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CHAPTER ONE

MANAGERIAL ECONOMICS - AN INTRODUCTION

INTRODUCTION TO MANAGERIAL ECONOMICS

The heart of Managerial economics is the micro economic theory. Much of this theory was formalized in a textbook written more than 100 years ago by Professor Alfred Marshall of Cambridge University. The world has changed a great deal since Marshall's ideas were developed. Yet, basic micro economic principles such as supply and demand, elasticity, short run and long-run shifts in resource allocation, diminishing returns, economies of scale, and pricing according to marginal revenue and marginal cost continue to be important tools of analysis for managerial decision makers.

Economics is divided into two broad categories: Micro and Macro.

Microeconomics is the study of the economic behavior of individual decision-making units. It has a great relevance to Managerial Economics. On the other hand, **Macroeconomics** is the study of the total or aggregate level of output, income, employment, consumption, investment, and prices for the economy viewed as a whole. In economics, the key term is **Scarcity**. In the presence of a limited supply relative to demand, countries must decide how to allocate their scarce resources. This decision is central to the study of economics:

- What to produce?
- How to produce?
- And for whom to produce?

These are the well known what, how and for whom questions found in the introductory chapter of all economics textbooks.

1.1. DEFINITION OF MANAGERIAL ECONOMICS

Joel Dean, author of the first managerial economics textbook, defines managerial economics as "The use of economic analysis in the formulation of business policies".

Douglas - "Managerial economics is the application of economic principles and methodologies to the decision-making process within the firm or organization."

Pappas & Hirschey - "Managerial economics applies economic theory and methods to business and administrative decision-making."

Salvatore - "Managerial economics refers to the application of economic theory and the tools of Analysis of decision science to examine how an organization can achieve its objectives most effectively."

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The meaning of this definition can best be examined with the aid of Figure 1-1

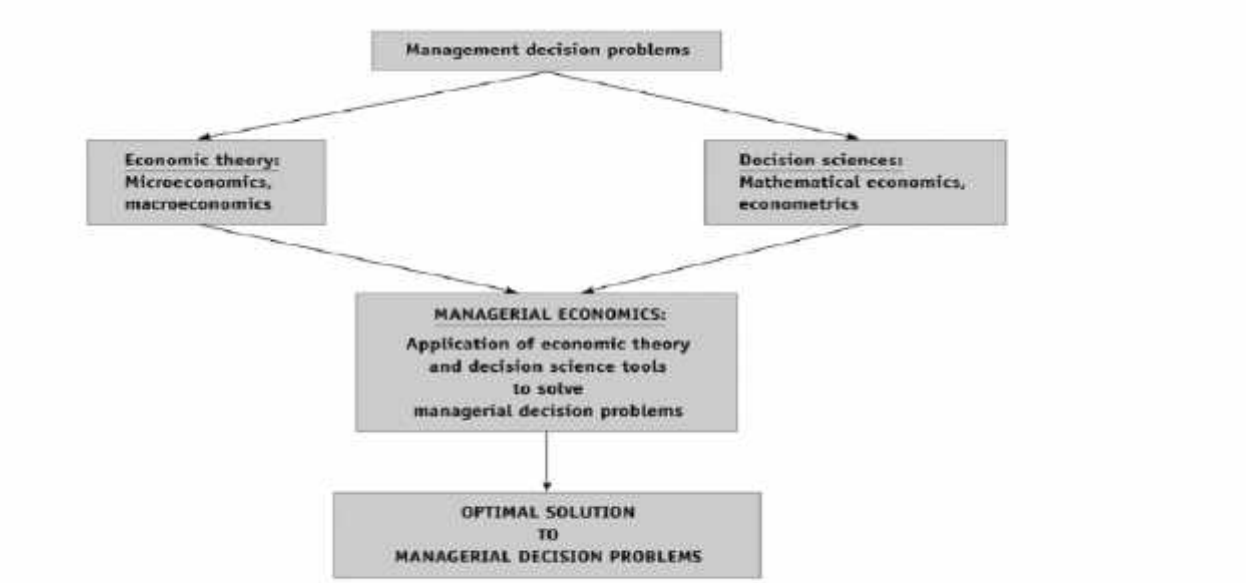


FIGURE 1-1 The Nature of Managerial Economics*
* Managerial economics *refers to the application of economic theory and decision science tools to find the optimal solution to managerial decision problems.*

RELATIONSHIP TO ECONOMIC THEORY

Economic theories seek to predict and explain economic behavior. Economic theories usually begin with a model. For example, the theory of the firm assumes that the firm seeks to maximize profits, and on the basis of that it predicts how much of a particular commodity the firm should produce under different forms of market structure. The profit-maximization model accurately predicts the behavior of firms, and, therefore, we accept it. Thus, the methodology of economics is to accept a theory or model if it predicts accurately.

RELATIONSHIP TO THE DECISION SCIENCES

Managerial economics is also closely related to the decision sciences. These use the tools of mathematical economics and econometrics to construct and estimate decision models aimed at determining the optimal behavior of the firm**. Mathematical economics** is used to formalize the economic models in equation form postulated by economic theory. Econometrics then applies statistical tool (particularly regression analysis) to real-world data to estimate the models postulated by economic theory and for forecasting.

1.2. SCOPE OF MANAGERIAL ECONOMICS

Managerial economics has applications in both profit and not-for-profit sectors. For example, an administrator of a nonprofit hospital seeks to provide the best medical care possible given limited medical staff, beds and equipment. Using the tools and concepts of managerial economics, the administrator can determine the optimal allocation of these limited resources. In short, managerial economics helps managers arrive at a set of operating rules that help in

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the efficient use of scarce human and capital resources. By following these rules, businesses, educational institutions, hospitals, other nonprofit organizations, and government agencies are able to meet their objectives efficiently.

THEORY OF THE FIRM

The theory of firm is the center-piece and central theme of Managerial economics. A firm is an organization that combines and organizes resources for the purpose of producing goods and/or services for sale. The model of business is called the theory of the firm. In its simplest version, the firm is thought to have profit maximization as its primary goal. Today, the emphasis on profits has been broadened to include uncertainty and the time value of money. In this more complete model, the primary goal of the firm is long-term expected value maximization.

EXPECTED VALUE MAXIMIZATION

The value of the firm is the present value of all expected future profit of the firm. Future profits must be discounted at an appropriate interest rate .to the present because a dollar of profit in the future is worth less than today. This model can be expressed as follows:
Formally the wealth or value of the Firm = Present Value of Expected Future Profits
Formally the wealth or value of the Firm = Present Value of Expected Future Profits

CONSTRAINTS AND THE THEORY OF THE FIRM

Managerial decisions are often made in light of constraints imposed by technology, resource scarcity, contractual obligations, laws, and regulations. Organizations frequently face limited availability of essential inputs, such as skilled labor, raw materials, energy, specialized machinery, and warehouse space.

LIMITATIONS OF THE THEORY OF THE FIRM

Some critics question why the value maximization criterion is used as a foundation for studying firm behavior. The theory of the firm which postulates that the goal of the firm is to maximize wealth or the value of the firm has been criticized as being much too narrow and unrealistic.

Hence, broader theories of the firm have been purposed. The most prominent among these are:

- Sales maximization (Adequate rate of profit)
- Management utility maximization (Principle-agent problem)
- Satisfying behavior

These alternative theories, or models, of managerial behavior have added to our understanding of the firm. Still, none can replace the basic value maximization model as a foundation for analyzing managerial decisions.

DEFINITIONS OF PROFIT

- **Business or Accounting Profit**: Total revenue minus the explicit or accounting costs of production.
- **Economic Profit**: Total revenue minus the explicit and implicit costs of production.

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THEORIES OF PROFIT

- Risk-Bearing Theories of Profit
- Frictional Theory of Profit
- Monopoly Theory of Profit
- Innovation Theory of Profit
- Managerial Efficiency Theory of Profit

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Define managerial economics		
Describe major elements in the theory of the firm		
Explain managerial decision making		
Explain the context of firm		
Describes the scope of managerial economics		
Enumerate importance of managerial economics		

Summary

Managerial economics is about the criteria for rational decision making in business enterprises and non-commercial decision settings. The world in which we live is characterized by scarcity rather than abundance. Economic opportunities can be found in supplying economic goods or removing nuisance goods. Specialization and division of labor enhance productive opportunities.

The firm may achieve internal resource allocation more efficiently with hierarchical, authoritative control than with market transactions. The management of a commercial enterprise is an exercise in economizing. Problems of coordination and control within the complex corporate organization may be remedied by divisionalization. The internal structure of an enterprise may be horizontal, vertical, or conglomerated. Strategic decision making, that involves the fundamental direction of the firm's activities, is essentially entrepreneurial in nature. The enterprise may engage in international activities in a variety of forms. Multi nationalization of enterprise is achieved when managerial personnel are recruited world-wide without national prejudice.

Human beings are essentially materialistic and hedonistic; rational human behavior consists in attempting to maximize the value of some positive quantity or to minimize the value of some negative quantity. Human approaches to decision making may be characterized as capriciousness, conditioned response, or deliberate and rational choice.

The decision maker, confronted by a multiplicity of possible goals, must select one for primary pursuit and subordinate others to it; subordinate goals may serve as constraints upon

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the pursuit of the primary goal. Any decision involves multiple possible courses of action among which the decision maker must choose. Often the alternative courses of action are greater or lesser quantities of the same action; the choice of an alternative quantity involves an incremental or marginal change. Any course of action may result in multiple possible outcomes; each possible outcome may span a range of variability; the wider the range of variability, the greater the degree of risk associated with the outcome. The identities of some of the possible outcomes or their ranges of variability may not be known with certainty by the decision maker; the decision maker may attempt to reduce the uncertainty by seeking additional information about the outcomes.

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CHAPTER TWO
FUNDAMENTAL ECONOMIC CONCEPTS

Learning objectives

Up on successful completion of this chapter students should be able to:

- Explain the concept of equilibrium analysis
- Describe the relationship of demand and supply
- Explain marginal analysis for optimal decision making
- Identify the time value of money

Introduction

The Success of any business depends up on its ability to generate revenue. Firms generate revenue by satisfying the demand of consumers. To meet the demand of consumers, Managers need a good knowledge of consumers demand and preferences. Demand theory and analysis, will provide useful insights for business decision making. In modern economy, thousands of goods are offered for sale. Meaning consumers are facing a problem of choice from such wide range of alternative choices. However, the choice of consumers is limited by many factors including their income. This implies a consumer faces a constrained optimization problem. That is, a consumer will select a basket of goods/services that gives him a maximum possible satisfaction (Utility) Knowledge about such theory provide a good back-ground for, pricing decision ,forecasting sales and, formulate marketing strategy.

2.1. Supply and Demand Analysis

General demand function ,**Direct** demand function ,**Inverse** demand function ,**Graph** (Sometimes the inverse demand function is called indirect demand function) Analogously, Ultimately, the goal is to **forecast** the new market price and quantity as a result of demand and/or supply shifts.

The general demand function can be expressed as:

$$Q_x = f(P, M, P_R, T, P_e, N)$$

Where:

P (own price) price of the good for which we are estimating the demand

M Income

P_R price of related goods

T – tastes

P_e – expected future prices

N – number of consumers

A linear form of the demand function is:

$$Q_D = \alpha + bP + cM + dP_R + eT + fP_e + gN$$

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Note that the demand function is not necessarily linear, but it will be in most cases in this course and in all cases of this chapter. In the linear equation, *b, c, d, e, f* are called coefficients and/or slope parameters.

$$\frac{\Delta Q_d}{\Delta \mathrm{P}} = b < 0$$

$$\frac{\Delta Q_d}{\Delta M} = c, c < 0 \text{ if the good is inferior, } c > 0 \text{ for a normal good}$$

Complements in consumption: consume the goods together. Substitutes in consumption: consumers **either** consume on good **or the other** good

$$\frac{\Delta Q_d}{\Delta P_g} - d, d < 0 \text{ if the good is a complement, } d > 0 \text{ for a substitute}$$

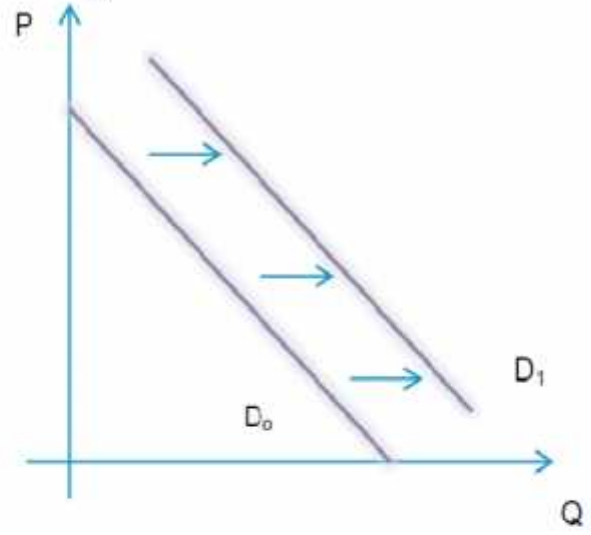
$$\frac{\Delta Q_d}{\Delta T} = e > 0$$

$$\frac{\Delta Q_d}{\Delta P_e} \quad f > 0$$

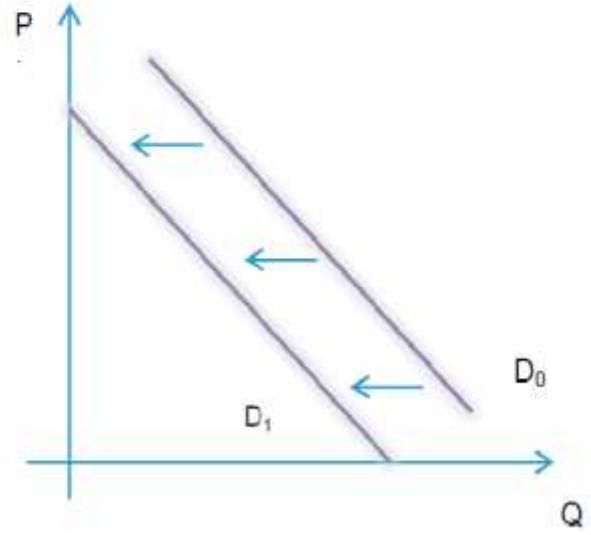
$$\frac{\Delta Q_d}{\Delta N} \quad g > 0$$

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A change in demand – increase in demand from D_0 to D_1:



A change in demand – decrease in demand from D_0 to D_1:



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The general supply function can be expressed as:

$$Q_S = f(P, P_I, P_R, T, P_e, F)$$

Where:

P – (Own price) price of the good for which we are estimating the supply

P_I – price of inputs

P_R – price of related goods

T – technology

P_E – expected future prices

F – number of firms

A linear form of the supply function is:

$$Q_S = h + kP + lP_I + mP_R + nT + rP_e, + sF$$

$$\frac{\Delta Q_S}{\Delta \mathrm{P}} = k > 0$$

$$\frac{\Delta Q_S}{\Delta P_I} = l < 0$$

Complements in production: produce good X and good Y together (for example, as a result of the production, for instance steak and ground beef for a meat processing plant) Substitutes in production: either produce and sell good X or produce and sell good Y (for example, wheat and corn)

$$\frac{\Delta Q_S}{\Delta P_R} = m, m < 0 \text{ if the good is a substitute, } m > 0 \text{ for a complement}$$

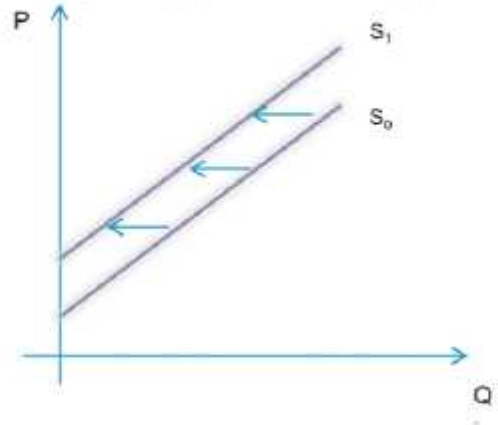
$$\frac{\Delta Q_S}{\Delta T} = n > 0$$

$$\frac{\Delta Q_S}{\Delta P_e} = r < 0$$

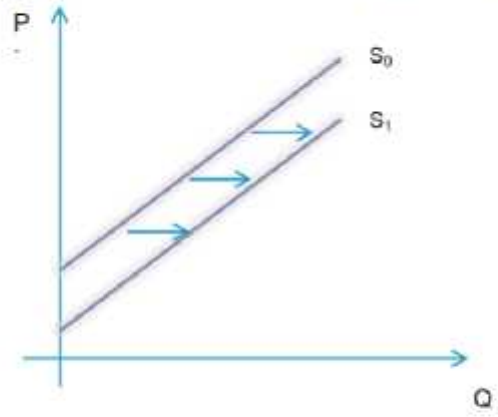
$$\frac{\Delta Q_S}{\Delta F} = s > 0$$

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A change in supply – increase in supply from S_0 to S_1:



A change in supply – decrease in supply from S_0 to S_1:



Market equilibrium:

$$Q_D = Q_S$$

Consumer and Producer Surplus

Price ceiling: legal maximum limit for a price. When set below the market clearing (equilibrium) price, creates a shortage, as suppliers would require a higher price to produce more. In order to determine the shortage, substitute the ceiling price in Q_S and in Q_D. $Q_D - Q_S$ determines the shortage.

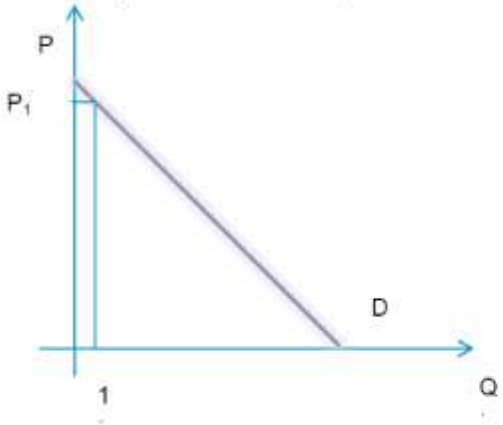
Price floor: legal minimum limit for a price, usually set by the government, who buys the supply at that set price if no one else does. When set above the market clearing (equilibrium) price,

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creates a surplus, as consumers would require a lower price to consume more. In order to determine the surplus, substitute the ceiling price in Q_D and in Q_S. $Q_S - Q_D$ determines the surplus.

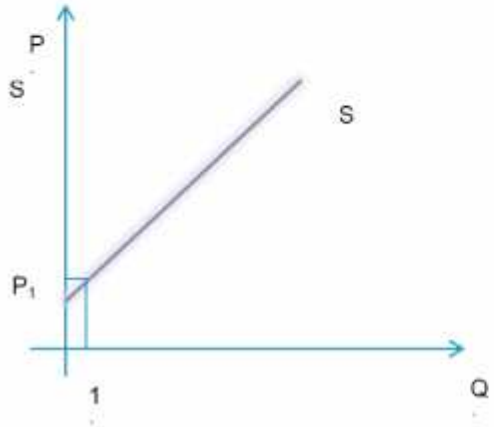
Consumer and Producer Surplus

Demand price: the maximum price a consumer would pay for a particular unit of a product.



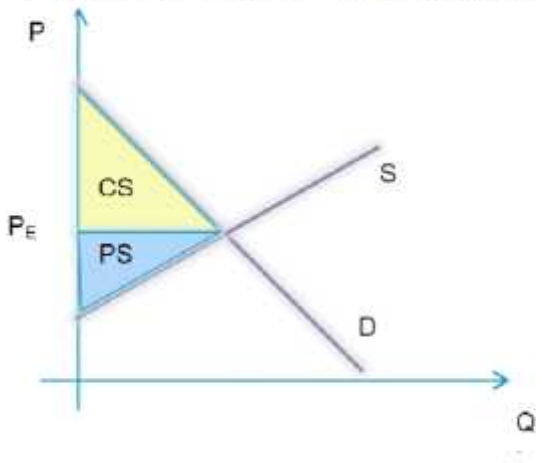
For instance, in the graph above, the consumer would pay up to P_1 for the first unit.

Supply price: the minimum price a supplier would require to supply for a particular unit of a product.



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For instance, in the graph above, the supplier would supply one unit if the price was P_1.



In the graph above, PE is the market equilibrium price. The yellow triangle represents **consumer surplus**. In order to calculate the amount of consumer surplus, you need to find the area of the yellow triangle. Similarly, the blue triangle represents **producer surplus** and its area represents the amount of producer surplus created by this market.

2.1.1.SUPPLY ANALYSIS

The term **Supply** refers to the quantity of a good or service that producers are willing and able to sell during a certain period under a given set of conditions. Factors that must be specified include the price of the good in question, prices of related goods, the current state of technology, levels of input prices, weather, and so on. The amount of product that producers bring to the market, the supply of the product—depends on all these influences.

LAW OF SUPPLY

A decrease in the price of a good, all other things held constant, will cause a decrease in the quantity supplied of the good. An increase in the price of a good, all other things held constant, will cause an increase in the quantity supplied of the good. Changes in price result in changes in

the quantity supplied shown as movement *along* the supply curve, while Changes in non-price determinants result in changes in supply shown as a *shift* in the supply curve.

Among the factors influencing the supply of a product, the price of the product itself is often the most important. Higher prices increase the quantity of output producers want to bring to market. When marginal revenue exceeds marginal cost, firms increase supply to earn the greater profits associated with expanded output. Higher prices allow firms to pay the higher production costs that are sometimes associated with expansions in output. On the other hand, lower prices typically cause producers to supply a lower quantity of output. Just as there are non-price determinants of demand, there are non-price determinants of supply. A change in

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any one or a combination of these factors will cause the supply curve shift to the right or to the left.

NON-PRICE DETERMINANTS OF SUPPLY

• costs and technology
• prices of other goods or services offered by the seller
• future expectations
• number of sellers
• input prices
• weather conditions

INDUSTRY SUPPLY VERSUS FIRM SUPPLY

Just as in the case of demand, supply functions can be specified for an entire industry or an individual firm. Even though factors affecting supply are highly similar in industry versus firm supply functions, the relative importance of such influences can differ markedly. Managerial decision making requires understanding both individual firm supply and market supply conditions. Market supply is the aggregate of individual firm supply, so it is ultimately determined by factors affecting firm supply.

SUPPLY CURVE AND SUPPLY FUNCTION

Supply curve shows price and quantity relation holding everything else constant. Along a supply curve, all non-price variables are held constant. A rise in price will increase the quantity supplied, while a fall in price will decrease the quantity supplied. The **supply function** specifies the relation between the quantity supplied and all variables that determine supply. The **supply curve** expresses the relation between the price charged and the quantity supplied, holding constant the effects of all other variables.

SUPPLY CURVE SHIFTS

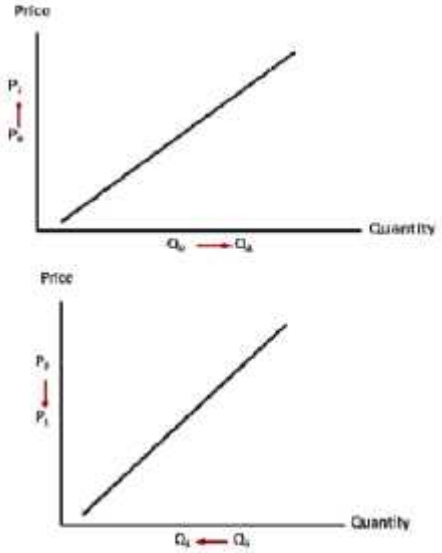
Supply increases if a non-price change allows more to profitably produced and sold. S-curve shits *downwards (right).* On the other hand, supply decreases if a non-price change causes less to be profitably produced and sold. S-curve shifts *upwards (left).* The market **supply function** for a product is a statement of the relation between the quantity supplied and all factors affecting that quantity. The generalized supply function expressed in a supply Equation must lists variables that influence supply. As is true with the demand function, the supply function must be made explicit to be useful for managerial decision making. Consider the supply function for automobile industry and assume that the supply function has been specified as follows:

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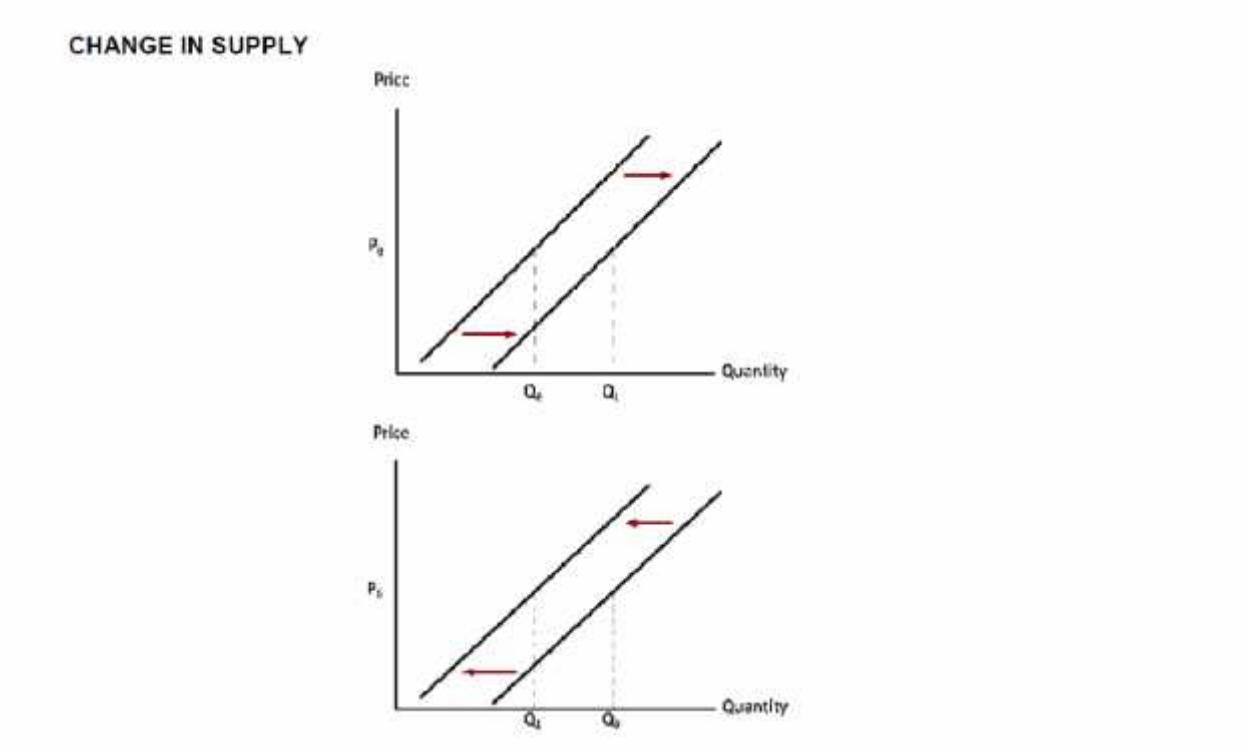
$Q = b_1P + b_2P' + b_3W + b_4S + b_5E + b_6i$

The above equation states that the number of new domestic cars supplied during a given period, Q, is a linear function of the average price of new domestic cars, P; average price of new sport car, P'; average hourly price of labor, W; average cost of steel, S; average cost of energy, E; and average interest rate (cost of capital in percent), i. The terms $b1, b2, \ldots, b6$ are the parameters of the supply function.

