\frac{I}{Q} \right) \frac{\partial Q}{\partial I}$$

  ➤ $\eta_I > 0$ for normal goods because $\dfrac{\partial Q}{\partial I} > 0$ for normal goods.
  * For most products, $\eta_I > 0$; that is, most goods are normal, since increases in aggregate income are associated with increases in aggregate consumer spending.
  ➤ $\eta_I < 0$ for inferior goods because $\dfrac{\partial Q}{\partial I} < 0$ for inferior goods.
  * *Examples:* Hamburgers and public transportation
  * *Fact:* When the economy is expanding, products with high-income elasticities will enjoy a significant increase in sales and managers must prepare for probable significant increase in sales.
* Strategic Management and the Income Elasticity of Demand
  ➤ The demand for a product that has an income elasticity of demand that is large in absolute value will vary widely with changes in income caused by economic growth and recessions.
  ➤ 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.

PROBLEM SOLVED:
Income Elasticity of Demand

Discussion Questions

1. Suppose that a market demand function is defined as $Q = 20{,}000 - 8P + 0.1I$ and suppose that $P = 2{,}000$ and $I = 20{,}000$. What is the income elasticity of demand at this point?

   Answer:
   Here, we have

   $\dfrac{\partial Q}{\partial I} = 0.1$ (a normal good). Then we have

   $$Q = 6{,}000, \text{ so that } \eta_I = 0.1(20{,}000/6{,}000) = -1/3$$

2. If the income elasticity of demand for a product is unitary, then a 1% change in income will change demand in the same direction by 1%. If price remains constant, then spending on the product will change by 1% and, consequently, spending on the product will be the same percentage of income after the income change as it was before. If the income elasticity of demand is greater than one, then spending will increase as a percentage of income as income increases. If it is less than one, spending will decrease as a percentage of income as income increases. How do you think the percentage of income spent on jewelry, food, clothing, housing, and automobiles responds to a 1% increase in income?

13. 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% change in the price of a related good (P_Y)
  - ➤ Income can be defined as aggregate consumer income or as per capita disposable income, depending on circumstances.
  - ➤ $$\eta_{XY} = \left(\frac{\Delta Q_X}{\Delta P_Y} \right)\left(\frac{P_Y}{Q_X} \right)$$
  - ➤ $\eta_{XY} > 0$ if the two products are substitutes.
    - ∗ *Example:* Wheat and corn
  - ➤ $\eta_{XY} < 0$ if the two products are complements.
    - ∗ *Example*: Computers and computer software
  - ➤ $\eta_{XY} = 0$ if the two products are independent or unrelated.
    - ∗ *Example*: Butter and airline tickets
  - ➤ *Example*: A linear demand function
    - ∗ Given: $Q_X = 1{,}000 - 0.2P_X + 0.5P_Y + 0.04I$, $Q_X = 2{,}000$, and $P_Y = 500$
    - ∗ $\eta_{XY} = 0.5(500/2{,}000) = 0.125$ so the two products are substitutes.