MOVEMENT ALONG THE SUPPLY CURVE

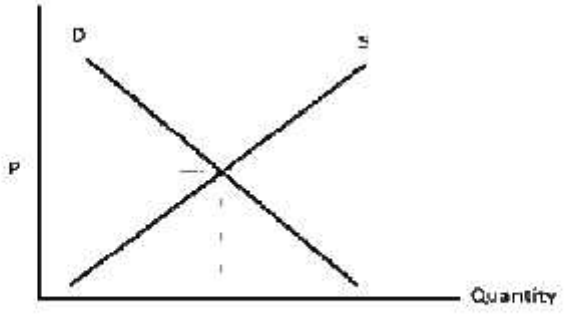


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2.1.2. MARKET EQUILIBRIUM

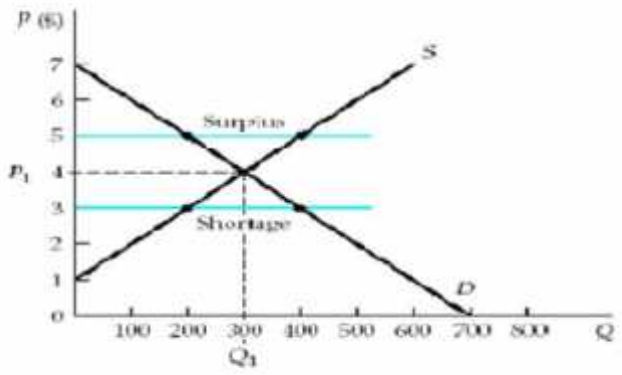
Market equilibrium is determined at the intersection of the market demand curve and the market supply curve. **Equilibrium price** is the price that equates the quantity demanded with the quantity supplied. This price is referred to as the **market equilibrium price**, or the market clearing price, because it just clears the market of all supplied product. **Equilibrium quantity** is the amount that people are willing to buy and sellers are willing to offer at the equilibrium price level. Market equilibrium describes a condition of perfect balance in the quantity demanded and the quantity supplied at a given price. In equilibrium, there is no tendency for change in either price or quantity.



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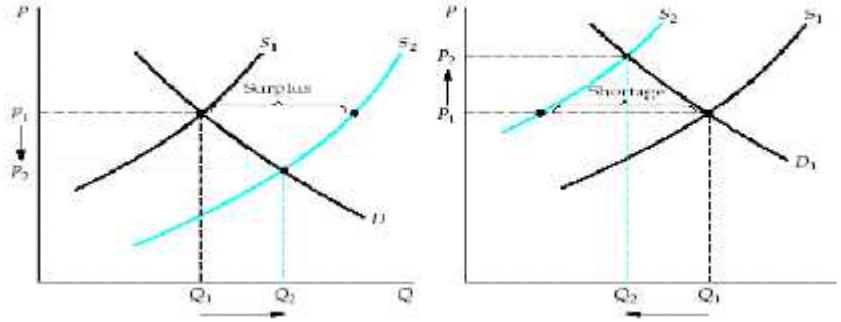
MARKET DISEQUILIBRIUM

A **surplus** is created when producers supply more of a product at a given price than buyers demand. Surplus describes a condition of excess supply. Conversely, a **shortage** is created when buyers demand more of a product at a given price than producers are willing to supply. Shortage describes a condition of excess demand. Neither surplus nor shortage will occur when a market is in equilibrium, because equilibrium is defined as a condition in which the quantities demanded and supplied are exactly in balance at the current market price. Surplus and shortage describe situations of market disequilibrium because either will result in powerful market forces being exerted to change the prices and quantities offered in the market.



COMPARATIVE STATICS: CHANGING SUPPLY

An increase in supply causes equilibrium price to fall and equilibrium quantity to rise while a decrease in supply causes equilibrium price to rise and equilibrium quantity to fall.

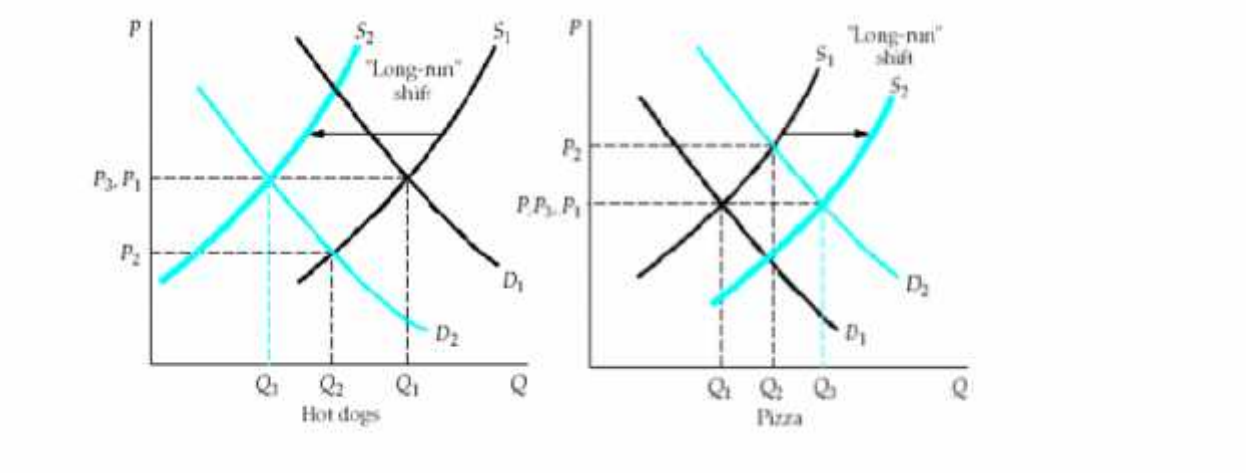


LONG RUN ANALYSIS

The **long run** is the period of time in which:

- new sellers may enter a market
- existing sellers may exit from a market
- existing sellers may adjust fixed factors of production
- buyers may react to a change in equilibrium price by changing their tastes and Preferences

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Initial change in the left panel: decrease in demand from D_1 to D_2, as a result there is a reduction in equilibrium price and quantity (to P_2, Q_2)
Follow-on adjustment:

- movement of resources out of the market
- leftward shift in the supply curve to S_2

Equilibrium price and quantity (to P_3, Q_3)
Initial change in the right panel: increase in demand from D_1 to D_2 that results in an increase in equilibrium price and quantity (to P_2, Q_2)
Follow-on adjustment:

- movement of resources into the market
- rightward shift in the supply curve to S_2

Equilibrium price and quantity (to P_3, Q_3)

2.1.3. Simultaneous shifts in supply and demand

When doing **quantitative** analysis, if you have the general supply and general demand curves and the values of the relevant variables, you **can** determine what happens with the equilibrium price and quantity by solving for equilibrium twice: once for before the changes, and once for after the changes.

When doing **qualitative** analysis (for instance, reading a newspaper article), you usually won't have the curves and the values of the variables. You can still determine the direction of **either** price or quantity, according to the table below:

		Demand	
		LEFT	RIGHT
Supply	LEFT	Quantity moves left Price indeterminate	Quantity indeterminate Price goes up
	RIGHT	Quantity indeterminate Price goes down	Quantity moves right Price indeterminate

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Note that the demand tells you the direction that the variable will shift. Also, note that if both supply and demand move in the **same direction**, you can tell what happens to **quantity**. If they move in **opposite directions**, you can tell what happens to **price**.

2.2. Marginal Analysis for Optimal Decisions

Dear learner can you give your own definition for the concept of marginal analysis in the context of managerial decision making?

_____

_____

The goal of marginal analysis is to help managers to make optimal decisions for the problems they face. In general, the problems can be represented by an **objective function.** The objective function is the function that the decision-maker wants to maximize or minimize. A profit function is a common example of an objective function.

The objective function can have one or more variables. Some of these variables are under the control of the decision maker. Those are called **choice variables** (they may also be called decision variables). Some variables are outside of the control of the decision maker, those are **exogenous** variables. Problems can be **unconstrained** (when the decision-maker can choose any value for the **choice variable**) or **constrained** (when the decision-maker has restrictions on the values he or she can choose).

Marginal Analysis ! ! ! ! ! ! !

A common example comes from the theory of the firm. Firms want to maximize $\Pi(Q) = TR(Q) - TC(Q)$, where $\Pi(Q)$ is the firm's profit as a function of quantity, TR(Q) is total cost as a function of Q and TC(Q) is total cost as a function of Q.

One experiment that can be run is the following: If the firm increases Q by a small amount, what happens to the profits? Do they increase, decrease or stay the same? Managers would want to keep increasing production as long as the profit increases and stop when the profit stops increasing.

Mathematically, this means that to maximize profit, we will set the derivative of the profit function to zero.

$$\max \Pi = TR(Q) - TC(Q)$$

$$\frac{\Delta \Pi}{\Delta Q} = \frac{\Delta TR}{\Delta Q} - \frac{\Delta TC}{\Delta Q} = 0$$

Making $\frac{\Delta TR}{\Delta Q} = MR$ (marginal revenue) and $\frac{\Delta TC}{\Delta Q} = MC$ (marginal cost), we have:

$$MR - MC = 0$$

Another way of writing $\frac{\Delta TR}{\Delta Q} - \frac{\Delta TC}{\Delta Q} = 0$ is to write $\frac{dTR}{dQ} - \frac{dTC}{dQ} = 0$.

Note: the derivative of any **Total** function is the **Marginal** function.

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Elasticity and Demand

Jan 20, 2011 – Southwest airlines is making more money on more traffic and higher ticket prices: 15% jump in revenue.

$$\epsilon_P = \frac{\%\ change\ in\ quantity\ demanded}{\%\ change\ in\ price}$$

Where ϵ_P represents the "own price elasticity of demand".

A more mathematical way of representing this:

$$\epsilon_P = \frac{\%\Delta Q}{\%\Delta P} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}}$$

Moreover:

$$\epsilon_P = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \frac{\Delta Q}{\Delta P}\frac{P}{Q} = \frac{dQ}{dP}\frac{P}{Q}$$

Note that in the demand function the price coefficient needs to be negative.

Therefore, the sign of ϵ_P is **negative**.

Another example of elasticity is the cross-price elasticity of demand. The cross-price elasticity of demand describes the sensitivity of the demand function to the change in the price of a related (complement or substitute) good.

$$\epsilon_{PR} = \frac{\%\Delta Q}{\%\Delta P_R} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P_R}{P_R}} = \frac{\Delta Q}{\Delta P_R}\frac{P_R}{Q} = \frac{dQ}{dP_R}\frac{P_R}{Q}$$

The sign of the cross-price elasticity of demand is positive if the related good is a substitute and negative if the related good is a complement.

Another one that is in the book is the elasticity of income: what happens to demand if income changes? Similarly:

$$\epsilon_M = \frac{\%\Delta Q}{\%\Delta M} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta M}{M}} = \frac{\Delta Q}{\Delta M}\frac{M}{Q} = \frac{dQ}{dM}\frac{M}{Q}$$

The sign of the income elasticity of demand is positive for normal goods and negative for inferior goods.

Lastly, we also have the advertising elasticity of demand.

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$$\epsilon_A = \frac{\%\Delta Q}{\%\Delta A} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta A}{A}} = \frac{\Delta Q}{\Delta A}\frac{A}{Q} = \frac{dQ}{dA}\frac{A}{Q}$$

Where A is the amount spent in advertising.

The flatter the demand curve, the more quantity changes for a given price change.

Elasticity Rules

If $\left|\frac{\%\Delta Q}{\%\Delta p}\right| > 1, |\%\Delta Q| > |\%\Delta P|$, we say that the demand is elastic. The quantity effect is larger than the price effect. One example is when there is a lot of substitutes.

If $\left|\frac{\%\Delta Q}{\%\Delta p}\right| < 1, |\%\Delta Q| < |\%\Delta P|$, we say that the demand is inelastic. The quantity effect is smaller than the price effect.

If $\left|\frac{\%\Delta Q}{\%\Delta p}\right| = 1, |\%\Delta Q| < |\%\Delta P|$, we say that the demand is unit elastic.

Price Elasticity	$\lvert\epsilon_P\rvert$	Effect on Total Revenue	Marginal Revenue
Elastic	$\lvert\epsilon_P\rvert > 1$	P↑.Q↓↓ = TR ↓ P↓.Q↑↑ = TR ↑	MR > 0
Unit Elastic	$\lvert\epsilon_P\rvert = 1$	Very small effect	MR = 0
Inelastic	$\lvert\epsilon_P\rvert < 1$	P↓↓.Q↑ = TR ↓ P↑↑.Q↓. = TR ↑	MR < 0

！！！Factors Affecting the Price Elasticity of Demand

- The higher the number of available substitutes, the more elastic the demand.
- The higher the percentage the item takes on one's budget, the more elastic the demand.
- Timeframe of product decision and/or usage

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Marginal revenue and inverse demand

$$P(Q) \quad a - bQ$$

$$TR = P(Q).Q \rightarrow TR = (a \quad bQ)Q \rightarrow TR = aQ \quad bQ^2$$

$$MR \quad \frac{dP(Q)}{dQ} \quad a - 2bQ$$

1) Marginal revenue and inverse demand curve will have the same vertical axis intercept.
2) The slope of the marginal revenue is twice as steep as the inverse demand curve

2.3. THE TIME VALUE OF MONEY

Dear learner can you give your own definition for the concept of time value of money? How can we relate with managerial decision making?

_____

_____

_____

In addition to the differences noted in Chapter one between long and short runs, a major distinction remains to set the long-run decision problem apart from short-run decision making. Since the effects of the long-run decision can be expected to impact the enterprise in the future, some recognition must be made of the **remoteness** of those effects. The sense of the problem is that the expectation of a benefit to be realized in the future is **worth less** to the decision maker than an equivalent benefit received immediately. Specialists in finance often refer to this phenomenon as the "time value of money," but the phenomenon would exist even in a barter economy (one which does not use money). The phenomenon is described by the ancient adage that "a bird in the hand is worth two in the bush." The problem pertains to costs as well as to benefits. In addition, costs which must be paid at some future time are also less meaningful to the decision maker than those which must be paid today, although the wise decision maker should plan and make careful arrangements to cover expected future costs.

Since future possibilities are worth less than present realities, economists have acknowledged this phenomenon by **discounting** the expected future values at an appropriate rate. This rate is usually taken to be the **best market rate of interest** for which the enterprise can qualify. The interest rate is used as a discount rate on the premise that the equivalent of the expected future value, less the cost of interest, can be had at present by borrowing the future sum. This relationship should be true whether the borrowed principle and the interest to be repaid are expressed in barter or monetary terms. If we let the symbol i stand for the interest rate which

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will serve as discount rate, the present value of the expected future outcome can be expressed as

$$(1)\quad PV = \frac{V_1}{(1+i)} + \frac{V_2}{(1+i)^2} + \ldots + \frac{V_n}{(1+i)^n},$$

where PV is the "present value" of an expected future income stream, V is a predicted future net income (or return) in each of n future periods (it is "expected" if it is a probability-weighted average of all possible outcomes which may occur). The value of V is taken to be the net of the difference between the future benefit, b, and the cost of realizing it, c, or V = (b - c). PV is less than the sum of the Vs because each V is divided by a number greater than 1, i.e., 1 plus the discount rate i.

If there are no risk considerations to be taken into account, the appropriate decision procedure is to first compute, using formula (1), the present values of the expected future net benefits for each of the k outcome possibilities for each of the decision alternatives. Then the expected values of possible outcomes of each decision alternative can be computed as their probability-weighted averages using formula (1) of Chapter A2 into which the computed present values, PV, are substituted for the outcomes, V. The proper decision criterion is to choose the alternative with the **largest present expected value** of the possible outcomes.

2.3.1.A Marginal Decision Criterion for the Long Run

In the present value formula (1), values for V and i are known or estimated, and the value of PV is computed. An alternative version of the present value formula permits computing the so-called internal rate of return,

$$(2)\quad K = \frac{V_1}{(1+r)} + \frac{V_2}{(1+r)^2} + \ldots + \frac{V_n}{(1+r)^n},$$

In formula (2), K is the **capital outlay** required to acquire and install an investment opportunity (since it is known today, it is the opportunity's "present value"), and r is the **internal rate of return** on the investment opportunity. In this approach, the value of K and the values for V are known (or can be estimated), but the value of r is to be computed. Actually, equation (2) cannot be easily solved for value r, but r may be estimated by successive approximation from annuity tables.

If we may abstract from the possibility of a scrap value of the capital at the end of its useful life, n, the conceptual sense of r is the **discount rate** which would be just sufficient to make the sum of the returns, $V_1 \ldots V_n$, just equal to the capital outlay, K. The discount rate, r, is interpreted as a rate of return because if all of the net amounts represented by V were invested at an interest rate equal to r, they and their interest earnings would add up to the capital outlay, K. The investment criterion which justifies undertaking the investment

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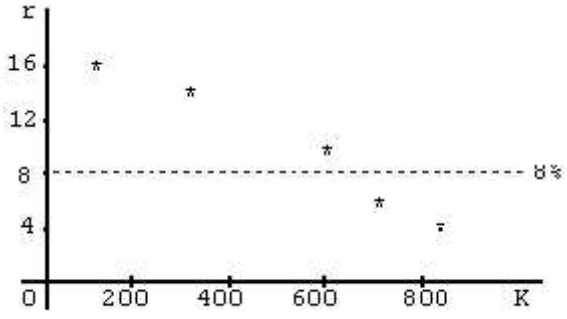
opportunity is that its **rate of return**, r, is at least as great as the **best market interest rate**, i, for which the enterprise can qualify, or **r >= i**.

If we may assume that the predicted net returns, $V_1...V_n$, can be estimated, the internal rates of return can be computed for each prospective investment opportunity currently under consideration by the enterprise's management. For example, suppose that the management of an enterprise is considering five prospective investment opportunities, designated A through E, which require the capital outlays and promise the internal rates of return reported in Table B1-1. These opportunities have already been arrayed in descending order of internal rates of return. When the capital outlays are "stacked" from left to right on a set of coordinate axes with capital expenditures on the horizontal axis and internal rates of return on the vertical axis as in Figure B1-1, the plotted points A through E constitute a downward sloping path which John Maynard Keynes called the "marginal efficiency of capital" (*The General Theory of Employment, Interest, and Money*, Harcourt, Brace & World, Inc., 1964, p. 135). Suppose that the enterprise can borrow funds from the capital markets at an interest rate i = 8 percent, represented by the horizontal dashed line. The marginal investment criterion then is to undertake additional investment opportunities in descending order of rates of return as long as the **rates of return** are at least as high as the **interest rate**, i, or **r >= i**. In the illustrated example, investment opportunities A, B, and C ought to be undertaken; opportunities D and E ought to be rejected because their rates of return would not be sufficient to pay the interest on borrowing to finance them.

Table B1-1. Hypothetical investment opportunities and rates of return.

Opportunity	r	Outlay	Cumulative
A	16%	$140,000	$140,000
B	14	218,000	358,000
C	10	250,000	608,000
D	6	98,000	706,000
E	4	124,000	830,000

Figure B1-1. The marginal efficiency of capital.



We should note that this long-run investment decision criterion is appropriate even if the enterprise can finance its capital outlays from **internal sources**. The rationale is that funds

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accumulated internally by **depreciation allowances** and **retaining earnings** have been (or could have been) "invested" on financial capital markets earning interest rate, i, which must now be foregone if the funds are used to finance the prospective investment opportunities instead.

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Define demand and supply analysis		
Explain marginal analysis in the context of decision making		
Identify factors that cause demand and supply to shift simultaneously		
Describe the time value of money		
Explain market equilibrium		
Identify the importance the concept of time value		
Identify factors that affect demand and supply		

Summary

Demand: Refers to a quantity that a consumer is willing to buy at a particular price, at a particular time (Ceteris Paribus). This can be represented as, Qd= f(P)……Ceteris Paribus. This relationship is given by the law of demand which state that there is an inverse relationship between price and quantity. At higher price consumer will buy less of a commodity and vice versa.

The question, however, is that How consumers decide how much of a particular commodity to buy at a particular price? Why they buy more of a commodity when its price fall and vice-versa Market demand : is the summation of all individual demand curves in particular market What are determinates of market demand? Demand curve was drawn on the basis of Ceteris Paribus assumption However, demand is affected by many factors. If business firms have to responsive to consumers demand they have to understand factors affecting demand of a good

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CHAPTER THREE
OPTIMIZATION TECHNIQUES

Learning objectives

Up on successful completion of this chapter students should be able to:

- ***Define optimization in the context of economic decision making***
- ***Explain different types of optimization techniques***
- ***Describe constrained optimization technique***

3.1. Introduction to optimization

Dear learner can you define optimization by using your own words? Support your definition with practical example?

_____

Optimization is mainly concerned with finding maximum and minimum points, also known as optimum points of a function. Applications include finding optimum values for functions such as

profit, cost, revenue, production and utility. These functions which are to be maximized or minimized are called objective function.

Examples

• Consumers maximize utility by purchasing an optimal combination of goods

• Firms maximize profit by producing and selling an optimal quantity of goods

• Firms minimize their cost of production by using an optimal combination of inputs

Just as there is no single "best" purchase decision for all customers at all times, there is no single "best" investment decision for all managers at all times. When alternative courses of action are available, the decision that produces a result most consistent with managerial objectives is the **optimal decision.** The process of arriving at the best managerial decision is the goal of economic optimization and the focus of managerial economics.

MAXIMIZING THE VALUE OF THE FIRM

In managerial economics, the primary objective of management is assumed to be maximization of the value of the firm. Maximizing the above equation is a complex task that involves consideration of future revenues, costs, and discount rates. For many day-to-day operating decisions, managers typically use less complicated, partial optimization techniques.

EXPRESSING ECONOMIC RELATIONSHIPS

Common ways of specifying Economic functions are:

• Set form

• Functional form

• Graphs

• table

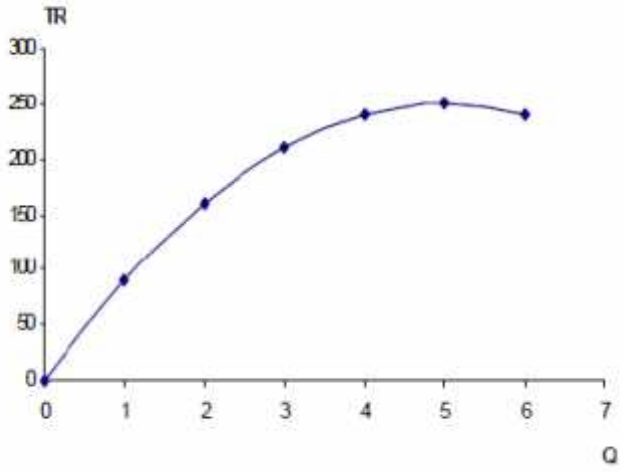
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Tables:

Q	0	1	2	3	4	5	6
TR	0	90	160	210	240	250	240

S = {(a,b)/ a ε Q and b ε R} (set form)

Equations: TR = 100Q - 10Q^2 (Functional Form)



Tables are the simplest and most direct form for presenting economic data. When these data are displayed electronically in the format of an accounting income statement or balance sheet, the tables are referred to as **spreadsheets**. When the underlying relation between economic data is simple, tables and spreadsheets may be sufficient for analytical purposes. In such instances, a simple **graph** or visual representation of the data can provide valuable insight. Complex economic relations require more sophisticated methods of expression. An **equation** is

an expression of the functional relationship among economic variables.

TOTAL, AVERAGE, AND MARGINAL RELATIONS

Total, average, and marginal relations are very useful in optimization analysis. The relationship between total, average and marginal concepts is extremely important in optimization analysis .A marginal relation is the change in the dependent variable caused by a one-unit change in an independent variable. For example, marginal revenue is the change in total revenue associated with a one-unit change in output; marginal cost is the change in total cost following a one-unit change in output; and marginal profit is the change in total profit due to a one-unit change in

output.

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REVENUE RELATIONS

Price and Total Revenue

Total Revenue = Price × Quantity

Marginal Revenue

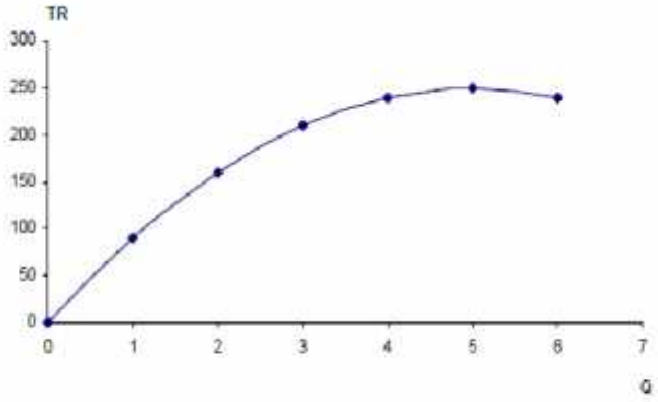
Change in total revenue associated with a one-unit change in output.

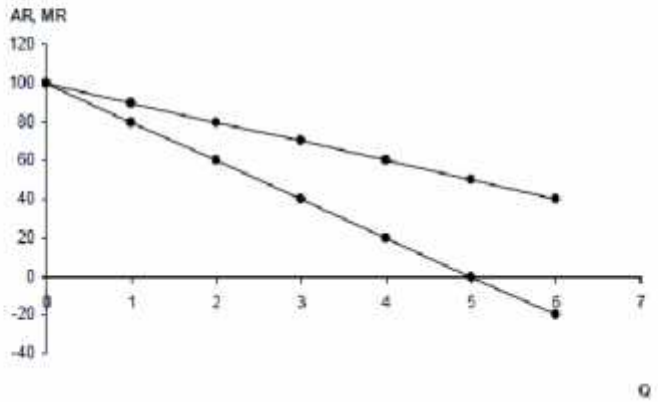
Revenue Maximization

Quantity with highest revenue, MR = 0.

32

Q	TR	AR	MR
0	0	–	–
1	90	90	90
2	160	80	70
3	210	70	50
4	240	60	30
5	250	50	10
6	240	40	-10





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PROFIT RELATIONS

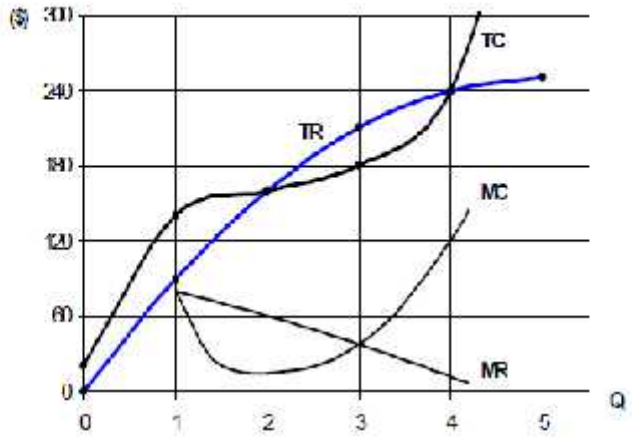
Total and Marginal Profit
- Total Profit (π) = Total Revenue - Total Cost.
- Marginal profit is the change in total profit due to a one-unit change in output. $M\pi = MR - MC$.

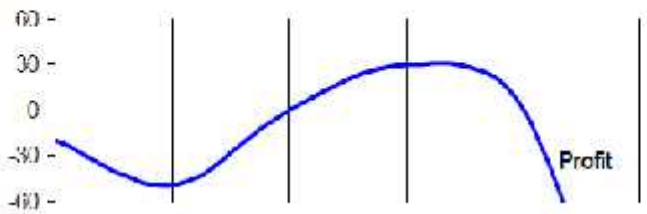
Profit Maximization
- Profit is maximized when $M\pi = MR - MC = 0$ or $MR = MC$, assuming profit declines as Q rises.

Marginal v. Incremental Profits
- Marginal profit is the gain from producing one more unit of output (Q).
- Incremental profit is gained tied to a managerial decision, possibly involving multiple units of Q.

PROFIT MAXIMIZATION

Q	TR	TC	Profit
0	0	20	-20
1	90	140	-50
2	160	160	0
3	210	180	30
4	240	240	0
5	250	480	-230





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COST RELATIONS

Total Cost

Total Cost = Fixed Cost + Variable Cost.

Marginal and Average Cost

Marginal cost is the change in total cost associated with a one unit change in output.

Average Cost = Total Cost/Quantity

Average Cost Minimization

• Average cost is minimized when MC = AC.

• Reflects efficient production of a given output level.

Total Cost (TC) = Fixed Costs (FC) + Variable Costs (VC)

FC = a

VC = bQ + Q2

TC = a + bQ + Q2

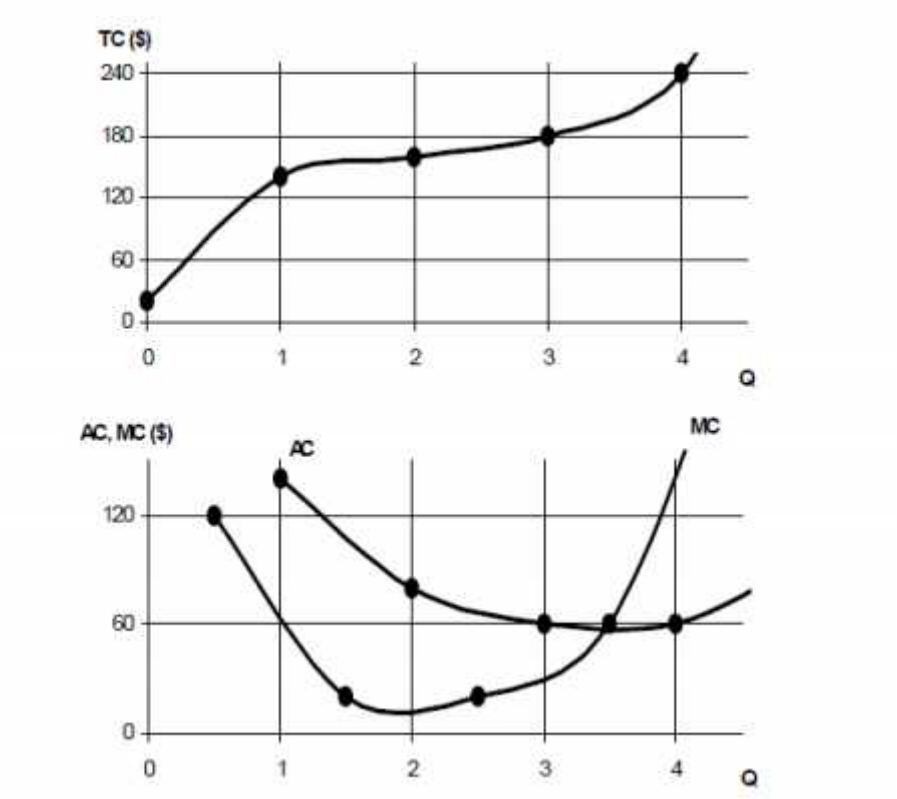
Marginal Costs (MC) = dTC/dQ

MC = b + 2Q

Average Total Cost (ATC) = Total Cost/Q

ATC = (a + bQ + Q2)/Q so that: ATC = a/Q + b + Q

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GEOMETRIC RELATIONSHIPS

• The slope of a tangent to a total curve at a point is equal to the marginal value at that point

• The slope of a ray from the origin to a point on a total curve is equal to the average value at that point

• A marginal value is positive, zero, and negative, respectively, when a total curve slopes upward, is horizontal, and slopes downward

• A marginal value is above, equal to, and below an average value, respectively, when the slope of the average curve is positive, zero, and negative

3.2. Types of Optimization Techniques

The marginal analysis is one of the most important concepts in managerial economics in general and in optimization analysis in particular. According to marginal analysis, the firm maximizes profits when marginal revenue equals marginal cost. Marginal cost (MC) is defined as the- change in total cost per unit change in output and is given by the slope of the TC curve. Marginal analysis gives clear rules to follow for optimal resource allocation. As a result, geometric relations between totals and marginals offer a fruitful basis for examining the role of marginal analysis in managerial decision making.

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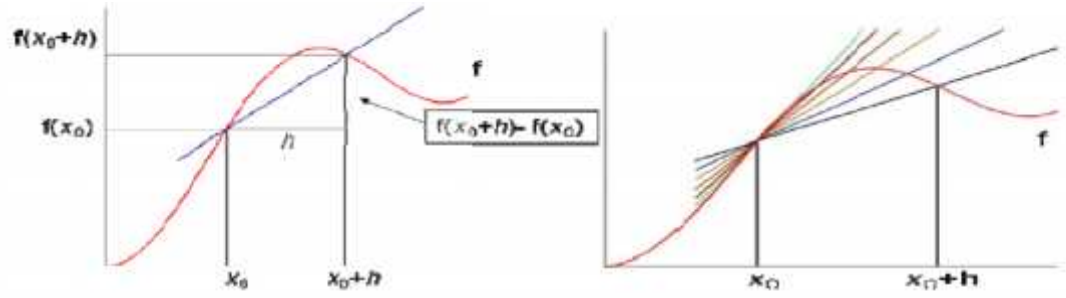
Geometric relations between totals and marginals offer a fruitful basis for examining the role of marginal analysis in economic decision making. Managerial decisions frequently require finding the maximum value of a function. For a function to be at a maximum, its marginal value (slope) must be zero. Evaluating the slope, or marginal value, of a function, therefore, enables one to determine the point at which the function is maximized.

TANGENTS AS LIMITS OF SECANT LINES

Slope is a measure of the steepness of a line and is defined as the increase (or decrease) in height per unit of movement along the horizontal axis. The slope of a straight line passing through the origin is determined by dividing the *Y* coordinate at any point on the line by the corresponding *X* coordinate. Using Δ (read *delta*) to designate change:

Slope = ΔY/ΔX

The marginal relation has a similar geometric association with the total curve. The slope of a nonlinear curve varies at every point on the curve. Slopes of nonlinear curves are typically found geometrically by drawing a line tangent to the curve at the point of interest and determining the slope of the tangent. A **tangent** is a line that touches but does not intersect a given curve. The basic problem that leads to differentiation is to compute the slope of a tangent line of the graph of a given function f at a given point *x*0. The key observation, which allows one to compute slopes of tangent lines, is that the tangent is a certain limit of secant lines as illustrated in the figure below. A secant line intersects the graph of a function f at two or more points. *x*=*x*0 and x=*x*0 + *h*. As h approaches 0, the secant line in question approaches the tangent line at the point (*x*0, f(*x*0)).



3.2.1. Differential Calculus

A marginal value is the change in a dependent variable associated with a 1– unit change in an independent variable. **If Y = f(X).** Using Δ to denote change, it is possible to express the change in the value of the independent variable, X, by the notation ΔX and the change in the dependent variable, Y, by ΔY. The ratio ΔY/ΔX is a general specification of the marginal concept. A derivative is a precise specification of marginal relation. A marginal value is the change in a dependant variable associated with a 1-unit change in an independent variable.

Marginal Y = ΔY/ ΔX

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Finding a derivative involves finding the value of the ratio ΔY/ ΔX for extremely small changes in X. In symbols: **dY/dX = Lim ΔY/ ΔX as ΔX → 0**

Lim of the slope of the Secant line as ΔX → 0 = slope of the Tangent The derivative of a function is a very precise measure of its slope or marginal value at a particular point. The terms derivative and marginal are interchangeable. Thus maxima or minima of a function occur where its derivative or marginal value is equal to zero. Geometrically, this corresponds to the point of graph, where the curve has zero slope.

RULES OF DIFFERENTIATION

1- Constant Function Rule: The derivative of a constant, Y = f(X) = a, is zero for all values of a
(the constant).

$$Y = f(X) = a$$

$$\frac{dY}{dX} = 0$$

2- Power Function Rule: The derivative of a power function, where a and b are constants, is defined as follows.

$$Y = f(X) = aX^b$$

$$\frac{dY}{dX} = b \cdot aX^{b-1}$$

3- Sum-and-Differences Rule: The derivative of the sum or difference of two functions, U and
V, is defined as follows.

$$U = g(X) \quad V = h(X) \quad Y = U \pm V$$

$$\frac{dY}{dX} = \frac{dU}{dX} \pm \frac{dV}{dX}$$

4- Product Rule: The derivative of the product of two functions, U and V, is defined as follows:

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$$U = g(X) \qquad V = h(X) \qquad Y = U \cdot V$$

$$\frac{dY}{dX} = U\frac{dV}{dX} + V\frac{dU}{dX}$$

5- Quotient Rule: The derivative of the ratio of two functions, U and V, is defined as follows:

$$U = g(X) \qquad V = h(X) \qquad Y = \frac{U}{V}$$

$$\frac{dY}{dX} = \frac{V\left(dU/dX\right) - U\left(dV/dX\right)}{V^2}$$

6- Chain Rule: The derivative of a function that is a function of X is defined as follows:

$$Y = f(U) \qquad U = g(X)$$

$$\frac{dY}{dX} = \frac{dY}{dU} \cdot \frac{dU}{dX}$$

DERIVATIVE OF A DERIVATIVE

Geometrically, the derivative refers to the slope of the function, while the second derivative refers to the *change* in the slope of the function. The value of the second derivative can thus be used to determine whether we have a maximum or a minimum at the point at which the first derivative (slope) is zero. The rule is *if the second derivative is positive, we have a minimum, and if the second derivative is negative, we have a maximum.*

Given objective function Y = f(X)

First Order Condition (F O C)

Find X such that dY/dX = 0

Second Order Condition (S O C)

If d2Y/dX2 > 0, then X is a minimum.

If d2Y/dX2 < 0, then X is a maximum.

EXAMPLE 1 MAXIMIZATION

Given the following total revenue (TR) function, determine the quantity of output (Q) that will maximize total revenue:

TR = 100Q – 10Q2

dTR /dQ = 100 – 20Q = 0

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Q* = 5 and d2TR/dQ2 = -20 < 0

EXAMPLE 2 MINIMIZATION

Given the following marginal cost function (MC), determine the quantity of output that will minimize MC:

MC = 3Q2 – 16Q + 57

dMC/dQ = 6Q - 16 = 0

Q* = 2.67 and d2MC/dQ2 = 6 > 0

MULTIVARIATE OPTIMIZATION

Objective function Y = f(X1, X2, X3)

Find all partials w.r.t X1, X2 & X3 & set them equal to zero

PARTIAL DERIVATIVE:

$\partial Y/\partial X1$ = dY/dX1 while keeping X2 and X3 constant. Partial derivatives follow the same pattern as

the rules that we have described for ordinary derivatives.

3.2.1.2. OPTIMIZATION OF MULTIVARIATE FUNCTIONS

Example 3

Determine the values of X and Y that maximize the following profit function:

$\pi = 80X – 2X2 – XY – 3Y2 + 100Y$

Solution

$\partial\pi/\partial X = 80 – 4X – Y = 0$

$\partial\pi/\partial Y = -X – 6Y + 100 = 0$

Solve simultaneously

X = 16.52 and Y = 13.92

$\pi = 80(16.52) – 2(16.52)2 – (16.52)(13.92) – 3(13.92)2 + 100(13.92)$

= $ 1,356.52

3.2.1.3. Constrained Optimization technique

Solution to economic problems frequently have to be found under constraints e.g. maximizing utility subject to a budget constraint or minimizing costs subject to production quota constraint. Managers frequently face constrained optimization problems, decision situations with limited choice alternatives. e.g.; marketing managers are assumed to maximize sales, subject to the constraint that they do not exceed a fixed advertising budget.

Mathematically, what the constraint does is to narrow down the domain, and hence the range of the objective function.

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STEPS IN CONSTRAINED OPTIMIZATION

• Define an objective mathematically as a function of one or more choice variables

• Define one or more constraints on the values of the objective function and/or the choice variables

• Determine the values of the choice variables that maximize or minimize the objective function while satisfying the constraint.

LAGRANGIAN METHOD

Form the Lagrangian function by adding the Lagrangian multiplier and constraint to the objective function and then optimize the Lagrangian function. The solution to the Lagrangian function will automatically satisfy the constraint.

Example 4: Lagrangian Method

Use the Lagrangian method to maximize the following profit function:

$\pi = 80X – 2X2 – XY – 3Y2 + 100Y$

Subject to the following constraint:

$X + Y = 12$ (output capacity constraint)

Set the constraint function equal to zero and obtain

$0 = 12 – X –Y$

Form the Lagrangian function

$L = 80X – 2X2 – XY – 3Y2 + 100Y + \lambda(12 - X - Y)$

Find the partial derivatives and solve simultaneously

$\partial L/\partial X = 80 – 4X –Y - \lambda = 0$ 1

$\partial L/ \partial Y = – X – 6Y + 100 - \lambda = 0$ 2

$\partial L/ \partial \lambda = 12 - X – Y = 0$ 3

Subtract Eq 2 from Eq 1, we get Eq 4

$- 3X + 5Y -20 = 0$ 4

Solution: $X = 5$, $Y = 7$, and $\lambda = 53$

Interpretation of the Lagrangian Multiplier, λ

The value of Lambda, λ, has an important economic interpretation. It is the marginal effect on the objective-function solution associated with a 1-unit change in the constraint. In our example, $\lambda = 53$, so a 1-unit increase in the output capacity constraint from 12 to 13 units will cause profit

to increase by approximately $53 i-e by λ times.

To generalize, a Lagrangian multiplier,λ, indicates the marginal effect of decreasing or increasing the constraint requirement by one unit. This will decrease or increase the optimal value of the objective-function by λ times. So it helps managers to evaluate the potential benefit or cost of relaxing constraints.

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🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Explain the concept of optimization		
Describe optimization rules		
Identify differentiation rules in decision making		
Explain the importance of constraints in decision making		
Apply the rule of constrained optimization in decision making		
Apply resource allocation by using optimization rules		

Summary

Optimization is a fundamental tool for the development of modern microeconomics analysis. Most economic models are based on the solution of optimization problems. Results of this subsection are used throughout the text. The basic optimization problem is that of maximizing or minimizing a function on some set. The basic and central result is the existence theorem of Weierstrass.

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CHAPTER FOUR
THEORY OF DEMAND AND ITS APPLICATION

Learning objectives;

Up on successful completion of this chapter students will be able to :

- ***Define demand in the context of managerial application***
- ***Identify the types of demand***
- ***Explain the component of demand function***
- ***Describe elasticity of demand and its application***

4.1. Meaning of Demand, Types of Demand and Demand function

Demand is one of the most important aspects of managerial economics, since a firm would not be established or survive if a sufficient demand for its product did not exist. That is, a firm could have the most efficient production techniques and the most effective management, but without a demand for its product, it simply would not survive. Many firms go out of business soon after being set up because their expectation of a sufficient demand for their products fails to come up, even with a great deal of advertising. Each year also sees many previously established and profitable firms close as a result of consumers shifting their purchases to different firms and products. Demand is, thus, essential for the creation, survival, and profitability of a firm.

Demand is the quantity of a good or service that customers are willing and able to purchase during a specified period under a given set of economic conditions. The time frame might be a month, or a year. Conditions to be considered include the price of the good in question, prices and availability of related goods, expectations of price changes, consumer incomes, consumer tastes and preferences, advertising expenditures, and so on.

For managerial decision making, a prime focus is on market demand. Market demand is the aggregate of individual demand Individual demand is determined by the value associated with getting and using any good or service and the ability to get it. Both are necessary for effective individual demand. Desire without purchasing power may lead to want, but not to demand.

4.1.1.Types of Demand

DIRECT DEMAND

There are two basic models of individual demand. One, known as the theory of consumer behavior, relates to the direct demand for personal consumption products. This model is appropriate for analyzing individual demand for goods and services that directly satisfy consumer desires. This is also labeled as consumer demand.

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DERIVED DEMAND

The outputs of engineers, production workers, managers, lawyers, consultants, office business Machines and natural resources are all examples of goods and services demanded not for direct consumption but rather for their use in providing other goods and services. Their demand is derived from the demand for the products they are used to provide. Input demand is called derived demand. This is also sometimes called business demand. The inputs purchased by a Business can be classified into raw materials, energy, labor, and capital, which may be substitutes or complements. .

LAW OF DEMAND

Holding all other things constant (*ceteris paribus*), there is an inverse relationship between the price of a good and the quantity of the good demanded per time period. It is often useful to examine the relationship between the quantity demanded of a commodity per, unit of time and the price of the commodity only. This can be achieved by assuming, for, the moment, that the individual's income, the price of related commodities, and tastes are unchanged. The inverse relationship between the price and the quantity demanded of the commodity per time period is then the individual's demand schedule for the commodity, and the plot of data (with price on the

vertical axis and the quantity on the horizontal axis) gives the corresponding individual's demand curve per time period at lower prices. The inverse relationship between the price of the commodity and the quantity demanded per time period is referred to as the law of demand.

COMPONENTS OF DEMAND

Substitution Effect

Income Effect

The reason for the negative slope of dX, or inverse relationship between PX and QdX, is not difficult to find. When PX falls, the quantity demanded of the commodity by the individual (QdX) increases because the individual substitutes in consumption, commodity X for other commodities (which are now relatively more expensive). This is called **the substitution effect**. In addition, when the price of a commodity falls, a consumer can purchase more of the commodity with a given money income (i.e., .his or her real income increases). This is called the

income effect. Thus, a fall in PX leads to an increase in QdX (so that dX is negatively sloped) because of the substitution effect and the income effect.

Assuming that *real income* is constant: If the *relative price* of a good rises, then consumers will try to substitute away from the good. Less will be purchased. If the *relative price* of a good falls,

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then consumers will try to substitute away from other goods. More will be purchased. The **substitution effect** is consistent with the law of demand. The *real value* of income is inversely related to the prices of goods. A change in the real value of income: will have a direct effect on quantity demanded if a good is normal and will have an inverse effect on quantity demanded if a good is inferior. The **income effect** is consistent with the law of demand only if a good is normal.

DEMAND CURVE DETERMINATION

Demand curve shows price and quantity relation holding everything else constant.

Change in quantity demanded or movements along the same demand curve

Quantity demanded falls if price rises.

Quantity demanded rises if price falls.

Role of Non-Price Variables

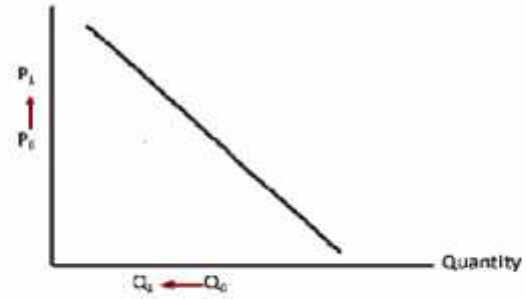
Change in non-price variables will define a new demand curve that is demand curve shifts upwards or downwards.

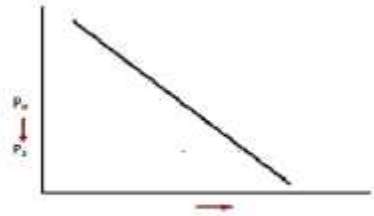
Demand increases if a non-price change allows more to be sold at every price.

Demand decreases if a non-price change causes less to be sold at every price.

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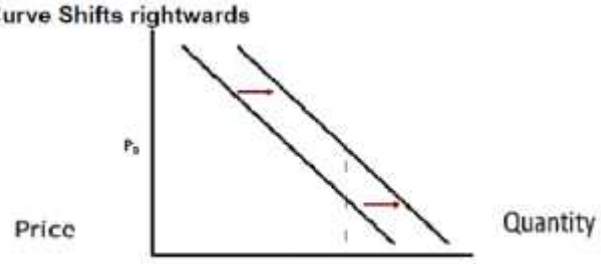
Movement along the same Demand curve '



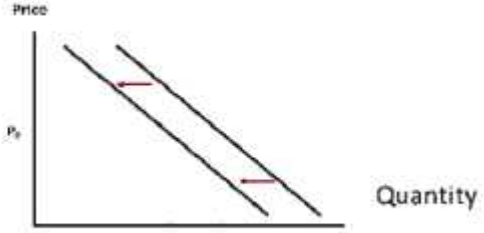


DEMAND SHIFTERS

Entire Demand Curve Shifts rightwards



Entire Demand Curve Shifts leftwards



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4.1.2. DEMAND FUNCTION

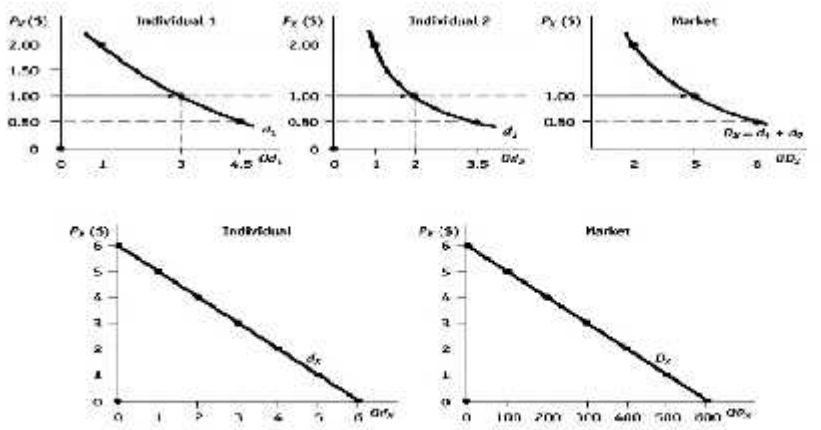
The demand for a commodity arises from the consumer's willingness and ability to purchase the commodity. Consumer demand theory assumes that the quantity demanded of a commodity is a function of, or depend on, the price of the commodity, the consumer's income, the price of related commodities, and the tastes of the consumer. In functional form, we can express this as:

$QD_X = f(P_X, N, I, P_Y, T)$,Where

QD_X = quantity demanded of commodity X
P_X = price per unit of commodity X
N = number of consumers on the market
I = consumer income
P_Y = price of related (substitute or complementary)commodity
T = consumer tastes

The market demand curve for a commodity is simply the horizontal summation of the demand curves of all the consumers in them market. For example, in the top part of the following figure, the market demand curve for commodity X is obtained by the horizontal summation of the demand curve of individual 1 (d1) and individual 2 (d2), on the assumption that they are the onlytwo consumers in the market. Thus, at P x = $1, the market quantity demanded of 5 units of commodity X is the sum of the 3 units of X demanded by individual 1 and the 2 units of X demanded by individual 2. If there were 100 individuals in the market instead, each with demand curve dX, the market demand curve for commodity X would be DX (see the bottom part of Figure). DX has the same shape as dX, but the horizontal scale refers to hundreds of units of commodity X. The market demand curve for a commodity shows the various quantities of the commodity demanded in the market per time period (QdX) at various alternative prices of the commodity, while holding everything else constant.

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In managerial economics we are primarily interested in the demand for a commodity faced by the firm. Since the analysis of the firm is central to managerial economics, we are primarily interested in the demand for a commodity faced by a firm. The demand for a commodity faced

by a particular firm depends on the size of the market or industry demand for the commodity, the form in which the industry is organized, and the number of firms in the industry. The demand for a firm's product also depends on the type of product that the firm sells. If the firm sells durable goods e.g., automobiles, washing machines, and refrigerators that provide services not only during the year when they are purchased but also in subsequent years, or goods that can be stored, the firm will generally face unstable demand than a firm selling nondurable goods. The reason is that consumers can run their cars, washing machines, or refrigerators a little longer by increasing their expenditures on maintenance and repairs, and they can postpone the purchase of a new unit until the economy improves and their income rises.

4.2. Elasticity of Demand, Importance of Elasticity Concept, Measuring Demand Elasticity

Dear learner can you explain demand in your own words? Support your answer with practical example?

_____

_____

_____

For useful managerial decision making, the firm must know the sensitivity or responsiveness of demand to changes in factors that make up the underlying demand function. One measure of responsiveness employed not only in demand analysis but throughout managerial decision making is **elasticity**, defined as the percentage change in a dependent variable, *Y*, resulting

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from a 1 percent change in the value of an independent variable, *X*. The equation for calculating
elasticity is:

$$E_p = \frac{\%\Delta \text{ Quantity}}{\%\Delta \text{ Price}}$$

POINT ELASTICITY AND ARC ELASTICITY

Elasticity can be measured in two different ways, point elasticity and arc elasticity. Elasticity measures sensitivity. Point elasticity shows sensitivity of Y to *small* changes in X. The most widely used elasticity measure is the **price elasticity of demand**, which measures the responsiveness of the quantity demanded to changes in the price of the product, holding constant the values of all other variables in the demand function.

$$\varepsilon_X = \partial Y/Y \div \partial X/X.$$

Arc elasticity shows sensitivity of Y to *big* changes in X.

$$E_X = \Delta Y/\Delta X * (X_2+X_1)/(Y_2+Y_1)$$

Elasticity Varies along Demand Curve:

- As price rises, so too does $|\varepsilon_P|$.
- As price falls, so too does $|\varepsilon_P|$.
- In all cases, $\varepsilon_P < 0$.

OPTIMAL PRICE FORMULA

Price elasticity estimates represent vital information because these data, along with relevant unit cost information, are essential inputs for setting a pricing policy that is consistent with value maximization. This stems from the fact that there is a relatively simple mathematical relation between marginal revenue, price, and the point price elasticity of demand. Given any point price elasticity estimate, relevant marginal revenues can be determined easily. When this marginal revenue information is combined with pertinent marginal cost data, the basis for an optimal pricing policy is derived.

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TR = P*Q
MR = dTR/dQ = dP*Q/dQ Applying the product rule of derivatives, we get:
= P + Q * dP/dQ
= P + P[Q/P * dp/dQ]
= P + P(1/E)
MR = P[1 + (1/E)]

Profit maximization requires that
MR = MC
P[1 + (1/E)] = MC
P = MC / P[1 + (1/E)] Optimal Price
MR and ε_P are directly related by the expression:

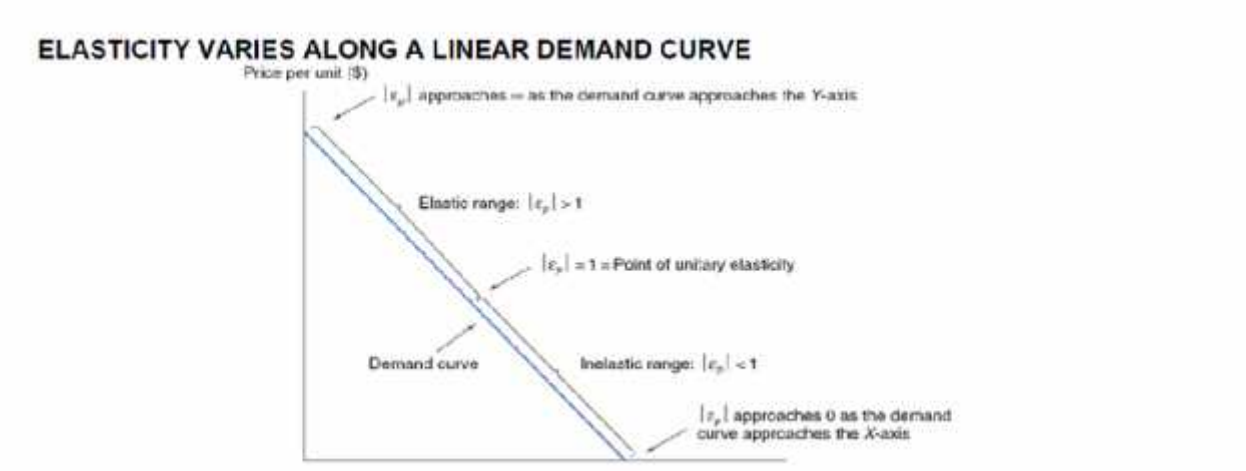
$MR = P/[1+(1/\varepsilon_P)]$.
Optimal $P^* = MC/[1+(1/\varepsilon_P)]$.

MARGINAL REVENUE, TOTAL REVENUE, AND PRICE ELASTICITY

There are simple, direct relations between price elasticity, marginal revenue, and total revenue. It is worth examining such relations in detail, given their importance for pricing policy. The relationship between price and revenue depends on elasticity. Why? By itself, a price fall will reduce receipts … BUT because the demand curve is downward sloping, the drop in price will also increase quantity demanded. The question is which effect will be stronger? One of the most important features of price elasticity is that it provides a useful summary measure of the effect of a price change on revenues. Depending on the degree of price elasticity, a reduction in price can increase, decrease, or leave total revenue unchanged. A good estimate of price elasticity makes it possible to accurately estimate the effect of price changes on total revenue. For decision- making purposes, three specific ranges of price elasticity have been identified.

- Price cut increases revenue if $|\varepsilon_P| > 1$.
- Revenue constant if $|\varepsilon_P| = 1$.
- Price cut decreases revenue if $|\varepsilon_P| < 1$.

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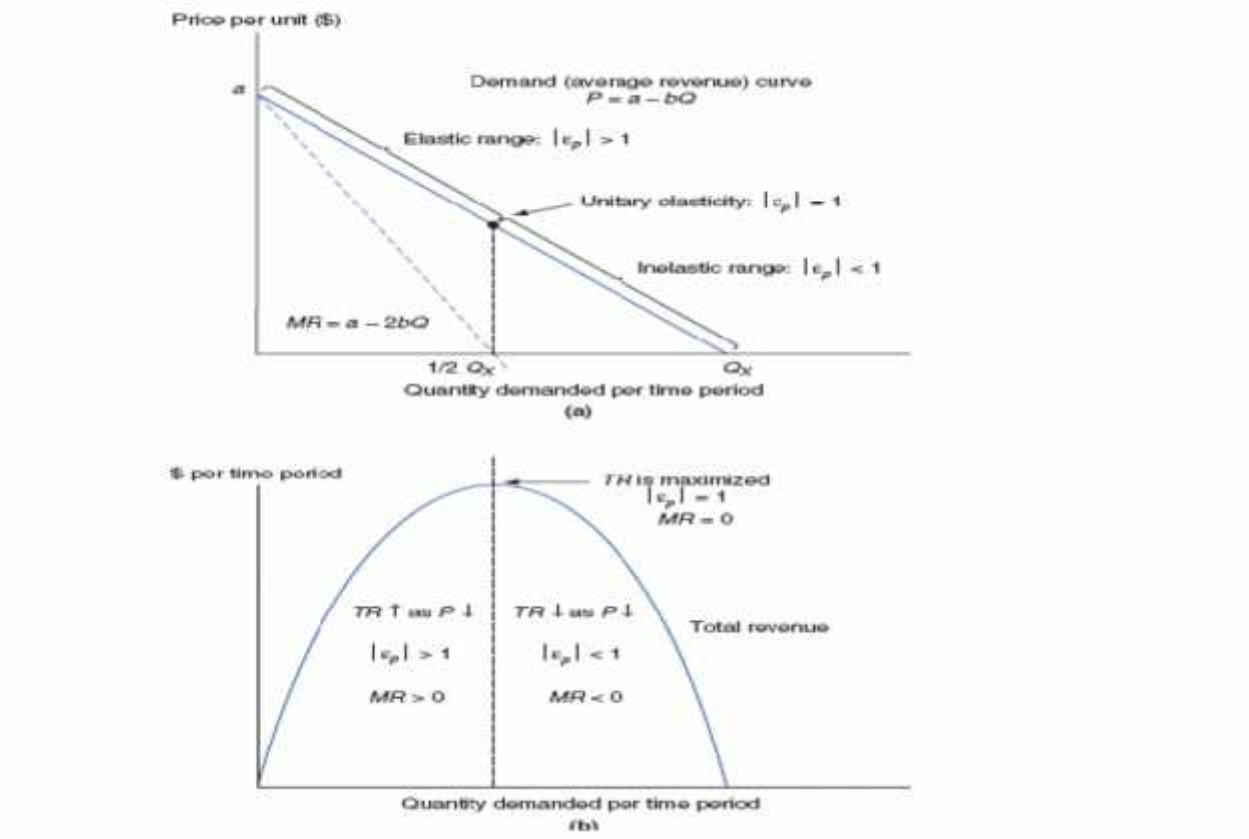


4.2.2.VARYING ELASTICITY AT DIFFERENT POINTS ON A DEMAND CURVE

All linear demand curves, except perfectly elastic or perfectly inelastic ones, are subject to varying elasticities at different points on the curve. In other words, any linear demand curve is price elastic at some output levels but inelastic at others.

- Relative elasticity of demand: $E_p > 1$
- Relative inelasticity of demand: $0 < E_p < 1$
- Unitary elasticity of demand: $E_p = 1$
- Perfect elasticity: $E_p = \infty$
- Perfect inelasticity: $E_p = 0$

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AS PRICE DECREASES

- revenue rises when demand is elastic
- revenue falls when it is inelastic
- revenue reaches its peak if elasticity =1

The lower chart shows the effect of elasticity on total revenue.

If P = AR = a – bQ (1)

TR = P*Q

= (a – bQ) * Q

= aQ – bQ2

Then MR = a – 2bQ (2)

The relation between the demand (average revenue) and marginal revenue curves becomes clear when one compares Equations (1) and (2). Each equation has the same intercept *a*. This means that both curves begin at the same point along the vertical price axis. However, the marginal revenue curve has twice the negative slope of the demand curve. This means that the marginal revenue curve intersects the horizontal axis at *1/2QX*, given that the demand curve intersects at *QX*. The above Figure(a) shows that marginal revenue is positive in the range where demand is price elastic, zero where Ep = –1, and negative in the inelastic range.

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Thus, there is an obvious relation between price elasticity and both average and marginal revenue. As shown in Figure (b), price elasticity is also closely related to total revenue.

CONSTANT PRICE ELASTICITY OF DEMAND

Some demand curves have **constant elasticity;** the Demand curve assumes the shape of a rectangular hyperbola (so that TR is constant regardless of price. Such a curve has a nonlinear equation:

$$Q = aP^{-b}$$

where $-b$ is the elasticity coefficient and equals to –b throughout the demand curve.

4.2.4.FACTORS AFFECTING THE PRICE ELASTICITY OF DEMAND

There are three major influences on price elasticities: (1) the extent to which a good is considered to be a necessity; (2) the availability of substitute goods to satisfy a given need; and (3) the proportion of income spent on the product. The size of the price elasticity of demand is larger the closer and the greater is the number of available substitutes for the commodity. For example, the demand for sugar is more price elastic than the demand for table salt because sugar has better and more substitutes (honey and saccharine) than salt. Thus, a given percentage increase in the price of sugar and salt elicits a larger percentage reduction per time period in the quantity demanded of sugar than of salt.

In general, the more narrowly a commodity is defined, the greater is its price elasticity of demand because the greater will be- the number of substitutes. For example, the price elasticity for Coke is much greater than the price elasticity for soft drinks in general and still larger than the price elasticity .of demand for all beverages. If a commodity is defined so that it has very close substitutes, its price elasticity of demand is likely to be large indeed and may be close to infinity. For example, if a producer of aspirin tried to increase the price above the general range of market prices for aspirin, he would lose a large portion of his sales as buyers can readily switch most of their purchases to competitors who sell similar products.

Similarly, the demand for “big ticket” items such as automobiles, homes, and vacation travel accounts for a large share of consumer income and will be relatively sensitive to price. Demand

for less expensive products, such as soft drinks, movies, and candy, can be relatively insensitive to price. Given the low percentage of income spent on “small ticket” items, consumers often find that searching for the best deal available is not worth the time and effort. Accordingly, the elasticity of demand is typically higher for major purchases than for small ones. The price elasticity of demand for CD players, for example, is higher than that for CDs.

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CROSS-PRICE ELASTICITY OF DEMAND

The demand for a commodity also depends on the price of related (i.e., substitute and complementary) commodities. On one hand, if the price of tea rises, the demand for coffee increases (i.e., shifts to the right, and more coffee is demanded at each coffee price) as consumers substitute coffee for tea in consumption. On the other hand, if the price of sugar (a complement of coffee) rises, the demand for coffee declines (shifts to the left so that less coffee is demanded at each, coffee price) because the price of a cup of coffee with sugar is now higher.

We can measure the responsiveness in the demand for commodity X to a change in the price of commodity Y with the cross price elasticity of demand (EXY). This is given by the percentage change in the demand for commodity X divided by the percentage change in the price of commodity, Y, holding constant all the other variables in the demand function, including income and the price of commodity X. As with price and income elasticities, we have point and arc cross-price elasticity of demand. Point cross price elasticity of demand is given by

$$\varepsilon_{PX} = \partial Q_Y / Q_Y \div \partial P_X / P_X.$$
$$\varepsilon_{PX} = \partial Q_Y / \partial P_X * P_X / Q_Y$$

If the value of EpX is positive, commodities X and Yare substitutes because an increase in PY leads to an increase in QX as X is substituted for Y in consumption. Examples of substitute commodities are coffee and tea, coffee and cocoa, butter and margarine, hamburgers and .hot dogs, Coca-Cola and Pepsi, and electricity and gas. On the other hand, if EXY is negative, commodities X and Y are complementary be cause an increase in PY leads to a reduction in QY
and QX. Examples of complementary commodities are coffee and sugar, coffee and cream, hamburgers and buns, hotdogs and mustard and cars and gasoline. The absolute value (i.e.,the value without the sign) of EXY measures the degree of substitutability and complementarity's between X and Y. For example, if the cross price elasticity of demand between coffee and tea is found to be larger than that between coffee and cocoa, this means that tea is a better substitute for coffee than cocoa. Finally, if EXY is close to zero, X and Yare independent commodities.

This may be the case with books and mutton, cars and muffins, pencils and potatoes, and so on. The cross price elasticity of demand is a very important concept in managerial decision making. Firms often use this concept to measure the effect of changing the price of a product they sell on the demand of other related products that the firm also sells. For example, the

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Indus Motors can use the cross-price elasticity of demand to measure the effect of changing the price of Toyotas on the demand for Hondas. Since Toyotas and Hondas are substitutes, lowering the price of the former will reduce the demand for the latter. However, a manufacture of both Lipstick and lip-liner can use cross-price elasticity of demand to measure the increase in the demand for Lipstick that would result if the firm reduced the price of lip-liner.

INCOME ELASTICITY OF DEMAND

For many goods, income is another important determinant of demand. Income is frequently as important as price, advertising expenditures, credit terms, or any other variable in the demand function. This is particularly true of luxury items such as big screen televisions, country club memberships, elegant homes, and so on. In contrast, the demand for such basic commodities as salt, bread, and milk is not very responsive to income changes. These goods are bought in fairly constant amounts regardless of changes in income. Of course, income can be measured in many ways—for example, on a per capita, per household or aggregate basis. Gross national product, national income, personal income, and disposable personal income have all served as income measures in demand studies.

NORMAL VERSUS INFERIOR GOODS

The **income elasticity** of demand measures the responsiveness of demand to changes in income, holding constant the effect of all other variables that influence demand. Income and the quantity purchased typically move in the same direction; that is, income and sales are directly rather than inversely related.

$\varepsilon I = \partial Q/Q \div \partial I/I.$

Normal goods have $\varepsilon I > 0$.

Inferior goods have $\varepsilon I < 0$.

This does not hold for a limited number of products termed **inferior goods**. Individual consumer demand for such products as beans and potatoes, for example, is sometimes thought to decline as income increases, because consumers replace them with more desirable alternatives. More typical products, whose individual and aggregate demand is positively related to income, are defined as **normal goods**.

One important use of the income elasticity of demand is in forecasting the change in the demand for the commodity that a firm sells under different economic conditions. On one hand, the demand, for a commodity with low-income elasticity will not be greatly affected (i.e., will not fluctuate very much) as a result of boom conditions or recession in the economy. On the other hand, the demand for a luxury item such as vacations in the Murree Hills or Swat, will increase very much when the economy is booming and fall sharply during recessionary periods.

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4.3. Elasticity applications

Dear learner can you mention the use of elasticity in managerial decision making?

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Elasticities are also used in production and cost analysis to evaluate the effects of changes in input on output as well as the effects of output changes on costs. Factors such as price and advertising that are within the control of the firm are called **endogenous variables**. It is important that management know the effects of altering these variables when making decisions. Other important factors outside the control of the firm, such as consumer incomes, competitor prices, and the weather, are called **exogenous variables**. The effects of changes in both types of influences must be understood if the firm is to respond effectively to changes in the economic environment. For example, a firm must understand the effects on demand of changes in both prices and consumer incomes to determine the price cut necessary to offset a decline in sales caused by a business recession (fall in income). Similarly, the sensitivity of demand to changes in advertising must be quantified if the firm is to respond appropriately with price or advertising
changes to an increase in competitor advertising.

Thus, the firm should first identify all the important variables that affect the demand for the product it sells. Then the firm should obtain variable estimates of the marginal effect of a change in each variable on demand. The, firm would use this information to estimate the elasticity of demand for the product it sells with respect to each of the variables in the demand function.

These are essential for optimal managerial decisions in the short run and in planning for growth
in the long run.
For example, suppose that the ABC Company markets coffee brand X and, estimated the following regression of the demand for its brand of coffee:

QX = 1.5 - 3.0PX + 0.8I + 2.0PY - 0.6PS -1.2A

Where QX = sales of coffee brand X in the United States, in millions' of pounds per year
PX = price of coffee brand X, in dollars per pound
I = personal disposable income, in trillions of dollars per year
PY = price of the competitive brand of coffee, in dollars per pound
Ps = price of sugar, in dollars per pound

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A = advertising expenditures for coffee brand X, in hundreds of thousands of dollars per year Suppose also that this year, PX = $2, I = $2.5, PY = $1.80, PS- $0.50, and A = $1. Substituting these values into Equation, we obtain.

QX = 1.5 - 3(2)+ 0.8(2.5) + 2(1.80) - 0.6(0.50) + 1.2(1) = 2

Thus, this year the firm would sell 2 'million pounds of coffee brand X., The firm can use this information to find the elasticity of the demand for coffee brand X with respect to its price, income, the price of competitive coffee brand Y, the price of sugar, and advertising. So that:

Ep = -3[2/2] = -3

EI = 0.8[2.5/2] = 1

Exy = 2[1.8/2] = 1.8

Exs = -0.6[0.5/2] = -0.15

EA = 1.2[1/2] = 0.6

4.3.1. Revenue and Elasticity

The **slope** of the own-price demand curve, Q/ P, contains some information which may be useful to the management of the enterprise. It may be interpreted as the number of units by which quantity sold can be expected to change in response to a change in the price of the item, given all other determinants of demand. If the management is interested in nothing more than predicting the number of additional units which can be sold by changing price, the slope of the own-price demand curve is an entirely adequate decision criterion. However, if the management is concerned about profitability or one of its components, the revenue generated in selling the item, the simple slope of the own-price demand curve is an inadequate decision criterion. The reason for its inadequacy is that the slope of a linear own-price demand curve never changes over its entire positive-price range, but, as became apparent in the previous chapter, **total revenue** does differ from one point to another along the demand curve.

Even if the slope of the demand curve does change because it is not linear, the simple slope still fails to convey information about how the revenue of the firm changes consequent upon a price change. A more useful revenue-oriented decision criterion can be constructed by computing the ratio of the percentage change of quantity demanded to the percentage change in the price which resulted in the quantity change, or % Q / % P.

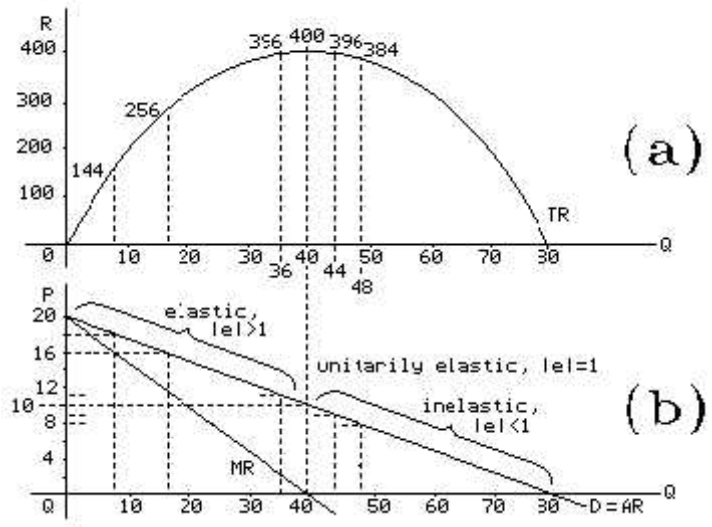
Economists refer to this ratio as the **own-price elasticity of demand**, and they interpret it as a measure of the sensitivity (or responsiveness) of quantity demanded to a change in the item's own price. The revenue-related importance of the own-price elasticity can be illustrated by demand equation Qx = 80 - 4Px, which is graphed in Figure C2-1. The linear demand curve has been divided into ranges indicated by brackets. The upper portion of the demand curve, from price of $20 down to $10, is labeled the **elastic range**. It is characterized by positive marginal revenues and elasticity ratios (absolute values) greater than unity. The lower portion of the demand curve, from price $10 down to $0, is labeled the **inelastic range**. It is characterized by negative marginal revenues and fractional elasticity ratios

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(again, absolute values). The midpoint of the linear demand curve (at price $10) is labeled the **unitarily elastic** point because the absolute value of the demand elasticity ratio is precisely 1.0 at this point. Demand at the unitarily elastic point is also characterized by zero marginal revenue.

Figure C2-1. Demand, Revenue, and Elasticity for $Q_x=80 - 4P_x$.

Figure C2-1.



In the elastic range of the demand curve, any particular percentage decrease of price will result in a larger percentage increase of quantity demanded. Thus, what is lost to revenue by cutting price is more than made up for in increased quantity sold, so total revenue increases. For example, if price is lowered from $18 to $16, quantity demanded will increase from 8 units to 16 units, and total revenue will increase from $144 to $256. Price fell by 11 percent, but this was more than made up for by a 100 percent increase in quantity sold.

However, in the elastic range of the demand curve, any particular percentage increase of price will result in a larger-percentage decrease of quantity demanded, thus causing a decrease of total revenue. In this case, what is gained in raising the price is more than offset by the loss in quantity sold. Thus, if the manager can verify that the enterprise is presently selling the item at a point in the elastic range of the demand curve, the appropriate direction in which to change price in order to increase revenue is down.

The opposite conclusions emerge for the inelastic range of the demand curve. A price cut in the inelastic range will result in an increase of quantity demanded, albeit one of a smaller percentage magnitude, so that total revenue can be expected to decrease. If the objective is to increase revenue, price should be raised because a smaller-percentage decrease in quantity demanded will result. In the example illustrated in Figure C2-1, a price cut from $9 to $8 will result in an increase of quantity sold from 44 to 48 units, but a decrease of total revenue from $396 to $384.

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Small percentage changes of price in the near neighborhood of the unitarily elastic point of the demand curve will be offset by the same percentage changes of quantity demanded (but in the opposite direction), thereby leaving revenue unchanged. In our example, if price is raised from $9 to $11, quantity demanded will fall from 44 to 36 units, leaving total revenue unchanged at $396.

If the enterprise were to progressively lower price, moving down the demand curve from its intercept with the price axis toward its intercept with the quantity axis, total revenue would increase to a maximum (at the unitarily elastic point), and then decrease; concurrently, marginal revenue would decrease from positive values, through zero (at the unitarily elastic point), to negative values. And, elasticity would fall from (absolute) values greater than unity to (absolute) values less than unity.

The significance of own-price elasticity of demand is that it is indicative of what is likely to happen to the enterprise's revenues when it changes the price of an item which it sells. Enterprise managers may not explicitly compute elasticity ratios, and they may not use the term elasticity of demand. However, we may infer that they must have employed an elasticity thought process in making a rational decision to change price if their enterprises have survived and are profitable.

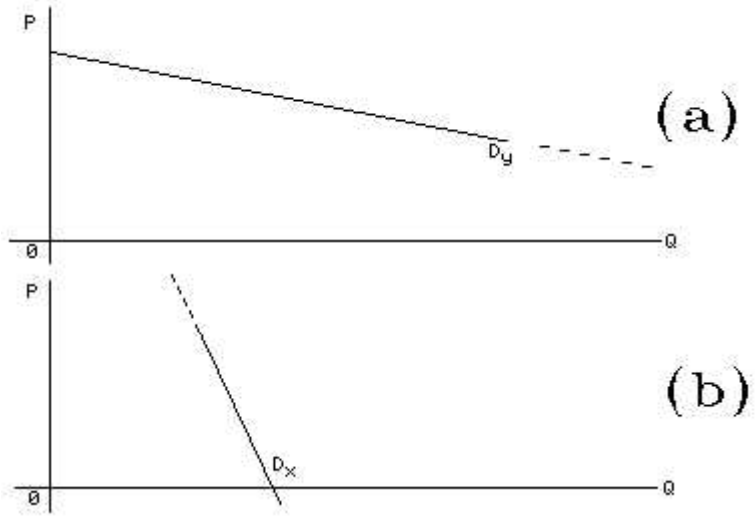
To this point we have assumed that the demand curve is linear, but only for purposes of simplicity. Since only one point on a demand curve exists at any moment (all other points are only hypothetical or virtual), it can be argued that the shape of the demand curve away from the extant point (whether curved, bent, kinked, etc.) is really a non-issue. But, even if the demand curve is curvilinear, all of the elasticity formulas introduced in this chapter can be applied to compute or estimate the elasticity of demand. Graphically, whether demand is elastic or inelastic at a particular point on a non-linear demand curve can be discerned by observing the characteristics of a tangent drawn to the curve at the point.

The demand curve for an item may take any slope, although a negative slope is expected according to the law of demand. Negatively-sloped demand curves which approach the vertical, as illustrated in panel (b) of Figure C2-2, are often said to be "inelastic demand curves." It would be more accurate to note that the relevant price range spans only the inelastic portion of the demand curve. There is an elastic range (off the vertical axis scale), but it is irrelevant under current pricing conventions. We should also note that the marginal revenues associated with points on the visible portion of this demand curve are all negative. This point is important because it is not possible for an enterprise to reach a profit maximizing equilibrium in the inelastic range of its demand curve since its marginal cost can never be negative.

Figure C2-2. "Elastic" and "inelastic" demand curves.

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Figure C2-2.



A similar consideration should also be noted in regard to demand curves with very shallow slopes, approaching the horizontal, as illustrated in panel (a) of Figure C2-2. While such demand curves are often described as being "highly elastic," it would be more accurate to say that the relevant quantity range encompasses only the elastic range of the demand curve. There is an inelastic range, but only at quantities which are unattainable under current market and supply conditions. Marginal revenues associated with elastic points on such shallowly sloped demand curves will be positive, and thus can accommodate a profit-maximizing equilibrium solution for the enterprise.

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Define demand and types of demand		
Describe elasticity of demand		
Explain factors that affect demand		
Explain the managerial implication of elasticity of demand		
Describes reasons for dealing with marginal analysis and demand elasticity		
Describe estimation elasticity		

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Summary

The computed income elasticity of demand for a **normal good** is expected to be positive, while that for an **inferior good** is expected to be negative. But conclusions should never be assumed before conducting empirical research. From this perspective, a computed positive income elasticity of demand ratio may be taken as the basis for an inference that the item is a normal good; likewise, a computed negative income elasticity ratio implies that the item is an inferior good. But even if the item is deemed normal, the value of the elasticity ratio may contain useful information. Positive income elasticities less than unity imply that the demand for the item is **relatively inelastic** (i.e., unresponsive) with respect to income changes. Income elasticities greater than unity suggest that the demand for the item is **relatively elastic** with respect to income changes. The reader is invited to review the earlier section of this chapter which suggested reasons for managerial preferences to produce normal and inferior goods.

The management of the firm may have chosen to take an aggressive approach to the demand for its item by mounting a promotional effort. The relevant question in this regard is whether the demand for the item is elastic with respect to the promotional expenditure (e.g., the advertising budget for a particular medium).

The management might be pleased to find a positive advertising elasticity ratio greater than unity. The reader is left to imagine the management's reactions to advertising elasticity ratios less than unity (or, heaven forbid, negative!).

Finally, we consider the sense of the so-called **cross** (or cross-price) elasticity of demand ratio. This term may be understood in comparison with the term "own-price" elasticity of demand. A **cross-price demand curve** shows the graphic relationship between the quantity demanded of one item, say x, relative to the price of another item, y or z. As noted earlier, y and z may refer to substitutes and complements, respectively, for x.

The sign of the **substitute** cross elasticity ratio is expected to be **positive**: when the price of y rises, less of y will be demanded, but more of its substitute x will be demanded. And the sign of the **complement** cross elasticity ratio is expected to be **negative**. Again, neither substitutability nor complementarities should be assumed; empirical evidence should be compiled to reveal whether two goods appear to be substitutes or complements, and the magnitudes of the computed ratios (in absolute value, greater or lesser than unity) should indicate how good or strong is the relationship. The substitute cross elasticity ratio has been proposed as an index of the ability of a competitor to **penetrate the market** of the enterprise by cutting price (or the ability of the enterprise to insulate itself from competitor's price changes).

We have now considered the managerial implications of own-price, cross-price, income, and advertising elasticity of demand. The principles underlying these concepts are applicable to demand elasticities of yet other determinants which have not been specified. Each item can

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be expected to have a set of demand determinants which are specific to it, and which may not be pertinent to many or any other items.

While demand elasticity can be computed for any demand determinant for which sufficient information is available, we do not mean to suggest that successful managers must make explicit demand elasticity computations before each and every demand decision. Rather, the concept of demand elasticity is the economist's explanation of a thought process through which the successful manager must have passed in making the decisions which resulted in the success of the enterprise. Whether or not any demand elasticity ratio has been computed, the manager has to have asked the question of whether a contemplated demand determinant change is likely to result in a larger or smaller percentage change in the quantity demanded of the item. We shall subsequently discover that the elasticity concept can be extended into the realm of supply, production, and cost.

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CHAPTER FIVE
DECISION MAKING UNDER RISK AND UNCERTAINTY

Learning objectives;

Up on successful completion of this chapter students will be able to

- Define decision making
- Identify types of managerial decision situations
- Describe the nature of risk
- Explain the relationship between risk and expected value of an investment

Introduction

Managerial economics is about the criteria for rational decision making by managers of business enterprises. The criteria elaborated here for business enterprises can also be applied to non-commercial decision settings, including government agencies, eleemosynary institutions, the home, and one's personal life. Before we precede to an examination of these decision criteria, we shall review the essential economic nature of decision making in order to establish the fundamental principles upon which decision criteria may be based.

As noted in a first Principles of Economics course, the world is characterized by scarcity rather than abundance. Human beings need certain things for survival, and they want to possess or consume a much larger variety of amenities. If all of these things were abundantly available, each person could simply gather as much as he or she wished, and still leave enough for everyone else to do likewise. Managerial decision making would require little more than determining the time sequence of acquisition.

In regard to most of the things that humans consume, scarcity is the rule and abundance is the exception. A scarcity of something means that the total of human wants for it exceeds the quantity of it available for human consumption. As a result, one person simply cannot take all that he or she might want without consequences for other persons. Something may be said to be scarce when its price exceeds zero (P greater than 0). The price may be expressed and paid in non-pecuniary terms as well as in money. There are a few things that have essentially zero prices, e.g., common air and the water available from a water fountain.[1]

We must make qualifications in regard to each of these examples. If someone wishes to breathe air of any particular quality or purity, he or she will have to go to some lengths to acquire it, and such pure air then is not a so-called "free good." The water that any one of us can "freely" drink from a water fountain does in fact cost the larger society of which the drinker is a member something to acquire it, to transport it to the site, and to cool it to a desirable temperature.

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Some other things are available in greater quantities than people wish to consume. The quantities of such items so exceed simple abundance that their effective prices are negative (P less than 0). People would not pay positive prices to acquire more of such things, but they might be willing to pay others to get rid of them. Such superabundance's may be regarded as nuisance goods (an obvious contradiction in terms), or "bads." Examples include garbage, sewage, and any of the other kinds of environmental pollutants that have become troublesome.

It is because of scarcity that humans have to make choices. The "economic problem" is the juxtaposition of productive resource scarcity against human want insatiability. In attempting to resolve the economic problem, humans must make choices in how to use their scarce resources as efficiently as possible in the satisfaction of human wants. Making choices is the essence of decision making, and making decisions is the central function of management. The management of any human activity is ultimately an exercise in economizing. Managerial economics focuses upon the criteria for making rational economic decisions in regard to the use of scarce resources.

5.1. The Nature of Decision Making

Managers may make a myriad of decisions every day. Some of the decisions are trivial in the sense that the consequences of them do not matter very much. The consequences of other decisions, for example, what employee health insurance plan to adopt or whether to add or drop a product line from the company's product mix may be monumental.

We shall assume as an operating premise that human beings are basically interested in their own welfare. Rational human behavior consists of trying to maximize the value of some positive quantity, or to minimize the value of something perceived as having negative connotations. Although human nature is culturally influenced, we shall also presume that human beings are more-or-less materialistic, i.e., more is better than less, and hedonistic, i.e., that pain and displeasure are to be avoided or minimized.

Human approaches to decisions may be categorized as capriciousness, conditioned response, and deliberate, reasoned choice. The more trivial the consequences of the decision, the less time and effort are devoted to the decision process. Sometimes people seem to act without engaging in any apparent decision-making process. The choices underlying such actions may have been nearly automatic, based upon an implicit summing-up of the current circumstance compared with the decision maker's accumulated stock of past experiences under similar circumstances. Occasionally, however, human beings indulge themselves in a capricious action (an act without deliberate choice), even when the consequences may be non-trivial. If a capricious action constitutes a "bad" decision, the actor must suffer the consequences.

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5.1.1. Dimensions of the Decision Problem

Multiple Goals. The decision maker may be confronted with a multiplicity of goals. Since it is technically not possible to try to maximize simultaneously the values of multiple conflicting goals, the decision maker has to choose one of the goals for primary pursuit. The other goals, expressed as minimum or maximum acceptable values, can then be regarded as constraints on the pursuit of the primary goal. The object of the decision is to maximize the value of the primary goal, subject to realization of satisfactory levels of subordinate goals. The mathematical modeling problems and possibilities with respect to multiple goals are elaborated in Chapter 2.

Multiple Strategies. With respect to any single goal, a decision involves multiple possible courses of action, or strategies. If there were no alternatives, no decision would be required other than selecting the goal for pursuit. The deliberate approach to decision making involves the identification of all possible courses of action and the benefits and costs likely to result from each of the alternatives. The rational choice is the alternative that yields the greatest relative positives or the largest sum of net benefits (positives less negatives), given the decision maker's set of preferences.

Marginal Changes. In many cases, the choices are not mutually-exclusive alternative courses of action; rather they involve more or less of the same course of action. The range of possible alternatives includes larger or smaller quantities to be selected. Typically, the decision problem is to select some quantity that is an alternative to the present one. Assuming that the alternative quantities are arrayed from smallest to largest, or vice-versa, choosing to shift from one to another involves additions to or subtractions from benefits or costs. Economists speak of such additions and subtractions as incremental changes, or marginal changes if they are the smallest possible changes that can be made. The rational choice in such cases is to make a quantitative change that will yield the greatest marginal benefit relative to marginal cost.

5. 2.Risk and Expected values of an Investment

Multiple Outcomes. Often the possible alternative courses of action can be identified, but each decision alternative may have several outcome possibilities. If the decision maker can in some meaningful sense assess the probability, p, of the occurrence of each possible outcome, V, for each of the alternative courses of action, he may then compute the expected value of each alternative. The expected value is a probability-weighted average of the possible outcomes for each decision alternative,

(1) $EV = p_1V_1 + p_2V_2 + ... + p_kV_k,$ or

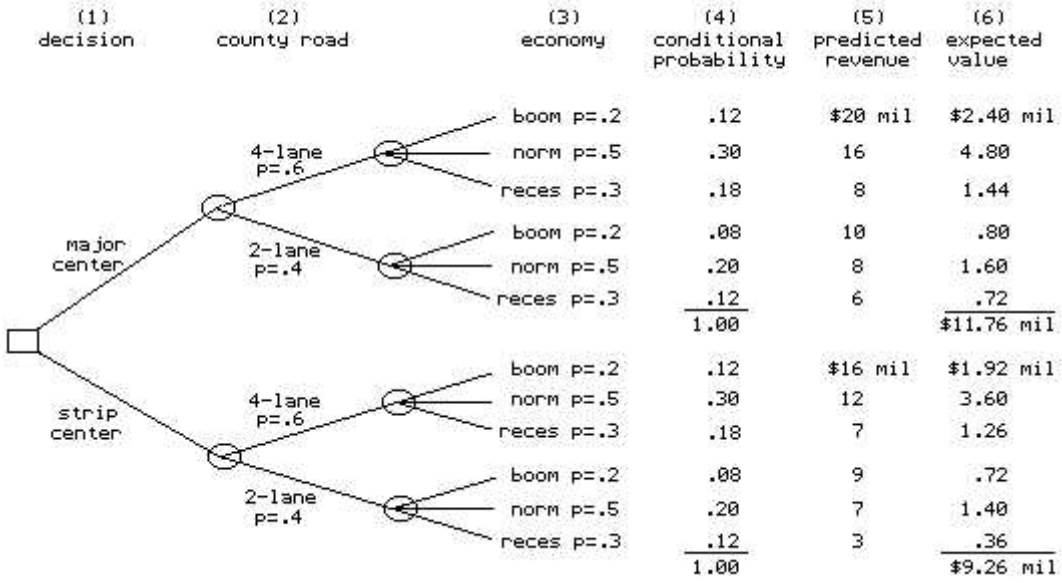
(1') $EV = \sum_{j=1,k} (p_jV_j),$

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Where EV is the expected value of the alternative, p is the probability of the outcome V for each of the k possible outcomes of the alternative. The presumption here is that the sum of the probabilities of the possible outcomes is 1.0. Each outcome may itself be a net difference between benefit (b) and cost (c), or V = b - c. Other things remaining the same, the rational decision then is the choice of the alternative that promises the largest expected value of possible outcomes.

An extension of the expected value concept may be employed in decision situations that unfold in stages such that subsequent stages depend upon what happens in previous stages. In such cases, the probability of occurrence of an ultimate outcome is a conditional probability, i.e., the product of the probabilities of the final outcome and all prior stages. Such a situation can best be visualized with a "decision tree," an example of which is illustrated in Figure A1-1. In this hypothetical situation the decision maker has to decide whether to develop a major shopping center anchored by two department stores, or a small strip shopping center with no department stores. In Figure A1-1, the decision point is represented by the box on the left side of the tree. The circles in the diagram indicate non-decision outcome branches. There is a 60 percent chance that if a major center is built, the county will construct a 4-lane approach road to the center, but a 40 percent chance that the existing 2-lane road will have to do. But if a small strip is constructed, there is only a 20 percent

Figure A1-1. Conditional probabilities in a decision tree.



chance of construction of a 4-lane. Beyond the estimated completion of the project, there is a 20 percent chance that the economy will boom, a 50 percent chance of normal economic conditions, and a 30 percent chance of recession.

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The expected values of the decision branches may be computed from the information in columns (4) through (6) of Figure A1-1. Column (4) shows the conditional probabilities computed as the products of the probabilities of conditions along the branches to the respective stems of the tree; the sum of the probabilities for each decision branch is 100 percent. Column (5) contains the best available estimates of the first-year revenue flows that will occur under the different conditions. Column (6) reveals the expected values of the first-year revenue flows. The sum of the expected values of the revenue flows for each branch reveals the expected value (a conditional probability-weighted average of the outcomes) of each of the respective decision branches. Real-world decision settings may be far more complicated than illustrated in this example, and may involve multiple decision points as well numerous states of nature. Other things remaining the same, the decision branch with the largest expected value is the decision choice.

Risk. Other things may not be the same, however, if the range of outcome variability differs from one alternative to another. It is typical for decision alternatives to have different expected values, but even if two decision alternatives have approximately the same expected values, one may have a wider range of possible outcome variability than the other. Risk is inherent in the dispersion of possible outcomes about the mean of all such outcomes. To illustrate, suppose that decision alternatives A and B may each result in any of five possible outcomes with probabilities of occurrence as indicated in Table A1-1. It is readily apparent that the possible outcomes for alternative A span a narrower range than do those of alternative B even though each has an expected value of $900. Figure A1-2 employs bar-charts in panel (a) to illustrate the probability distributions of the outcomes of the two alternatives. A common measure of risk associated with a decision alternative is the standard deviation (sigma) of the alternative's possible outcomes,

$$= [\ _{j=1,k}\ (V_j - EV)^2 p_j]^{1/2}.$$

The justification for using the standard deviation as a measure of risk is the assumption that outcome probability distributions tend to be normally distributed about their means as illustrated by the smooth probability distribution curves drawn in panel

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Table A1-1. Probable outcomes of two possible decision alternatives.

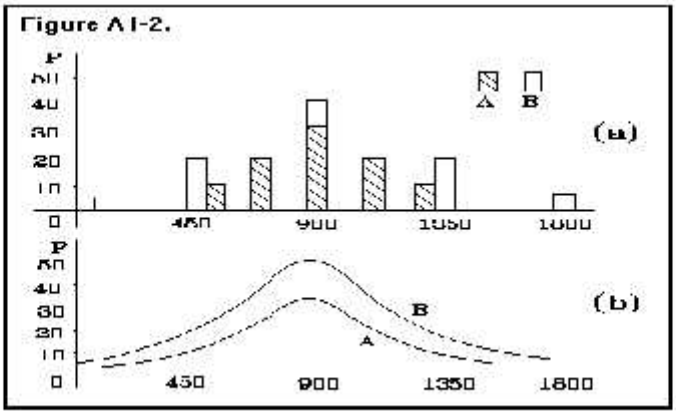
	Possible outcomes	Prob of Occurrence
Alternative A:	$500	10 percent
	650	20
	900	40
	1150	20
	1300	10
Alternative B:	0	5
	450	20
	900	50
	1350	20
	1800	5

(b) of Figure A1-2. If this assumption is valid, then the mean of the distribution plus and minus (one / two / three) standard deviations contains (68.26 / 95.44 / 99.74) percent of the outcomes in the distribution. The decision alternative with the wider range of outcome variability, i.e., greater standard deviation, is said to be the riskier of the two. If the expected values are equal, the lower-risk decision alternative would be preferred by most people. Since $_A$ is only 238.7 while $_B$ is 402.5, alternative A is the lower-risk alternative.

However, when the expected values of two decision alternatives differ substantially, so also will their standard deviations be of different magnitudes, and will therefore not serve as a reliable basis for comparing risks. In such cases, the decision maker may compute a coefficient of variation, v, for each decision alternative, where v is the ratio of the standard deviation to its respective expected value, v = / EV.
The decision alternative with the smaller coefficient of variation is the less-risky alternative. It is not uncommon for a decision alternative with a higher expected value of outcomes to also be riskier in the sense of having a wider range of outcome possibilities. In addition to assessing the riskiness of the decision alternatives, the decision maker must also be able to rationally make comparisons of the expected values of outcomes (or returns) in light of

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Figure A1-2. Probability distributions of two decision alternatives.



Their comparative risks. Since a decision maker might be willing to trade off risk for return (i.e., expected value), he must be able to decide whether the higher expected value of a decision alternative is adequate compensation for the additional risk that must be assumed. Theoretically, a preference function relating satisfaction (or utility) to any pair of desirable goods (or phenomena) may be constructed for a decision maker. Practically, the specification of such a preference function is difficult if not impossible to achieve. A functional notation representation of such a preference function might appear as

U = f(V,(1-) / ...),

where U is the amount of utility realized by the decision maker, V is the value of the return from a decision alternative, and sigma indicates the risk associated with the opportunity. The argument (1-sigma) is the complement of the amount of risk incurred, or the degree of certainty that a particular outcome within the range of all such possible outcomes will occur. Graphically, such a preference function for a normal decision maker might appear as depicted in Figure A1-3. Risk (degree of uncertainty) and return occupy the floor axes of the three-dimensional graph; utility is measured in the vertical dimension. The right-hand side of the utility surface can be identified because the degree of certainty reaches a maximum, i.e., the degree of risk approaches zero. But the left-hand end of the risk-certainty axis cannot be specified since risk may increase without bound. The utility surface may be "sliced" parallel to the floor and at any altitude of utility. Four such slices are illustrated in Figure A1-3, and their vertical projections down into the floor of the surface have been drawn. These projections constitute so-called "indifference curves" for the two phenomena represented on the floor axes, i.e., return and degree of certainty. Any number of such indifference curves may be constructed by slicing the utility surface at any chosen utility altitudes.

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5.2. 2.Risk and Probability Distributions

Decision makers' **attitudes toward risk** may vary widely. People who have strong preferences for risk assumption may turn out to be chronic gamblers. Such people get their "kicks" from accepting adverse-odds bets (long shots) with negative expected values. Even though the odds are against them, it is more intellectually satisfying to them to win "big" on rare occasions than to gain small sums more frequently on favorable-odds bets. **Risk preferrers** are likely to lose (on net balance) over the long run. Luckily for society (and themselves), they are in the minority. It is theoretically possible for a decision maker to be essentially **risk-neutral**, having neither preference for nor aversion toward risk. However, this is such a "razor's edge" state that few people find themselves there.

The vast majority of all people who regard themselves as rational thinkers are **risk-averse**, and the more extreme of them are **risk avoiders** (they expect bad things to happen to them each morning as soon as they get out of bed). A normally risk-averse decision maker likely would not accept an even-odds bet on a two-possibility event (50 percent chance each way) because the loss of the sum at risk would mean more to them (negatively) than would the gain of an identical sum would mean to them (positively). It is likely that most business decision makers, who tend to be a conservative lot, are risk averse. This does not mean that they seek to avoid risk altogether (if so they would not behave as entrepreneurs); rather, they attempt to **manage risk** by seeking more information in order to diminish it, by attempting to take offsetting positions, or by attempting to insure against the risk.

If it were practical to specify **personal utility functions** for decision makers, it would be possible to include the decision maker's attitude toward risk as an argument (i.e., one of the independent variables) in the function. We might find the risk preferrer to "consume" risky items under conditions of increasing marginal utility, the risk-indifferent decision maker to exhibit a linear risk utility function, and one who is averse to risk to experience diminishing marginal utility with respect to risk.

5.3. Approaches of incorporating Risk into Decision Making Process

A first approach to dealing with risk is to seek **more information** about the decision alternative. Additional information often reveals that the range of outcome variability is narrower than at first thought, and that the decision alternative is thus less risky than earlier imagined. But information itself is a **scarce resource** which is costly to acquire. The determination to acquire additional information is a managerial decision which is based on a comparison of the benefits of the additional information relative to the cost of acquiring it. At some point, the benefits of acquiring additional information must be judged as not outweighing the costs, and the decision must be made under conditions of uncertainty or risk. The decision maker must then find some way to deal with (i.e., manage) the remaining risk, possibly by insuring against it, offsetting it (possibly by hedging), or by simply accepting it.

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One of the essential functions of an entrepreneur is to assume risk in undertaking new ventures or in changing the operation of the enterprise.

Since it has not been found practical to specify utility functions, we shall take a more intuitive approach to how decision makers might deal with risk.
A potentially useful concept for short-run decision analysis is that of the **certainty equivalent**. In this approach, the decision maker must ask himself what certain sum he would be willing to accept in lieu of the risky outcome at issue. The **risk-averse** decision maker can be expected to indicate a **lesser certain sum** than the risky possibility ("a bird in the hand is worth two in the bush"), whereas the **risk preferrer** would have to have a **larger certain sum** as a compensation for the insult of removing the gamble from his consideration. The certainty equivalent, CE, of the risky outcome, EV, is then substituted in the numerators of the ratios in the expected value (1) and present value (2) formulas:

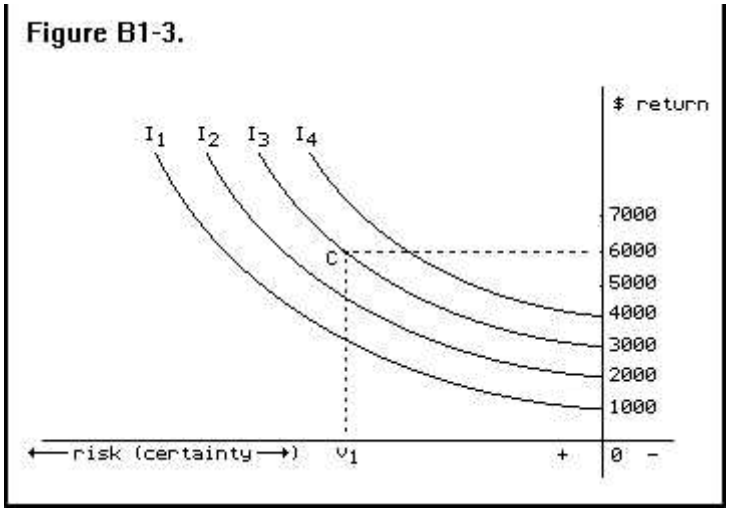
$$(1') \quad PV = \frac{CE_1}{(1+i)} + \frac{CE_2}{(1+i)^2} + \ldots + \frac{CE_n}{(1+i)^n},$$

$$(2') \quad K = \frac{CE_1}{(1+r)} + \frac{CE_2}{(1+r)^2} + \ldots + \frac{CE_n}{(1+r)^n},$$

For a risk averse decision maker, CE < V; where the decision maker is risk indifferent, CE = V; and in the case of a risk preferrer, CE > V.
Although it may not be practical to specify preference functions, the certainty equivalent approach may be illustrated by the hypothetical risk-return indifference map first introduced in Figure A2-3. The map is reproduced in Figure B1-3. The preference function illustrated in this map is for a normally risk-averse decision maker. Suppose that a decision opportunity promises a return of $6000, but entails a risk of v_1. This particular combination of risk and return lies at point C on indifference curve I_3. If we now follow indifference curve I_3 downward to the right until the vertical axis is reached, we find that it intersects the vertical axis (where risk is zero) at $3000. The sum of $3000 is thus the certainty equivalent of the $6000 return which entails risk v_1. The certainty equivalent of any other risky sum may be found in similar fashion. The reader may imagine the appearance of an indifference curve map for a decision maker who prefers risk.

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Figure B1-3. Risk-return indifference Map.



Another approach is possible in the analysis of risk in the long run. In the present value formula (2), a subjectively determined **risk premium**, a, is added to the interest rate discount in the denominator,

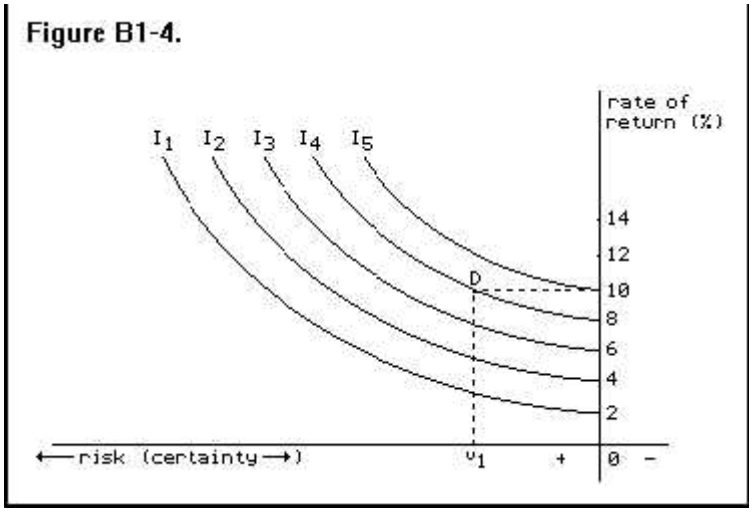
$$(3)\quad PV = \frac{V_1}{(1+i+a)} + \frac{V_2}{(1+i+a)^2} + \ldots + \frac{V_n}{(1+i+a)^n}.$$

The premium a constitutes a risk adjustment to the discount rate, i. The **risk-adjusted present value** will be smaller than before risk adjustment in reflection of the larger denominator. The risk-adjustment factors will differ from one decision opportunity to another, but their present values, adjusted for risk, will be more realistic selection criteria.

The determination of a risk adjustment factor may be illustrated by an indifference map which is a variation upon that illustrated in Figure B1-3. Figure B1-4 depicts a decision maker's indifference map with risk on the horizontal axis as illustrated above, but with percentage rates of return (rather than dollar amounts of returns) on the vertical axis. In this case, the procedure is first to find on the right-hand vertical axis the current riskless return on something like a government bond, say 8 percent. This identifies the relevant indifference curve, I_4, which may be followed. Then, when the risk factor, v_1, for the decision opportunity is computed, a vertical may be erected at v_1 on the horizontal axis to intersect indifference curve I_4 at point D. At point D the decision maker is indifferent between the low return on the riskless government bond and the higher return on the risky decision opportunity.
A horizontal may be drawn from D to the right-hand vertical axis to find the higher return, 10 percent as illustrated. In the denominator of the present value formula, the value of i is taken to be 8 percent, and the risk premium a is 2 percent (i.e., 10 percent minus 8 percent). If the market interest rate on government bonds changes, then some other indifference curve would become relevant and a new risk premium found in similar fashion.

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Figure B1-4. A risk-rate of return indifference map.



The illustrated procedure for determining the risk adjustment factor is operational only if the decision maker's preference function can be specified (heroic at best), but this model does illustrate the thought process which must be used by a rational decision maker in selecting a risk adjustment factor. There is no scientific way to specify a schedule of either certainty-equivalent or discount rate adjustment factors. These are such **highly subjective** matters that they must be left to the personal judgment of each decision maker. This is one reason that different decision makers, confronted with the same scenarios and information, can reach such different investment conclusions. The naive or inexperienced decision maker may have no ability at all to determine either certainty equivalents or discount adjustment factors. The ability to determine either will come only with time and the accumulation of a **stock of experience** in considering risky alternatives.

accelerate or decelerate over the life of the decision opportunity.

5.4. Decision Making Under Uncertainty

In the previous section we considered the utility implications of different probability assessments, but suppose that a decision maker simply cannot in any meaningful way assess the probabilities of the possible outcomes. How can the decision maker decide whether or not to invest in the venture described in the above example? Under the **maximin** decision rule, the decision maker would examine the worst-case scenarios, $0 for not investing and -$1 million if the investment is undertaken and fails; the choice under this rule would be not to invest because it yields the **least of the worst** scenarios.

The **minimax regret** rule, however, yields a different conclusion. A so-called "payoff matrix" may help to illustrate the computations. In Table B1-2, columns (1) and (2) show the outcomes of the invest and do-not-invest alternatives if successful or failures. Columns (3) and (4) show the "regrets" associated with each outcome if selected relative to the best possible outcomes of success and failure. The regrets in column (3) are computed by

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subtracting each entry in column (1) from the highest-valued entry in column (1). Likewise, the regrets in column (4) are computed as the differences between each entry in column (2) and the highest-valued entry in column (2). The zeros in columns (3) and (4) result from subtracting the highest-valued entries from themselves. According to the minimax regret rule, the alternative with the **least regret** of not selecting the best outcome should be chosen. In the example above, a much larger regret ($4 million) would be suffered from not investing if the investment turns out to be successful than would be realized ($1 million) from investing which is not successful. Therefore, under this rule the decision maker should choose to invest.

Table B1-2. Regret Matrix for Investment Decision.

	outcomes		regrets	
strategy				
	success	failure	success	failure
	(1)	(2)	(3)	(4)
invest	$4 mil	−$1 mil	$0 mil	$1 mil
not invest	$0	$0	$4	$0

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Define decision making		
Describe types of decision making situation		
Explain risk in the context of decision making		
Explain risk and probability in decision making		
Describe decision making under uncertainty		
Define decision making and expected value of money		

Summary

Managerial economics is about the criteria for rational decision making in business enterprises and non-commercial decision settings. The world in which we live is characterized by scarcity rather than abundance. Economic opportunities can be found in supplying economic goods or removing nuisance goods. Specialization and division of labor enhance productive opportunities. The firm may achieve internal resource allocation more efficiently with hierarchical, authoritative control than with market transactions.

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The management of a commercial enterprise is an exercise in economizing. Problems of coordination and control within the complex corporate organization may be remedied by divisionalization. The internal structure of an enterprise may be horizontal, vertical, or conglomerated. Strategic decision making, that involves the fundamental direction of the firm's activities, is essentially entrepreneurial in nature. The enterprise may engage in international activities in a variety of forms.

Multinationalization of enterprise is achieved when managerial personnel are recruited world-wide without national prejudice. Human beings are essentially materialistic and hedonistic; rational human behavior consists in attempting to maximize the value of some positive quantity or to minimize the value of some negative quantity. Human approaches to decision making may be characterized as capriciousness, conditioned response, or deliberate and rational choice. The decision maker, confronted by a multiplicity of possible goals, must select one for primary pursuit and subordinate others to it; subordinate goals may serve as constraints upon the pursuit of the primary goal.

Any decision involves multiple possible courses of action among which the decision maker must choose. Often the alternative courses of action are greater or lesser quantities of the same action; the choice of an alternative quantity involves an incremental or marginal change. Any course of action may result in multiple possible outcomes; each possible outcome may span a range of variability; the wider the range of variability, the greater the degree of risk associated with the outcome. The identities of some of the possible outcomes or their ranges of variability may not be known with certainty by the decision maker; the decision maker may attempt to reduce the uncertainty by seeking additional information about the outcomes.

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CHAPTER SIX
THEORY OF PRODUCTION

Learning objectives;

Up on successful completion of this chapter students will be able to :

- ***Define the production process***
- ***Explain the production function***
- ***Describe the optimal combination of factors of production***
- ***Explain the concept of return to scale***

6.1. Production Defined

Production refers to the transformation of inputs or resources into outputs of goods and services. For example, IBM hires workers to use machinery, parts, and raw materials in factories to produce personal computers. The output of a firm can either be a final commodity (such as a personal computer) or an intermediate product, such as semiconductors (which are used in the production of computers and other goods). The output can also be a service rather than a good. Examples of services are education, medicine, banking, communication, transportation, and many others.

Inputs are the resources used in the production of goods and services. Inputs are classified into labor (including entrepreneurial talent), capital, and land or natural resources. Each of these broad categories, however, includes a great variety of the basic input. For example, labor includes workers, accountants, lawyers, doctors, scientists, and many others. Inputs are also classified as fixed or variable. **Fixed inputs** are those that cannot be readily changed during the time period under consideration. Examples of fixed inputs are the firm's plant and specialized equipment (it takes several years for IBM to build a new factory to produce computer chips to go into its computers). On the other hand **variable inputs** are those that can be varied easily and on very short notice. Examples of variable inputs are most raw materials and unskilled labor.

The time period during which at least one input is fixed is called the **short run**, while the time period when all inputs are variable is called the **long run**. The length of the long run (i.e., the time period required for all inputs to be variable) depends on the industry.

6.2. The Production Function

Just as demand theory centers on the concept of the demand function, production theory revolves around the concept of the production function. A production function is an equation, table, or graph showing the maximum output of a commodity that a firm can produce per period of time with each set of inputs. Both inputs and outputs are measured in physical

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rather than in monetary units. Technology is assumed to remain constant during the period of the analysis.

Q = f (L, K) (1)

Equation (1) reads: The quantity of output is a function of, or depends on, the quantity of labor and capital used in production. Output refers to the number of units of the commodity (say, automobiles) produced, labor refers to the number of workers employed, and capital refers to the amount of the equipment used in production. We assume that all units of Land K are homogeneous or identical.

A production function specifies the maximum output that can be produced for a given amount of

input. Alternatively, a production function shows the minimum quantity of input necessary to produce a given level of output. Production functions are determined by the technology available for effectively using plant, equipment, labor, materials, and so on. Any improvement in technology, such as better equipment or a training program that enhances worker productivity, results in a new production function.

TABLE 6-1 Production Function with Two Inputs

Capital (K)							
	6	10	24	31	36	40	39
	5	12	28	36	40	42	40
	4	12	28	36	40	40	36
	3	10	23	33	36	36	33
↑	2	7	18	28	30	30	28
K	1	3	8	12	14	14	12
		1	2	3	4	5	6
		$L \rightarrow$		Labor (L)			

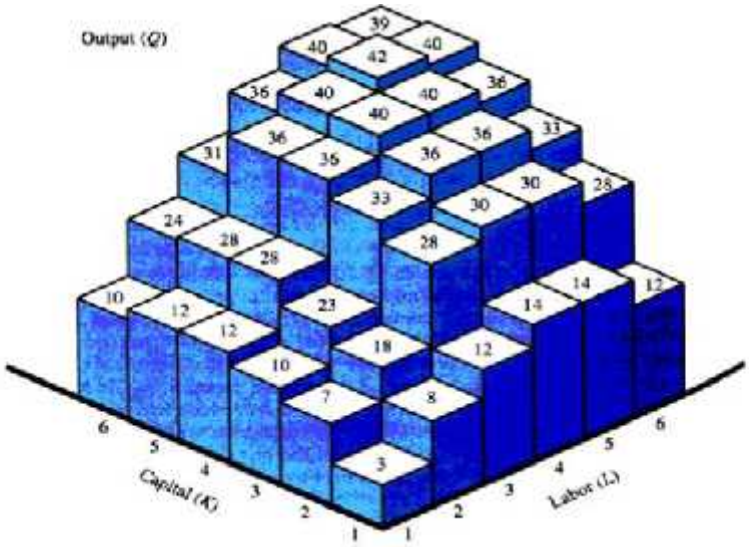
Output (Q)

Table (1) gives a hypothetical production function which shows the outputs (the Q's) that the firm can produce with various combinations of labor (L) and capital (K). The table shows that by

using 1 unit of labor (1L) and 1 unit of capital (1K), the firm would produce 3 units of output (3Q). With 2L and K, output is 8Q; with 3L and 1K, output is 12Q and so on. The production relationships given in Table (1) are shown graphically in Figure (1), which is three-dimensional. In Figure (1), the height of the bars refers to the maximum output that can be

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produced with each combination of labor and capital shown on the axes. Thus, the tops of all the bars form the production surface for the firm.



There are two types of Production functions, one is **discrete** production function (shown in Table (1) and Figure (1)) and the other is a continuous production function. A **continuous** production function is one in which inputs can be varied in an unbroken fashion rather than incrementally.

6.3. Production Functions with one Variable Input

Total product is the output from a production system. It is synonymous with Q in Equation (1). Total product is the overall output that results from employing a specific quantity of resources ina given production system. The total product concept is used to investigate the relation between output and variation in only one input in a production function. By holding the quantity of one input constant and changing the quantity used of the other input, we can derive the total product (TP) of the variable, input. For example, by holding capital constant at 1 unit (i.e., with K = 1) and increasing the units of labor used from zero to 6 units, we generate the total product of labor given by the last row in Table (1) which is reproduced in column 2 of Table (2). We can see that when no labor is used, total output or product is zero. With one unit of labor (1L), total product (TP) is 3. With 2L, TP = 8. With 3L, TP = 12, and so on.

Q=f(L/ K = 1) (2)

From the total product schedule we can derive the marginal and average product schedules of the variable input. The marginal product (MP) of labor (MPL) is the change in total product, or extra output per unit change in labor used, while the average product (AP) of labor (APL) equals total product divided by the quantity of labor used. That is,

MPL = ΔTP/ΔL

APL = TP/L

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Column 3 in Table (2) gives the marginal product of labor (MPL). Since labor increases by 1 unit at a time in column 1, the MPL in column 3 is obtained by subtracting successive quantities of TP in column 2. For example, TP increases from 0 to 3 units when the first unit of labor is used. Thus, MPL = 3. For an increase in labor 1 from 1L to 2L, TP rises from 3 to 8 units, so that MPL
= 5, and so on. Column 4 of Table (2) gives the APL. This equals TP (column 2) divided by L (column 1). Thus, with 1 unit of labor (1L), APL = 3. With 2L, APL = 4, and so on.

TABLE 6-2 Total, Marginal, and Average Product of Labor, and Output Elasticity

(1)	(2)	(3)	(4)	(5)
Labor (number of workers)	Output or Total Product	Marginal Product of Labor	Average Product of Labor	Output Elasticity of Labor
0	0	—	—	—
1	3	3	3	1
2	8	5	4	1.25
3	12	4	4	1
4	14	2	3.5	0.57
5	14	0	2.8	0
6	12	−2	2	−1

Column 5 in Table (2) gives the production or output elasticity of labor (EL). This measure the percentage change in output divided by the percentage change in the quantity of labor used. That is,

EL = %ΔQ

%ΔL

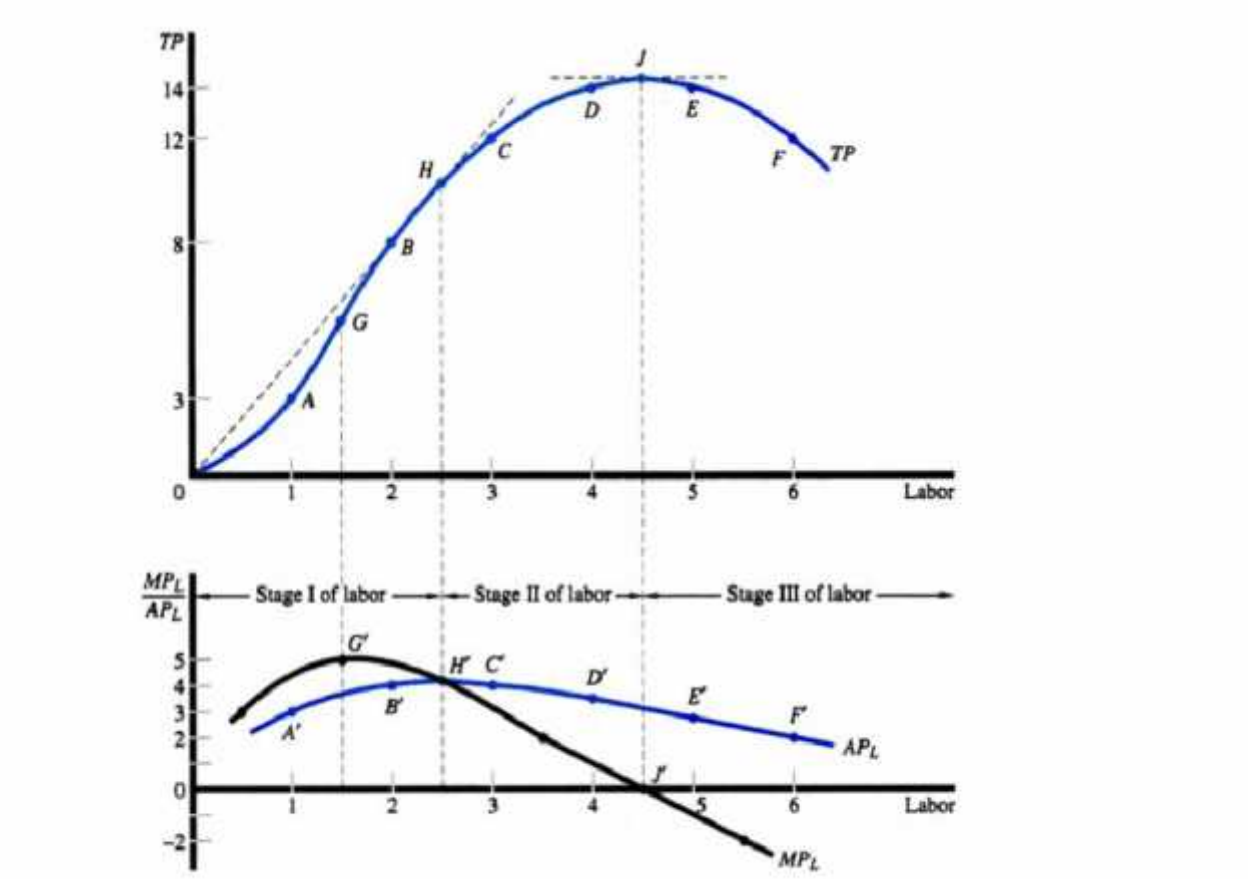
By rewriting the above equation in a more explicit from and rearranging, we get

EL = ΔQ/Q = ΔQ/ΔL = MPL

ΔL/L Q/L APL

That is, output elasticity of labor is equal to the ratio of MPL to the APL. In terms of calculus it can be expressed as: **∂Q / ∂L * L / Q**

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In order to show graphically the relationship between the total product, marginal product and average product of labor, we assume that labor time is continuously divisible (i.e., it can be hired
for any part of a day). Then the TP, MPL, and APL become smooth curves as indicated in Figure
(2). The MPL at a particular point on the TP curve is given by the slope of the TP curve at that point. From Figure (2), we see that the slope of the TP curve rises up to point G (the point of inflection on the TP curve), is zero at point J, and is negative thereafter. Thus, the MPL rises up
to point G, is zero at point J, and is negative afterward.

The APL is given by the slope of a ray from the origin to the TP curve. From Figure (2), we see that the slope of the TP curve rises up to point H and falls thereafter but remains positive as long as TP is positive. Thus, the APL rises up to point H and falls afterward. Note that at point H the slope of a ray from the origin to the TP curve (or APL) is equal to the slope of the TP (or MPL) curve. So that MPL = APL at point H'. Note also that APL rises as long as MPL is above it and falls when MPL is below it.

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MPL = APL when APL is maximum
MPL > APL when APL is rising
MPL < APL when APL is falling
Three points of interest, G, H, and J, can be identified on the total product curve in Figure (2). Each has a corresponding location on the average or marginal curves. Point G is the inflection point of the total product curve. The marginal product of L (the slope of the total product curve) increases until this point is reached, after which it begins to decrease. This can be seen in the
bottom panel of Figure (2), where **MPL** reaches its highest level at G'.

The second point on the total product curve, H, indicates the output at which the average product and marginal product are equal. The slope of a line from the origin to any point on the total product curve measures the average product of L at that point, whereas the slope of the total product curve equals the marginal product. The third point, J, indicates where the slope of the total product curve is zero and the curve is at a maximum. Beyond J the marginal product of L is negative, indicating that increased use of input L results in a *reduction* of total product. The corresponding point in the bottom panel of Figure (2) is J', the point where the marginal product curve intersects the *X*-axis.

From Figure (2), we can also see that up to point G, the TP curve increases at an increasing rate so that the MPL rises. Labor is used so scarcely with the 1 unit of capital that the MPL rises as more labor is used. Past point G, however, the TP curve rises at a decreasing rate so that the MPL declines. The declining portion of the MPL curve is a reflection of the **law of diminishing returns.** This postulates that as we use more and more units of the variable input with a given amount of the fixed input, after a point, we get diminishing returns (marginal product) from the variable input. The law of diminishing returns states that the marginal product of a variable factor must eventually decline as more of the variable factor is combined with other fixed resources.

The law of diminishing returns is sometimes called the law of diminishing marginal returns to emphasize the fact that it deals with the diminishing marginal product of a variable input factor. The law of diminishing returns cannot be derived deductively. It is a generalization of an empirical regularity associated with every known production system. In Figure (2), the law of diminishing returns begins to operate after 1.5L is used (after point G' in the bottom panel of Figure (2). The relationship between the MPL and APL curves in the bottom panel of Figure (2) can be used to define **three stages of production** for labor (the variable input). The range from the origin to the point where the APL is maximum (point H' at 2.5L) is stage I of production for labor. Stage II of production for labor extends from the point where the APL is maximum to the point where the MPL is zero (i.e., from point H' at 2.5L to point J' at

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4.5L). The range over which the MPL is negative (i.e., past point J' or with more than 4.5L) is stage III of production for labor. The rational producer would not operate in stage III of labor, even if labor time were free, because

MPL is negative. In short:

Stage I: from zero units of the variable input to where APL is maximized (where MPL = APL)

Stage II: from the maximum APL curve to where MPL= 0

Stage III: from where MPL=0 and onwards

In the short run, rational firms should be operating only in Stage II as in Stage III firm uses more variable inputs to produce less output; over-utilizing fixed input; MPL is negative. The question arises why not Stage I? Well the answer is it reflects underutilizing fixed capacity, so the firm can increase output per unit by increasing the amount of the variable input; in stage I MPK is negative.

6.4. Determining the Optimal Use of the Variable Input

How much labor (the variable input in our discussion) should the firm use in order to maximize profits? The answer is that the firm should employ an additional unit of labor as long as the extra revenue generated from the sale of the output produced exceeds the extra cost of hiring the unit of labor (i.e., until the extra revenue equals the extra cost). The extra revenue generated by the use of an additional unit of labor is called the marginal revenue product of If labor (MRPL). This equals the marginal product of labor (MPL) times the marginal revenue (MR) from the sale of the extra output produced. That is, **MRPL = (MPL)(MR)**

On the other hand, the extra cost of hiring an additional unit of labor or marginal resource cost of labor (MRCL) is equal to the increase in the total cost to the firm resulting from hiring the additional unit of labor. That is, **MRCL = ΔTC /ΔL**

The optimal use of labor requires that:

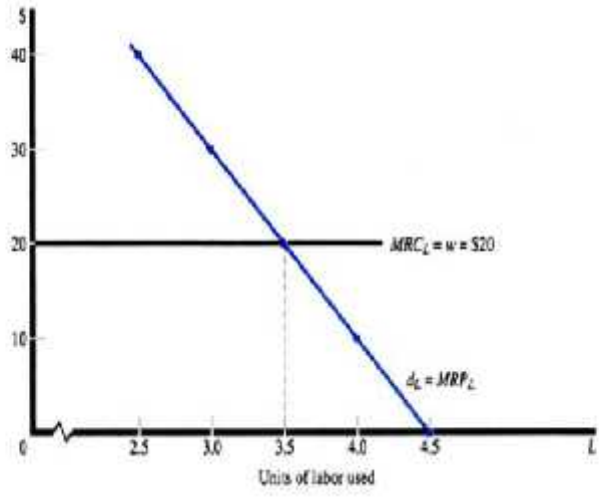
MRPL = MRCL

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TABLE 6-3 Marginal Revenue Product and Marginal Resource Cost of Labor

(1)	(2)	(3)	(4) = (2) × (3)	(5)
Units of Labor	Marginal Product	Marginal Revenue = P	Marginal Revenue Product	Marginal Resource Cost = w
2.5	4	$10	$40	$20
3.0	3	10	30	20
3.5	2	10	20	20
4.0	1	10	10	20
4.5	0	10	0	20

Table (3) shows that the optimal use of labor is 3.5 units because only with 3.5L, MRPL = MRCL = w = $20. The marginal revenue product of labor (MRPL) schedule in column 4 of Table (3) represents the firm's demand schedule for labor. It gives the amount of labor demanded by the firm at various wage rates. See Figure (3) where dL = MRPL is shown as a downward sloping curve.



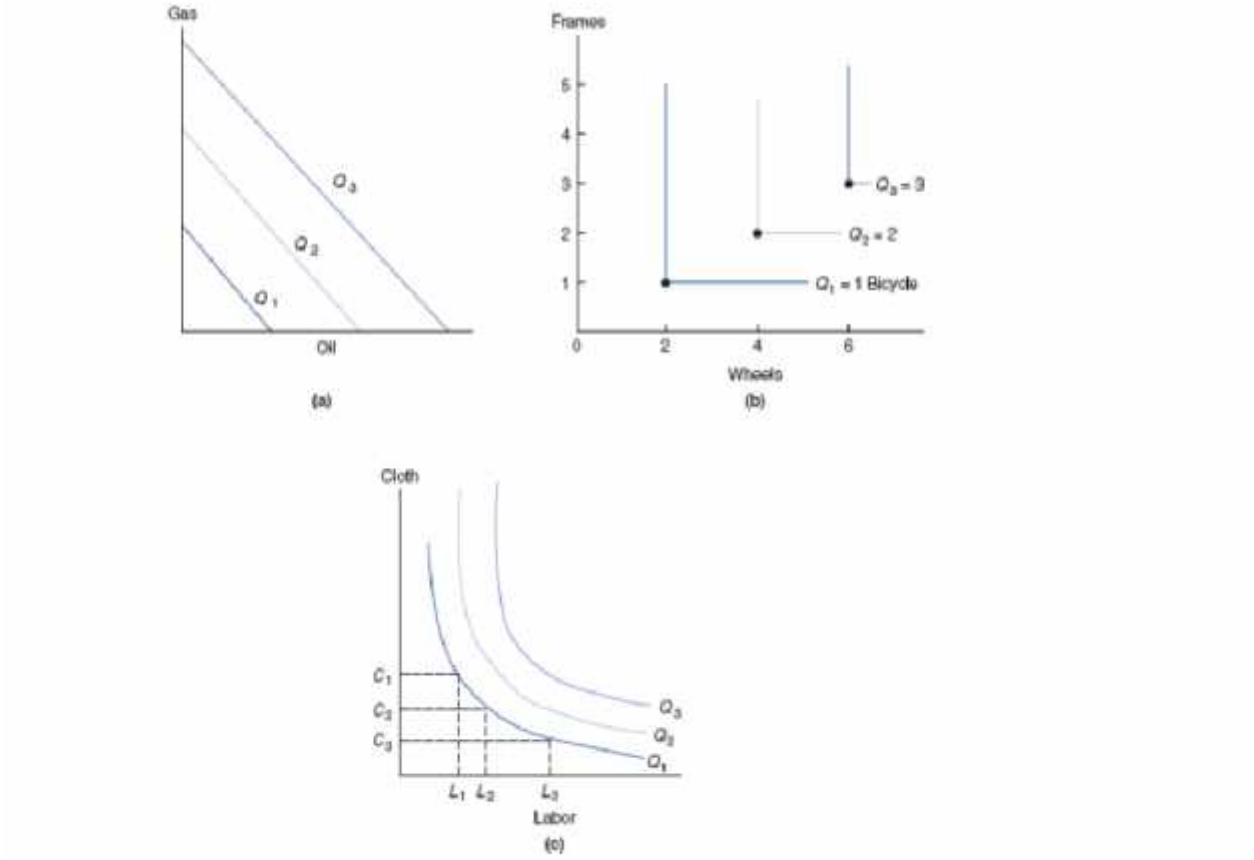
For example, if the wage rate per day (w) were $40, the firm would hire 2.5 units of labor because that would be where MRPL = MRCL = W = $40. If w = $30, the firm would demand 3 units of labor. If w = $20, the firm would demand 3.5L, and with w = $10, the firm would demand 4L. This is shown in Figure (3), where dL = MRPL represents the firm's

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demand curve for labor; The figure shows that if the wage rate per day (w) were constant at $20, the firm would demand 3.5L, as indicated above.

6.5. Production Functions with Two Variable Inputs

The term **Isoquant**—derived from *iso*, meaning equal, and *quant*, from quantity—denotes a curve that represents the different combinations of inputs that can be efficiently used to produce a given level of output. Efficiency in this case refers to **technical efficiency**, meaning the least cost production of a target level of output. An Isoquant shows the various combinations of two inputs (say, labor and capital) that the firm can use to produce a specific level of output. A higher Isoquant refers to a larger output, while a lower Isoquants refers to a smaller output. Isoquants shapes reveal a great deal about the substitutability of input factors, as illustrated in Figure 1) (a), (b), and (c).



On one hand, the smaller the curvature of an Isoquant, the greater is the degree of substitutability of inputs in production. On the other hand, the greater the curvature of an Isoquant, the smaller is the degree of substitutability.

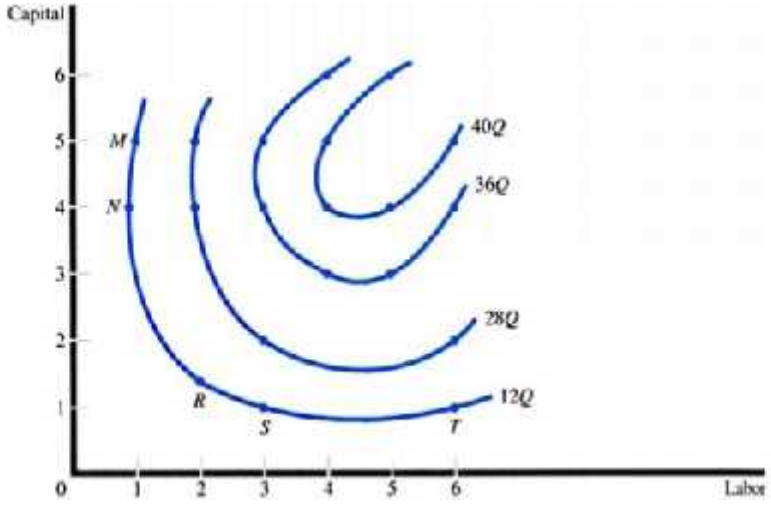
At one extreme are Isoquants that are straight lines, as shown in the left panel of, Figure (1). In this case, labor and capital are perfect substitutes. That is, the rate at which labor can be substituted for capital in production (i.e., the absolute slope of the Isoquant or MRTS) is

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constant. This means that labor can be substituted for capital (or vice versa) at the constant rate given by the absolute slope of the Isoquant. And time in a drying process, and fish meal and soybeans used to provide protein in a feed mix.

At the other extreme of the spectrum of input substitutability in production are Isoquants that are

at a right angle, as in the right panel of Figure (1). In this case labor and capital are perfect complements. That is, labor and capital must be used in the fixed proportion of 2K/1L. In this case there is zero substitutability between labor and capital in production. Examples of perfect complementary inputs are certain chemical processes that require basic elements (chemicals) to be combined in a specified fixed proportion, engine and body for automobiles, two wheels and a frame for bicycles, and so on. In these cases, inputs can be used only in the fixed proportion specified (i.e., there is no possibility of substituting one input for another in production).



Although perfect substitutability and perfect complementarity's of inputs in production are possible, in most cases Isoquants exhibit some curvature (i.e., inputs are imperfect substitutes), as shown in Figure (2). This means that in the usual production situation, labor can be substituted for capital to some degree. The smaller is the degree of curvature of the Isoquant, the more easily inputs can be substituted for each other in production. In addition, when the Isoquant has some curvature, the ability to substitute labor for capital (or vice versa) diminishes as more and more labor is substituted for capital. This is indicated by the declining absolute slope of the Isoquant or marginal rate of technical substitution (MRTS) as we move down along an Isoquant. The ability to substitute one input for another in production is extremely important in keeping production costs down when the price of an input increases relative to the price of another.

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MARGINAL RATE OF TECHNICAL SUBSTITUTION

The marginal rate of technical substitution (MRTS) is the amount of one input factor that must be substituted for one unit of another input factor to maintain a constant level of output. Algebraically

MRTS = ∂K/∂L = Slope of an Isoquant (1)

The marginal rate of technical substitution usually diminishes as the amount of substitution increases. In Figure 1 (c), for example, as more and more labor is substituted for cloth, the increment of labor necessary to replace cloth increases. At the extremes, Isoquants may even become positively sloped, indicating that the range over which input factors can be substituted for each other is limited. A classic example is the use of land and labor to produce a given output of grain. At some point, as labor is substituted for land, the farmers will trample the grain. As more labor is added, more land eventually must be added if grain output is to be maintained.

The input substitution relation indicated by the slope of a production Isoquant is directly related to the concept of diminishing marginal productivity. The marginal rate of technical substitution is equal to –1 times the ratio of the marginal products of the input factors [MRTS = –1(MPL / MPK)].Along any Isoquant the total differential of the production function must be zero (output is fixed along an Isoquant). Thus, for the production function given by **Q = f (L, K),** setting the total differential equal to zero gives:

∂Q/∂LdL + ∂Q/∂KdK = 0

And, rearranging terms, we get:

∂Q/∂KdK = (-)∂Q/∂LdL

– MPL / MPK = DK / dL

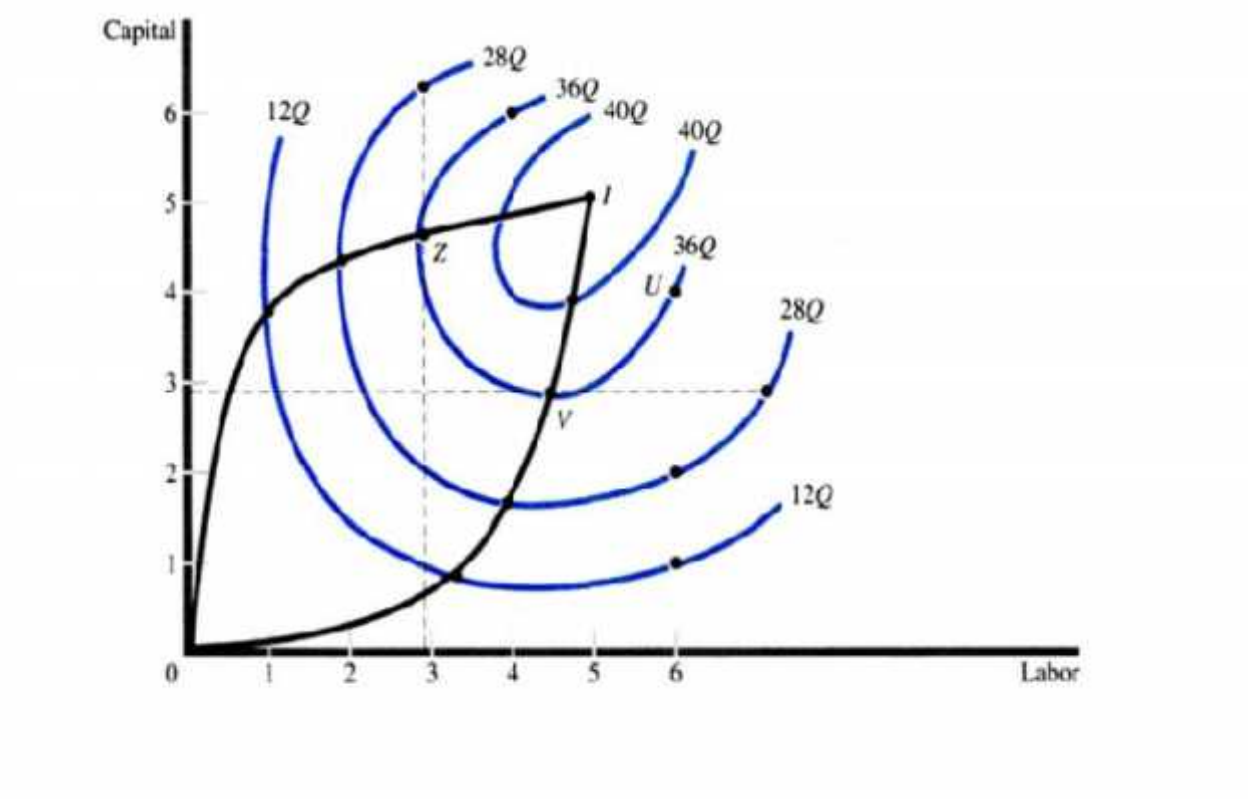
Or **MRTS = dK/dL = (-)MPL/MPK Slope of an Isoquant (2)**

The slope of a production Isoquant such as in Equation (1) and as derived in Equation (2) is equal to ∂K/∂L and is determined by the ratio of the marginal products of both inputs.

RATIONAL LIMITS OF INPUT SUBSTITUTION RIDGE LINES

It is irrational for a firm to combine resources in such a way that the marginal product of any input is negative, because this implies that output could be increased by using less of that resource. From Equation (2), we can see that if the inputs L and K are combined in proportions such that the marginal product of either factor is negative, then the slope of the production Isoquant will be positive. For a production Isoquant to be positively sloped, one of the input factors must have a negative marginal product. Input combinations lying along a positively sloped portion of a production Isoquant are irrational and would be avoided by the firm.

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While the Isoquants in Figure (2) (repeated in Figure (3)) have positively sloped portions, these portions are irrelevant. That is, the firm would not operate on the positively sloped portion of an Isoquant because it could produce the same level of output with less capital and less labor. In Figure (3), the rational limits of input substitution are where the Isoquants become positively sloped. Limits to the range of substitutability of L for K are indicated by the points of tangency between the Isoquants and a set of lines drawn perpendicular to the Y-axis. Limits of economic
substitutability of K for L are shown by the tangents of lines perpendicular to the X-axis.

Maximum and minimum proportions of K and L that would be combined to produce each level of output are determined by points of tangency between these lines and the production Isoquants. It is irrational to use any input combination outside these tangents, or **ridge lines**, as they are called. Such combinations are irrational because the marginal product of the relatively more abundant input is negative outside the ridge lines. The addition of the last unit of the excessive input factor actually reduces output. Obviously, it would be irrational for a firm to buy and employ additional units that cause production to decrease. Ridge lines separate the relevant (i.e., negatively sloped) from the irrelevant (or positively sloped) portions of the Isoquants. In Figure (3), ridge line 0VI joins points on the various Isoquants where the Isoquants have zero slope. The Isoquants are negative sloped to the left of this ridge line and positively sloped to the right. On the other hand, ridge line OZI, joins points

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where the Isoquants have infinite slope. The Isoquants are negatively sloped to the right of this ridge line and positively sloped to the left. Hence the economic region of production is given by the negatively sloped segment of Isoquants between ridge lines OVI and OZI. The firm will not produce in the positively sloped portion of the Isoquants because it could produce the same level of output with both less labor and less capital.

6.6. Determining the Optimal Combination of Inputs

As an Isoquant shows the various combinations of labor and capital that a firm can use to produce a given level of output. An **Isocost line** shows the various combinations of inputs that a firm can purchase or hire at a given cost. By the use of Isocost and Isoquants, we determine the optimal input combination for the firm to maximize profits.

ISOCOST LINES

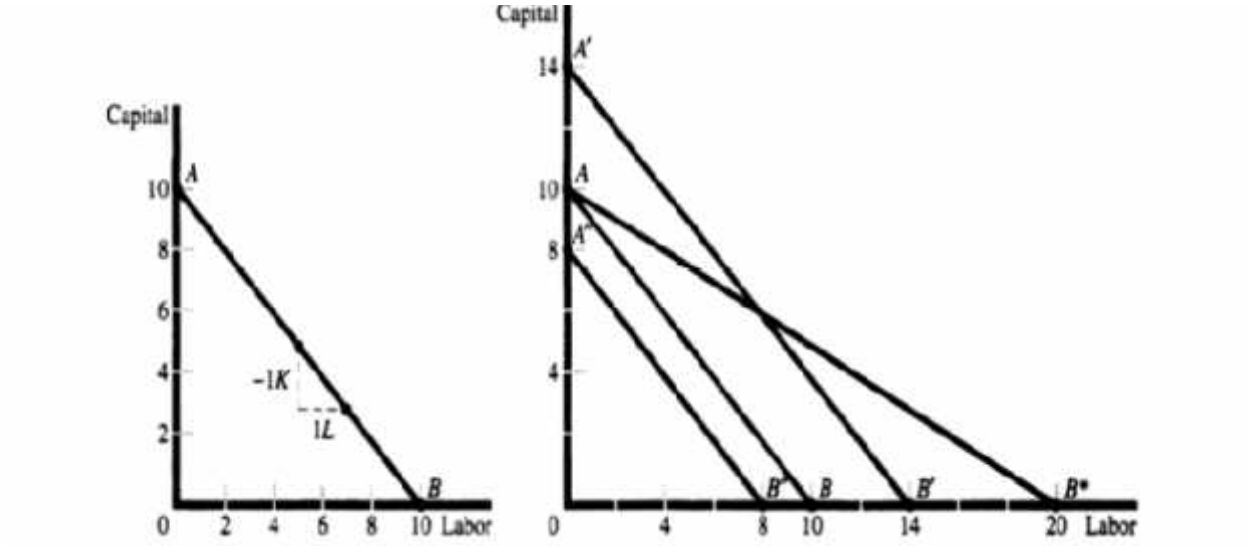
Optimal input proportions can be found graphically for a two-input, single-output system by adding an Isocost curve or budget line, a line of constant costs, to the diagram of production Isoquants. Each point on the Isocost curve represents a combination of inputs, say, L and K, whose cost equals a constant expenditure. Suppose that a firm uses only labor and capital in production. The total costs or expenditures of the firm can then be represented by

C = wL + rK (3)

Where C is total costs, w is the wage rate of labor, L is the quantity of labor used, r is the rental price of capital, and K is the quantity of capital used. Thus, Equation (3) postulates that the total costs of the firm (C) equals the sum of its expenditures on labor (wL) and capital (rK). Equation (3) is the general equation of the firm's Isocost line or equal cost line. It shows the various combinations of labor and capital that the firm can hire or rent at a given total cost. For example, if C = $100, w = $10, and r = $10, the firm could either hire 10L or rent 10K, or any combination

of L and K shown on Isocost line AB in the left panel of Figure (4). For each unit of capital the firm gives up, it can hire one additional unit of labor. Thus, the slope of the Isocost line is -1.

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By subtracting wL from both sides of Equation (3) and then dividing by r, we get the general equation of the Isocost line in the following more useful form:

K = C – w L/r r

Where C/r is the vertical intercept of the Isocost line and w/r is its slope. A different total cost by the firm would define a different but parallel Isocost line, while different relative input prices would define an Isocost line with a different slope. For example, an increase in total expenditures to C' = $140 with unchanged w = r = $10 would give Isocost line A' B' in the right panel of Figure (4), with vertical intercept C'/r = $140/$10 = 14K and slope of -w/r = - $10/$10= -1.

MRTS = w/r

Since the MRTS = MPL/MPK, we can rewrite the condition for the optimal combination of inputs as:

MPL = w

MPK r

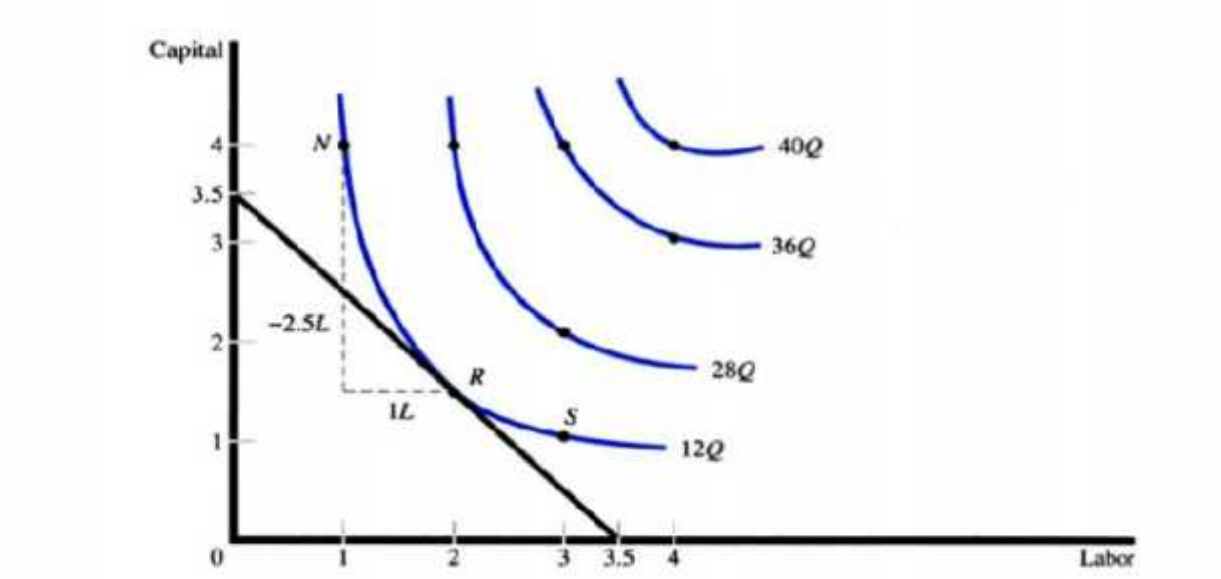
Cross-multiplying, we get:

MPL = MPK w/ r

Figure (5)

MRTS = -(-2.5/1) = 2.5

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At the point of optimal input combination, Isocost and the Isoquant curves are tangent and have qual slope. The slope of an Isocost curve equals *–PX/PY* i-e w/r. The slope of an Isoquant curve equals the marginal rate of technical substitution of one input factor for another when the quantity of production is held constant. Therefore, for optimal input combinations, the ratio of input prices must equal the ratio of input marginal products, as is shown:

$$\frac{w}{r} = \frac{MP_L}{MP_K}$$

Alternatively, marginal product to price ratio must be equal for each input:

$$MP_X/P_X = MP_Y/P_Y$$

6.7. Returns Scale

Closely related to the productivity of individual inputs is the question of how a proportionate increase in all inputs will affect total production. **Constant returns to scale** exist when a given percentage increase in all inputs leads to that same percentage increase in output. **Increasing returns to scale** are prevalent if the proportional increase in output is larger than the underlying proportional increase in inputs. If output increases at a rate less than the proportionate increase in inputs, **decreasing returns to scale** are present.

Returns to scale refers to the degree by which output Changes as a result of a given change in the quantity of all inputs used in production. There are three types of returns to scale constant, increasing, and decreasing. If the quantity of all inputs used in production is increased by a given proportion, we have constant returns to scale if output increases in the same proportion increasing returns to scale if output increases by a greater proportion; and

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decreasing returns to scale if output increases by a smaller proportion. That is, suppose that starting with the general production function.

Q = f (L, K) (1)

We multiply Land K by h, and Q increases by 1, as indicated in Equation (1):

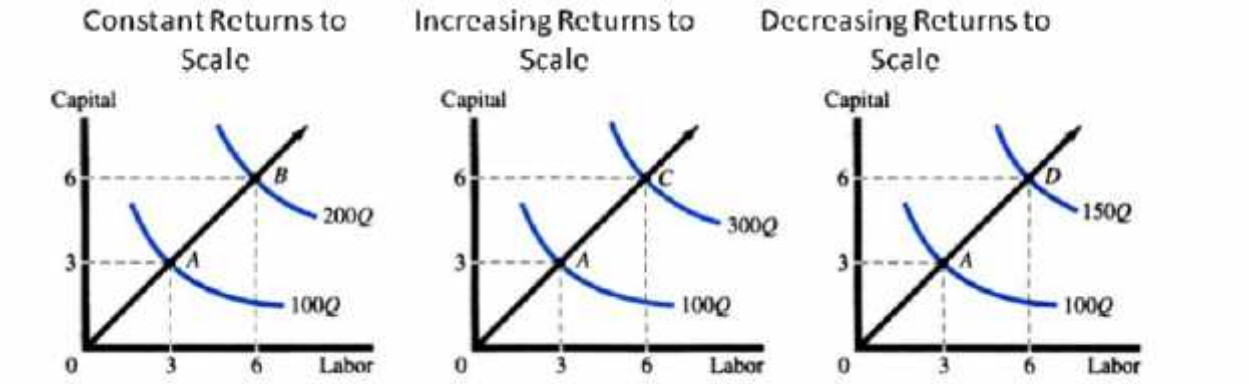
λQ = f(hL, hK) (2)

We have constant, increasing, or decreasing returns to scale, respectively, depending on whether λ = h, λ > h, or λ < h.

For example, if all inputs are doubled, we have constant, increasing, or decreasing returns to scale, respectively, if output doubles, more than doubles, or less than doubles. This is shown in Figure (1). In all three panels of Figure (1) we start with the firm using 3L and 3K and producing

100Q (point A). By doubling inputs to 6L and 6K, the left panel shows that output also doubles to 200Q (point B), so that we have constant returns to scale.

Increasing returns to scale arise because as the scale of operation increases, a greater division of labor and specialization can take place and more specialized and productive machinery can be used. Decreasing returns to scale, on the other hand, arise primarily because as the scale of operation increases, it becomes ever more difficult to manage the firm effectively and coordinate the various operations and divisions of the firm.



A more general condition is a production function with first increasing, then decreasing, returns to scale. The region of increasing returns is attributable to specialization. As output increases, specialized labor can be used and efficient, large-scale machinery can be used in the production process. Beyond some scale of operation, however, further gains from specialization are limited, and coordination problems may begin to increase costs substantially. When coordination expenses more than offset additional benefits of specialization, decreasing returns to scale set in.

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For certain production functions, called **homogeneous production functions**, when each input factor is multiplied by a constant *k*, the constant can be completely factored out of the production function expression. Following a *k*-fold increase in all inputs, the production function takes the form $hQ = kr\, f(X, Y, Z)$. The exponent *r* provides the key to returns-to-scale estimation. If $r = 1$, then $h = k$ and the function exhibits constant returns to scale. If $r > 1$, then $h > k$, indicating increasing returns to scale, whereas $r < 1$ indicates $h < k$ and decreasing returns to scale.

Q = f(X,Y,Z)
hQ = f(kX,kY, kZ)
hQ = kr f(X,Y,Z) Where r is degree of homogeneity (3)
If k = h, then f has constant returns to scale.
If k > h, then f has increasing returns to scale.
If k < h, then f has decreasing returns to scale.

OUTPUT ELASTICITY AND RETURNS TO SCALE

Returns to scale can be accurately determined for any production function through analysis of output elasticities. **Output elasticity**, *EQ*, is the percentage change in output associated with a 1
percent change in all inputs and a practical means for returns to scale estimation. Letting *X* represent all input factors,

$$E_Q = \frac{\text{Percentage Change in Output } (Q)}{\text{Percentage Change in All Inputs } (X)} = \partial Q/Q \div \partial X_i/X_i$$

Where *X* refers to capital, labor, energy, and so on, then the following relations hold:

If	Then	Returns to Scale
Percentage change in *Q* >Percentage change in *X*	$E_Q > 1$	Increasing
Percentage change in *Q* = Percentage change in *X*	$E_Q = 1$	Constant
Percentage change in *Q* < Percentage change in *X*	$E_Q < 1$	Diminishing

Thus, returns to scale can be analyzed by examining the relationship between the rate of increase in inputs and the quantity of output produced.

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

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I CAN	Yes	No
Define production process		
Describe production function		
Explain optimal combination of resources		
Explain marginal rate of technical substitution		
Describes expansion path		
Describe returns to scale		

Summary

Types of production functions depending on their degree of power:

- short run, Linear: one fixed factor, one variable factor
  $Q = f(L)_K$
- cubic: increasing marginal returns followed by decreasing marginal returns, all 3 stages of production
  $Q = a + bL + cL^2 - dL^3$
- quadratic: diminishing marginal returns but no Stage I
  $Q = a + bL - cL^2$

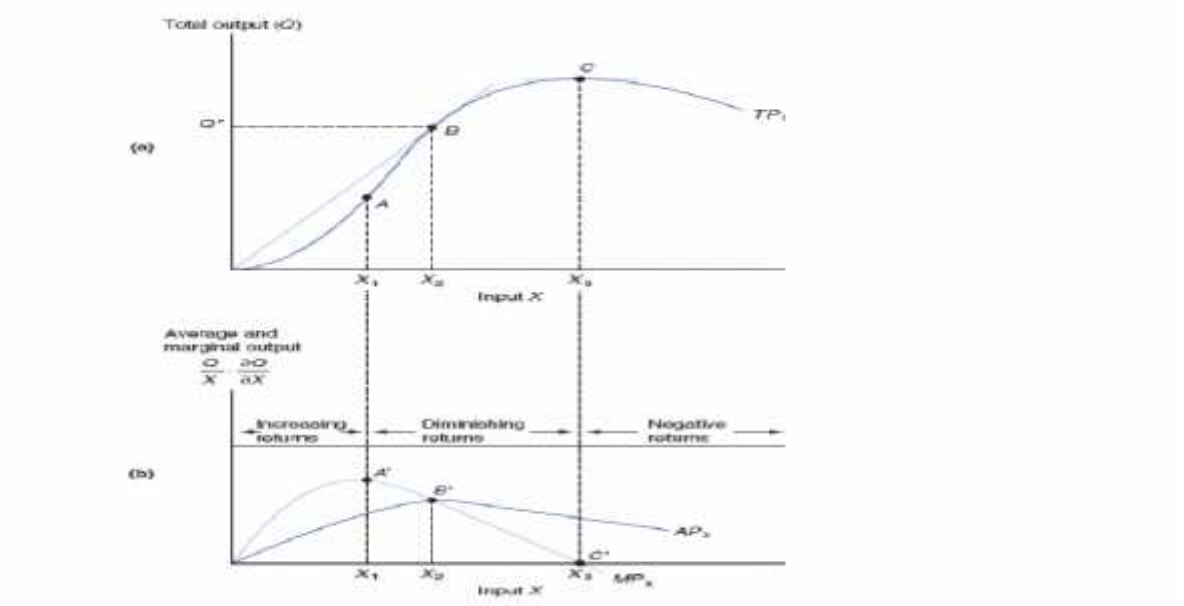
Given enough input/output observations, either over time for a single firm or at a single point in time for a number of firms in an industry, regression techniques can be used to estimate the parameters of production functions.

From a theoretical standpoint, the most appealing functional form for production function estimation might be cubic, such as the equation

$$Q = a + bXY + cX^2Y + dXY^2 - eX^3Y - fXY^3 \quad (4)$$

This form is general in that it exhibits stages of first increasing and then decreasing returns to scale. The marginal products of the input factors exhibit a pattern of first increasing and then decreasing returns, as is illustrated in Figure (2).

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Frequently, however, real-world data do not exhibit enough dispersion to indicate the full range of increasing and then decreasing returns. In these cases, simpler functional specifications can be used to estimate production functions. The full generality of a cubic function may be unnecessary, and an alternative linear or log-linear model specification can be usefully applied in empirical estimation.

The production function most commonly used in empirical estimation is the power unction of the
form

$$Q = A K^a L^b \qquad (7)$$

Where Q, K, and L refer, respectively, to the quantities of output, capital, and labor, and A, a, and b are the parameters to be estimated empirically. Equation (7) is often referred to as the Cobb-Douglas production function in honor of Charles W. Cobb and Paul H. Douglas, who introduced it in the 1920s. Where Q, K, and L refer, respectively, to the quantities of output, capital, and labor, and A, a, and b are the parameters to be estimated empirically. Equation (7) is often referred to as the Cobb-Douglas production function in honor of Charles W. Cobb and Paul H. Douglas, who introduced it in the 1920s.

The Cobb-Douglas production function has several useful properties.

• First, the marginal product of capital and the marginal product of labor depend on both the quantity of capital and the quantity of labor used in production, as is often the case in the real world.

• Second, the exponents of K and L (i.e., a and b) represent, respectively, the output elasticity of labor and capital (EK and EL), and the sum of the exponents (i.e., a + b) measures the

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returns to scale. If a + b = 1, we have constant returns to scale; if a + b > 1, we have increasing returns to scale and if a + b < 1, we have decreasing returns to scale.

• Third, the Cobb-Douglas production function can be estimated by regression analysis by transforming it into linear in the logarithms:

In Q =In A + a In K + b In L (8)

• In production theory it is assumed that technology is fixed, however, the data fitted by the researchers may span a period over which technology has changed and improved, one of the independent variable could represent technical change (a time-series) and thus adjust the function to take technology into consideration.

• Finally, the Cobb-Douglas production function can easily be extended to deal with more than two inputs (say, capital, labor, and natural resources or capital, production labor, and non production labor). The Cobb-Douglas production function can be estimated either from data for a single firm, industry, or nation over time (i.e., using time-series analysis), or for a number of firms, industries, or nations at one point in time (i.e., using cross-sectional data). In either case, the researcher faces three potential difficulties:

1.If the firm produces a number of different products, output may have to be measured in monetary rather than in physical units, and this will require deflating the value of output by the price index in time-series analysis or adjusting for price differences for firms located in different

regions in cross-sectional analysis.

2. Only the capital consumed in the production of the output should be counted, ideally. Since machinery and equipment are of different types and ages and productivities, however, the total stock of capital in existence has to be used instead.

3. In time series analysis a time trend is also usually included to take into consideration technological changes over time, while in cross sectional analysis we must ascertain that all firms or industries use the same technology (the best available).

4.Cannot show MP going through all three stages in one specification, also it cannot show a firm or industry passing through increasing, constant, and decreasing returns to scale.

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The results showed that the Management variable was found statistically significant.
Given Cobb-Douglas function: $Q = AL^{\alpha}K^{\beta}$

If $\alpha + \beta > 1$, IRTS
If $\alpha + \beta = 1$, CRTS
If $\alpha + \beta < 1$, DRTS

$MP_L = \partial Q/\partial L = \alpha AL^{\alpha-1}K^{\beta}$
$MP_K = \partial Q/\partial K = \beta AL^{\alpha}K^{\beta-1}$
$MP_L = \partial Q/\partial L = \alpha AL^{\alpha-1}K^{\beta}$
$= \alpha \cdot Q/L$
Since $AP_L = Q/L$
Hence $AP_L > MP_L$, Similarly
$AP_K > MP_K$

$$\varepsilon_L = \partial Q/Q \div \frac{\partial L/L}{L} = \frac{\alpha Q}{Q} \frac{L}{} = \alpha$$

$$\varepsilon_K = \partial Q/Q \div \frac{\partial K/K}{K} = \frac{\beta Q}{Q} \frac{K}{} = \beta$$

Since $MRTS = -MP_L/MP_K$
$MRTS = -\alpha AL^{\alpha-1}K^{\beta} / \beta AL^{\alpha}K^{\beta-1}$
Using rules for indices:
$MRTS = -\alpha/\beta \cdot K/L$

The graphical approach provides a useful interpretation of constrained optimization and enables us to justify some familiar microeconomic results. However, it does not offer a practical way of

actually solving such problems, since it is difficult to produce an accurate Isoquant map from any given production function. The most popular algebraic method for solving this problem is the *Lagrange multiplier method*.

$$L^* = wL + rK + \lambda(Y - f(K, L))$$

$$L^* = f(L, K) + \lambda(C - wL + rL)$$

$$\lambda = \frac{\text{marginal benefit of } x_i}{\text{marginal cost of } x_i}$$

We use the **Lagrangian multiplier** method to examine the condition for a firm to be (1) maximizing output for a given cost outlay and (2) minimizing the cost of producing a given output. Suppose that a firm that uses labor *(L)* and capital *(K)* in production wants to determine the amount of labor and capital that it should use in order to maximize the output *(Q)* produced with a given cost outlay *(C*).* That is, the firm wants to

Maximize Q = f(L, K) (1)
Subject to C* = wL +rK (2)

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Where w is the wage of labor and r is the rental price of capital. This constrained maximization problem can be solved by the Lagrangian multiplier method. To do so, we first form the Lagrangian function:

$$Z = f(L, K) + \lambda(C^* - wL - rK) \qquad (3)$$

To maximize Z, we then find the partial derivatives of Z with respect to L, K, and λ and set them equal to zero. That is,

$$\frac{\delta Z}{\delta L} = \frac{\delta f}{\delta L} - \lambda W = 0 \qquad (4)$$

$$\frac{\delta Z}{\delta K} = \frac{\delta f}{\delta K} - \lambda r = 0 \qquad (5)$$

$$\frac{\delta Z}{\delta \lambda} = C^* - wL - rK = 0 \qquad (6)$$

By substituting MP_L for $\delta f / \delta L$ and MP_K for $\delta f / \delta K$, transposing w and r to the right of the equals sign, and dividing Equation (4) by Equation (5), we have.

$$\frac{MP_L}{MP_K} = \frac{W}{r}$$

$$\frac{MP_L}{W} = \frac{MP_K}{r}$$

That is, the firm should hire labor and capital so that the marginal product per dollar spent on each input (λ) is equal. This is the first-order condition for output maximization for the given cost outlay or expenditure of the firm. The second-order condition is for the Isoquant to be convex to the origin.

Suppose, on the other hand, that ,the firm of the previous section wants to determine the amount of labor and capital to use to minimize the cost of producing a given level of output (Q*).The problem would then be

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Minimize $C=wL+rK$ **(7)**

Subject to $Q^* = f(L,K)$ **(8)**

This constrained cost minimization problem can also be solved by the Lagrangian multiplier method. To do so, we first form the Lagrangian function:

$$Z' = wL + rK + \lambda'[Q^* - f(L, K)] \quad (9)$$

To minimize Z', we then find the partial derivatives of Z' with respect to L, K, and λ', and set them equal to zero. That is,

$$\frac{\delta Z'}{\delta L} = \frac{\lambda' \delta f}{\delta L} = 0$$

$$\frac{\delta Z'}{\delta K} = r - \frac{\lambda' \delta f}{\delta K} = 0$$

$$\frac{\delta Z'}{\delta \lambda'} = Q^* - f(L, K) = 0$$

By substituting MP_L for δf / δL and MP_K for δf / δK, transposing them to the right of the equal sign, and dividing Equation 6-30 by Equation 6-31, we have

$$\frac{w}{r} = \frac{MP_L}{MP_K}$$

or

$$w / MP_L = r / MP_K \quad (10)$$

Each term in Equation (10) equals λ' and refers to the marginal cost in terms of labor and capital. That is, Equation (10) assumes that to minimize the costs of producing Q*, the firm should use labor and capital in such a way that the extra cost of producing an additional unit of output is the same whether the firm produces it with more labor or more capital.

In general, the firm will want to determine the amount of labor and capital needed to maximize
profits rather than to maximize output or minimize costs. Total profit (л) is

Π = **TR – TC (11)**

= p * Q - wL – rK (12)

Since Q = f(L, K), we can rewrite the profit function as

Π = **P. f(L, K) - wL – rK (13)**

To determine the amount of labor and capital that the firm should use in order to maximize profits, we take the partial derivatives of Equation (13) with respect to Land K and set them equal to zero. That is,

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$$\frac{\delta \pi}{\delta L} = \frac{P \delta f}{\delta L} - w = 0$$

$$\frac{\delta \pi}{\delta K} = \frac{P \delta f}{\delta K} - r = 0$$

Assuming that the price of the final commodity (P) is constant so that it is equal to marginal revenue (MR), we can rewrite Equations 6-38 and 6-39 as

$$(MP_L)(MR) = MRP_L = w \qquad (14)$$
$$(MP_K)(MR) = MRP_K = r \qquad (15)$$

That is, in order to maximize profits, the firm should hire labor and capital until the marginal revenue product of labor equals the wage rate, and until the marginal revenue product of capital is equal to the rental price of capital. Dividing Equation (14) by Equation (15), we get the following expression:

$$\frac{MP_L = w}{MP_K = r}$$

Cross-multiplying the above expression gives the condition for the optimal combination of inputs
given by:

$$\frac{MP_L}{w} = \frac{MP_K}{r}$$

That is, hiring labor and capital so that the above expressions hold which implies optimal input combinations will be satisfied.

A high value of λ indicates that Q could be increased substantially by relaxing the constraint

A low value of λ indicates that there is not much to be gained by relaxing the constraint

λ = 0 implies that the constraint is not binding

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? ? ? ? Self Test Exercise

Question No 1: OUTPUT MAXIMIZATION

Maximize

$Q = 12L^{0.5}K^{0.5}$ Subject to: $C = 25L + 50K$;

When cost constraint is \$1414.

$1414 - 25L - 50K = 0$

Solution:

$L = 12L^{0.5}K^{0.5} + \lambda\,[1414 - 25L - 50K]$

FOC

$LL = 6L^{-0.5}K^{0.5} - 25\lambda = 0$ (1)

$LK = 6L^{0.5}K^{-0.5} - 50\lambda = 0$ (2)

$L\lambda = 1414 - 25L - 50K = 0$ (3)

$K/L = ½$ so substitute $K = L/2$ in Eq (3), we get

$1414 = 25L + 50(L/2)$ or $50L = 1414$ so; $L = 28.28$ and $K = 14.14$

$Q = 12\,(28.28)^{0.5}(14.14)^{0.5} = 12(5.31)(3.76)$

$Q = 240$ units

Question No 2: Cost Minimization

Minimize

$C = 25L + 50K$ Subject to: $Q = 12L^{0.5}K^{0.5}$

When production constraint is 240 units

Solution:

$L = 25L + 50K + \lambda\,[\,240 - 12L^{0.5}K^{0.5}\,]$

FOC

$LL = 25 - \lambda 6L^{-0.5}K^{0.5} = 0$ (1)

$LK = 50 - \lambda 6L^{0.5}K^{-0.5} = 0$ (2)

$L\,\lambda = 240 - 12L^{0.5}K^{0.5} = 0$ (3)

$K/L = ½$ so substitute $K = L/2$ in Eq (3), we get

$240 = 12L^{0.5}(L/2)^{0.5}$;$L = 28.28$ and $K = 14.14$

Therefore $C = 25L + 50K = 25(28.28) + 50(14.14) = \$1414$

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CHAPTER SEVEN
THEORY OF COST

Learning objectives;

Up on successful completion of this chapter students will be able to:

- ***Explain cost and its components***
- ***Identify types of costs***
- ***Describe short run and long run cost curves and their implication***
- ***Explain breakeven analysis and operating leverage***
- ***Describe the learning curve and its decision implication***

7.1. The Meaning and Measurement of Cost

Cost is an important consideration in managerial decision making, and cost analysis is an essential and major aspect of managerial economics. Cost analysis is made difficult by the effects of unforeseen inflation, unpredictable changes in technology, and the dynamic nature of input and output markets

Typically, the costs of using resources in production involve both out-of-pocket costs, or explicit costs, and other non-cash costs, called implicit costs. Wages, utility expenses, payment for raw materials, interest paid to the holders of the firm's bonds, and rent on a building is all examples of explicit expenses. The implicit costs associated with any decision are much more difficult to compute. These costs do not involve cash expenditures and are therefore often overlooked in decision analysis.

One crucial distinction in the analysis of costs is between explicit and implicit costs. **Explicit costs** refer to the actual expenditures of the firm to hire, rent, or purchase the inputs; it requires in production. These include the wages to hire labor the rental price of capital, equipment, and buildings, and the purchase price of raw materials and semi finished products. **Implicit costs** refer to the value of the inputs owned and used by the firm in its own production activity. Even though the firm does not incur any actual expenses to use these inputs, they are not free, since the firm could sell or, rent them out to other firms. The amount for which the firm could sell or rent out these owned inputs to other firms represents a cost of production of the firm owning and using them. Implicit costs include the highest salary that the entrepreneur could earn in his or her best alternative employment (say, in managing another firm).

In economics, both explicit and implicit costs must be considered. That is, in measuring production costs, the firm must include the alternative or opportunity costs of all inputs, whether purchased or owned by the firm. The reason is that the firm could not retain a hired

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input if it paid a lower price for the input than another firm. Similarly, it would not pay for a firm to use an
owned input if the value (productivity) of the input is greater to another firm. These **economic costs** must be distinguished from **accounting costs**, which refer only to the firm's actual expenditures or explicit costs incurred for purchased or rented inputs. Accounting or historical costs are important for financial reporting by the firm and for tax purposes. For managerial decision making purposes, however, economic or opportunity costs are the relevant cost concept that must be used.

Suppose that a firm purchased a machine for $1,000. If the estimated life of the machine is 10 years and the accountant uses a straight-line depreciation method (that is, $100 per year), the accounting value of the machine is zero at the end of the tenth year. Suppose, however, that the machine can still be used for (i.e., it would last) another year and that the firm could sell the machine for $120 at the end of the tenth year or use it for another year. The cost of using the machine is zero as far as the accountant is concerned (since the machine has already been fully depreciated), but it is $120 for the economist. Again, incorrectly assigning a zero cost to the use of the machine would be wrong from an economics point of view and could lead to wrong managerial decisions.

Opportunity cost is the foregone value associated with the current rather than next-best use of an asset. In other words, cost is determined by the highest-valued *opportunity* that must be foregone to allow current use. The cost of aluminum used in the manufacture of soft drink containers, for example, is determined by its value in alternative uses. Soft drink bottlers must pay an aluminum price equal to this value, or the aluminum will be used in the production of alternative goods, such as airplanes, building materials, cookware, and so on.
When costs are calculated for a firm’s income tax returns, the law requires use of the actual dollar amount spent to purchase the labor, raw materials, and capital equipment used in production. For tax purposes, **historical cost**, or actual cash outlay, is the relevant cost. Despite their usefulness, historical costs are not appropriate as a sole basis for many managerial. Current costs are typically much more relevant. **Current cost** is the amount that must be paid under prevailing market conditions. Current cost is influenced by market conditions measured by the number of buyers and sellers, the present state of technology, inflation, and so on. For assets purchased recently, historical cost and current cost are typically the same. For assets purchased several years ago, historical cost and current cost are often quite different.

Although it is typical for current costs to exceed historical costs, this is not always the case. Computers and many types of electronic equipment cost much less today than they did just a few years ago. In many high-tech industries, the rapid advance of technology has overcome

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the general rate of inflation. As a result, current costs are falling. Current costs for computers and electronic equipment are determined by what is referred to as **replacement cost**, or the cost of duplicating productive capability using current technology. For example, the value of used personal computers tends to fall by 30 to 40 percent per year. In valuing such assets, the appropriate measure is the much lower replacement cost—not the historical cost.

In discussing production costs, we must also distinguish between marginal cost and incremental cost. Marginal cost refers to the change In total cost for a 1-unIt change in output. For example, if total cost is $140 to produce 10 units of output and $150 to produce 11 units of output, the marginal cost of the eleventh unit is $10. Incremental cost, on the other hand, is a broader concept and refers to the change in total costs from implementing a particular management decision, such as the introduction of a new product line, the undertaking of a new advertising campaign, or production shift.

Inherent in the incremental cost concept is the principle that any cost not affected by a decision is irrelevant to that decision. A cost that does not vary across decision alternatives is called a **sunk cost**; such costs do not play a role in determining the optimal course of action. For example, suppose a firm has spent $5,000 on an option to purchase land for a new factory at a price of $100,000. Also assume that it is later offered an equally attractive site for $90,000. What should the firm do? The first thing to recognize is that the $5,000 spent on the purchase option is a sunk cost that must be ignored. As any costs not affected by available decision alternatives are sunk and irrelevant.

7.2. Short-run Cost Functions

The **short run** is the operating period during which the availability of at least one input is fixed. In the **long run**, the firm has complete flexibility with respect to input use. In the short run, operating decisions are typically constrained by prior capital expenditures. In the long run, no such restrictions exist. At least one input is fixed in the short run while all inputs are variable in the long run. Long-run cost curves are called *planning curves*; short-run cost curves are called *operating curves*. In the long run, plant and equipment are variable, so management can plan the most efficient physical plant, given an estimate of the firm's demand function. Once the optimal plant has been determined and the resulting investment in equipment has been made, short-run
operating decisions are constrained by these prior decisions.

Fixed costs do not vary with output. These costs include interest expenses, rent on leased plant and equipment, depreciation charges associated with the passage of time, property taxes, and salaries for employees not laid off during periods of reduced activity. Because all costs are variable in the long run, long-run fixed costs always equal zero. **Variable costs**

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fluctuate with output. Expenses for raw materials, depreciation associated with the use of equipment, the variable portion of utility charges, some labor costs, and sales commissions are all examples of variable expenses. In the short run, both variable and fixed costs are often incurred. In the long run, all costs are variable while fixed cost is a short-run concept

A **short-run cost curve** shows the minimum cost impact of output changes for a specific plant size and in a given operating environment. Such curves reflect the optimal or least-cost input combination for producing output under fixed circumstances. Wage rates, interest rates, plant configuration, and all other operating conditions are held constant. Any change in the operating environment leads to a *shift* in short-run cost curves. For example, a general rise in wage rates leads to an upward shift; a fall in wage rates leads to a downward shift. Such changes must not be confused with *movements along* a given short-run cost curve caused by a change in production levels. For an existing plant, the short-run cost curve illustrates the minimum cost of production at various output levels under current operating conditions. Short-run cost curves are a useful guide to operating decisions.

Both fixed and variable costs affect short-run costs. Total cost at each output level is the sum of total fixed cost (a constant) and total variable cost. Using *TC* to represent total cost, *TFC* for total fixed cost, *TVC* for total variable cost, and *Q* for the quantity of output produced, various unit costs are calculated as follows:

Total Cost = TC = TFC + TVC
Average Fixed Cost = AFC = TFC/Q
Average Variable Cost = AVC = TVC/Q
Average Cost = AC = TC = AFC + AVC
Marginal Cost = MC = ∂TC/∂Q

Marginal cost is the change in cost associated with a one-unit change in output. Because fixed costs do not vary with output, fixed costs do not affect marginal costs. Only variable costs affect marginal costs. Therefore, marginal costs equal the change in total costs *or* the change in total variable costs following a one-unit change in output:

MC = ∂TC/∂Q = ∂TVC/∂Q

7.2.1.SHORT-RUN COST RELATIONS

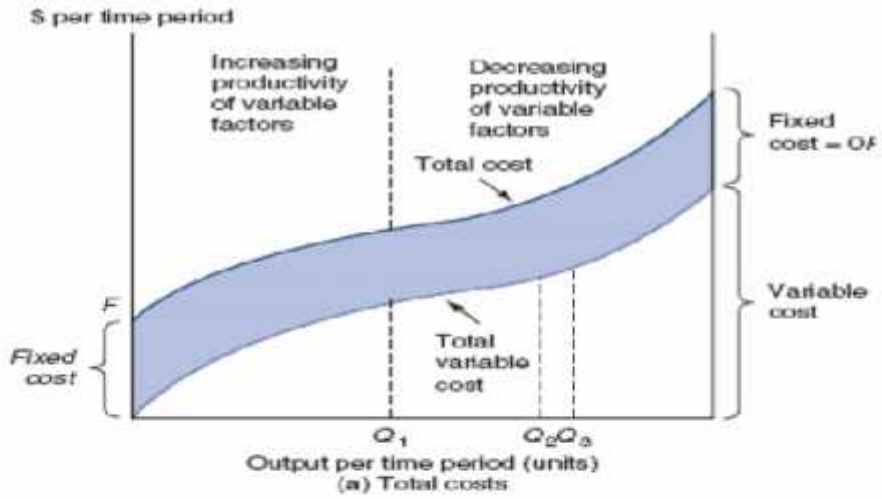
Relations among short-run cost categories are shown in Figure 1. Figure 1(a) illustrates total cost and total variable cost curves. The shape of the total cost curve is determined entirely by the total variable cost curve. The slope of the total cost curve at each output level is identical to the slope of the total variable cost curve. Fixed costs merely shift the total cost curve to a higher level. This means that marginal costs are independent of fixed cost.

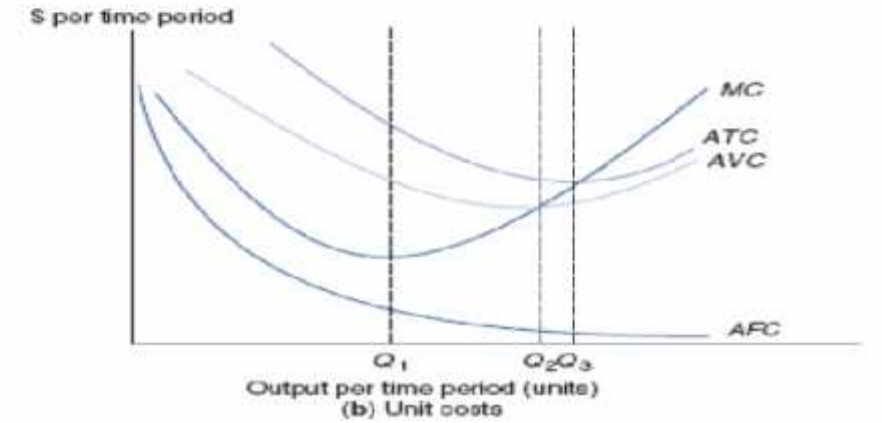
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The shape of the total variable cost curve, and hence the shape of the total cost curve, is determined by the productivity of variable input factors employed. The variable cost curve in Figure 1 increases at a decreasing rate up to output level *Q*1, then at an increasing rate. Assuming constant input prices, this implies that the marginal productivity of variable inputs first increases, then decreases. Variable input factors exhibit increasing returns in the range from 0 to *Q*1 units and show diminishing returns thereafter. This is a typical finding. Past point Q1, the law of diminishing returns operates, and the *TVC* curve faces upward (concave upwards) or rises at an increasing rate. Since *TC = TFC + TVC*, the *TC* curve has the same shape as the *TVC* but is *OF* (the amount of the *TFC*) level above it at each input level.

The relation between short-run costs and the productivity of variable input factors is also reflected by short-run unit cost curves, as shown in Figure 1(b). Marginal cost declines over the range of increasing productivity and rises thereafter. This imparts the familiar U-shape to average variable cost and average total cost curves. At first, marginal cost curves also typically decline rapidly in relation to the average variable cost curve and the average total cost curve. Near the target output level, the marginal cost curve turns up and intersects each of the *AVC* and *AC* short-run curves at their respective minimum points.

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We can explain the U shape of the *AVC* curve as follows. With labor as the only (variable input, *TVC* for any output level (Q) equals the wage rate (w, which is assumed to be fixed) times the quantity of labor (L) used. Thus,

AVC = Average Variable Cost

Since TVC = WL

$AVC = TVC/Q = w/AP_L$

Since the average physical product of labor (AP_L or Q/L) usually rises first, reaches a maximum, and then falls, it follows that the *AVC* curve first falls, reaches a minimum, and then rises. Since the *AVC* curve is U-shaped, the *ATC* curve is also U-shaped. The *ATC* curve continues to fall after the *AVC* curve begins to rise as long as the decline in *AFC* exceeds the rise in *AVC*.

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The U shape of the *MC* curve can similarly be explained as follows:

MARGINAL COST

$\Delta TC/\Delta Q = \Delta TVC/\Delta Q = W(\Delta L)/\Delta Q = w/MP_L$

Since the marginal product of labor (MP_L or $\Delta Q/\Delta L$) first rises, reaches a maximum, and then falls, it follows that the *MC* curve first falls, reaches a minimum, and then rises. Thus, the rising portion of the *MC* curve reflects the operation of the law of diminishing returns.

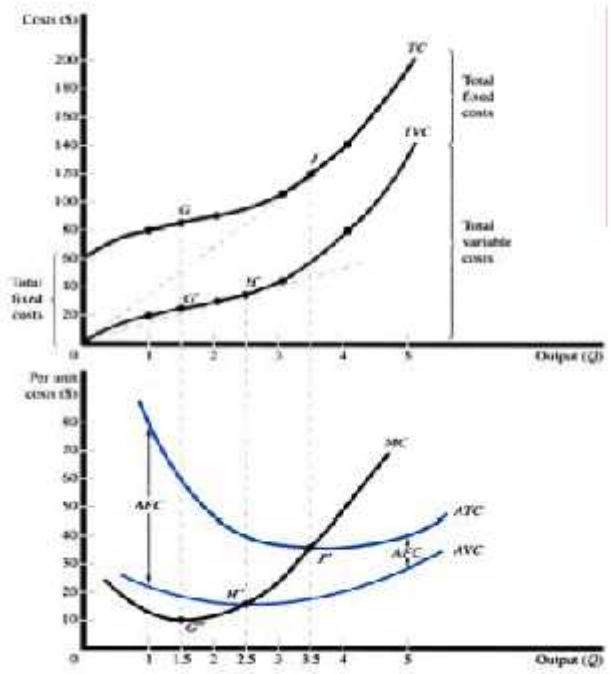
Table 1

Q	TFC	TVC	TC	AFC	AVC	ATC	MC
0	$60	$0	$60	-	-	-	-
1	60	20	80	$60	$20	$80	$20
2	60	30	90	30	15	45	10
3	60	45	105	20	15	35	15
4	60	80	140	15	20	35	35
5	60	135	195	12	27	39	55

Table 1 shows the hypothetical short-run total and per-unit cost schedules of a firm. These schedules are plotted in Figure 2. From, column 2 of Table 1 we see that TFC are $60 regardless of the level of output. TVC (column 3) are zero when output is zero and rise as output rises. Up to point G' (the point of inflection in the top panel of Figure 2), the firm uses little of the variable inputs with the fixed inputs, and the law of diminishing returns is not operating. Thus, the curve faces downward or rises at a decreasing rate. Past point G' (i.e., for output levels greater than 1.5 units in the top panel of Figure 2), the law of diminishing returns operates, and the TVC curve faces upward or rises at an increasing rate. Since TC = TFC + TVC, the TC, curve has the same shape as the TVC curve but is $60 (the amount of the TFC) above it at each output level. These TVC and TC schedules are plotted in the top panel of the following figure

Figure 2.

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RELATIONSHIP BETWEEN AC AND MC CURVES

$$d/dQ\ C(Q)/Q = \frac{[C'(Q)^* Q - C(Q).I]}{Q}$$

$1/Q[C'(Q) - C(Q)/Q]$ for $Q > 0$

$d/dQ\ C(Q)/Q > 0$ when MC > AC

$d/dQ\ C(Q)/Q = 0$ when MC = AC

$d/dQ\ C(Q)/Q < 0$ when MC < AC

7.3. Long-run Cost Functions

In the long run all aspects of the enterprise's circumstances are changeable; all costs are variable. The impetus for long-run change may come from a variety of sources:

a. recognition from short-run decision contexts that total and overhead costs are not being adequately covered;

b. increasing or decreasing demand which requires changes in the scale of operations;

c. the departure or acquisition of managerial ability and entrepreneurial capacity;

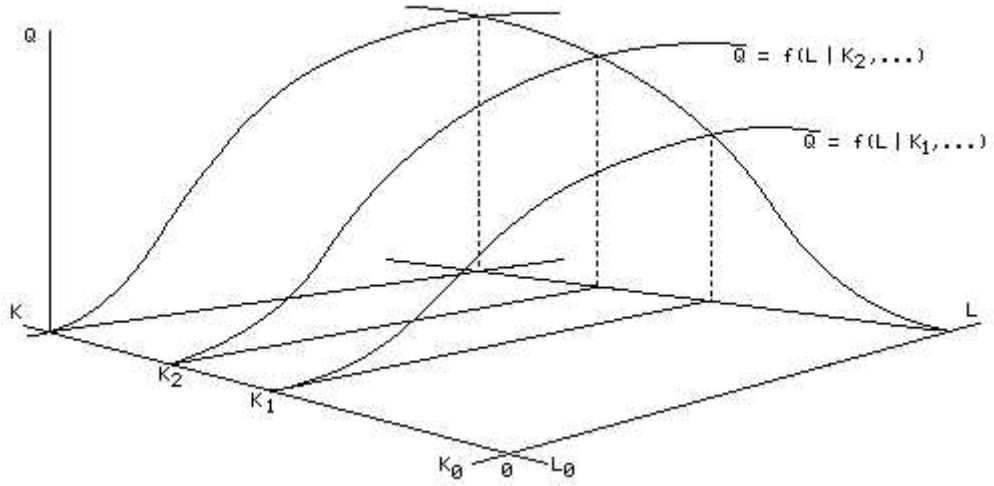
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d. technological advances which alter production functions or result in new products; and yet other possibilities.

Possibilities (c) and (d) above will cause shifts and perhaps twists or warps in the production surface as described in Chapter C3, with consequent alterations in the short-run cost curves which may be generated from any total product curve sliced through the production surface. How any such change in technology, management, or entrepreneurship likely affect costs must be analyzed on the merits of each change?

We can reach some general conclusions on how costs are affected when the long-run change is to adjust the scale of the enterprise's operation by constructing a larger or smaller plant. A larger plant than the one represented by the K_1 quantity of capital in Figure C3-2 results in another slice through production function surface at, say K_2, as illustrated in Figure C6-1. The total product curve drawn from K_2 likely rises higher into the output dimension, and may reach its peak at a larger volume of labor utilization than does the K_1 total product curve. Any number of successively larger plants could be represented by cutting total product slices through the production surface at quantities of capital greater than K_2.

Figure C6-1. Total Product Curve for Different Plant Sizes.



The total cost curves associated with the K_2 plant likely lie farther to the right than those associated with plant K_1, as illustrated by TC_2 relative to TC_1 in panel (a) of Figure C6-2. Correspondingly, the average total cost curve for plant K_2, illustrated by ATC_2, in panel (b) of Figure C6-2, likely lie slightly to the right of the position of ATC_1 for plan K_1, and ATC_2 may reach minimum at a lower per-unit cost level than does ATC_1.

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Figure C6-2. Total Cost Curves for Different Plant Sizes.

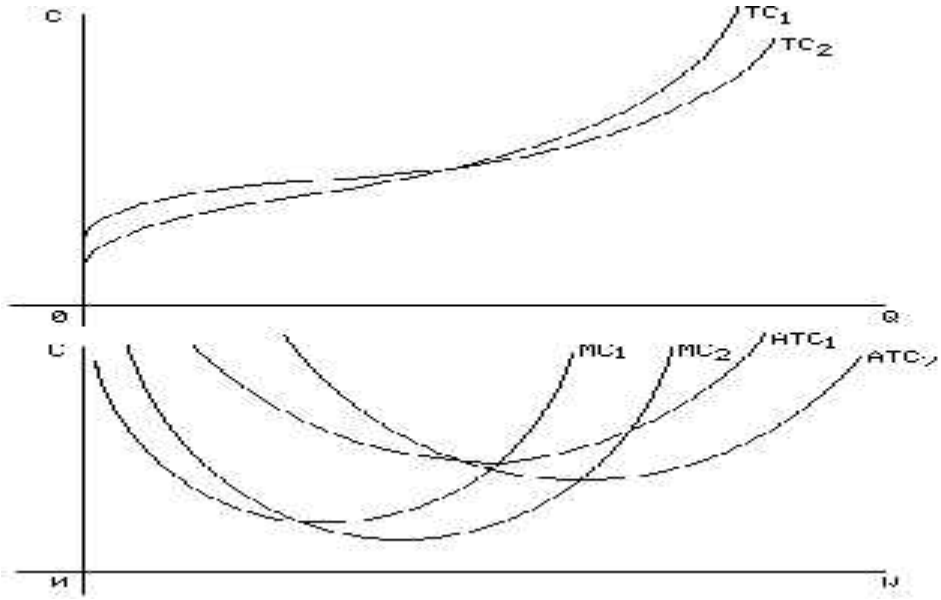
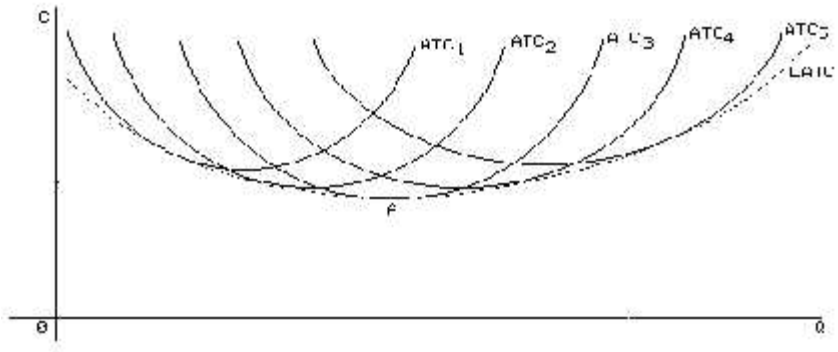


Figure C6-3 illustrates an idealized representative set of such ATC curves which might result from building a sequence of ever larger plants, given the same technology and managerial capacity. This is an admittedly heroic representation since most firms would have the occasion to build only one plant for any particular technology. However, if we may indulge in the presumption that the management might at least contemplate the construction of any of a range of possible plant sizes, we may note that the successively larger plants initially achieve ever higher and wider output ranges accompanied by falling per-unit costs. This occurs up to point A in Figure C6-3. Economists describe this phenomenon as the range of economies of scale and note that the decreasing costs correspond to the phenomenon of increasing returns to scale described in Chapter C4. Increasing returns to scale, with the consequent scale economies, are attributable to greater division and specialization in the use of labor, or (and perhaps to say the same thing in other terms) more efficient use of plant and equipment.

Figure C6-3. Average Total Costs in the Long Run.



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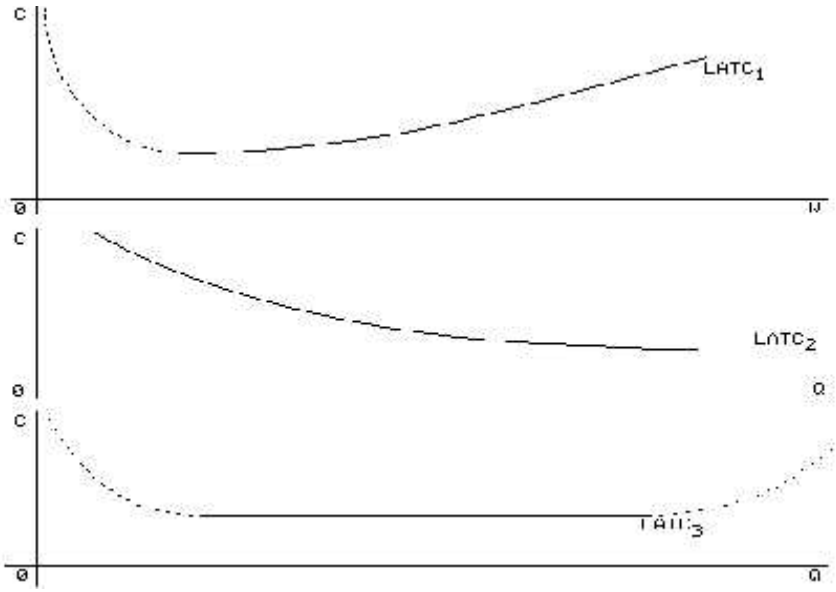
Beyond point A in Figure C6-3 the ATC curves, though they reach higher output ranges, incur ever increasing per-unit costs. Economists describe this as the range of diseconomies of scale which are associated with the phenomenon of decreasing returns to scale. Scale diseconomies are most often attributed to limitations on the abilities of management to coordinate and control the ever more complex productive relationships involved in the larger-scale operations.

7.3.1.The Long Run Average Cost Curve

The curve in Figure C6-3 which is tangent to the sequence of ATC curves is a long run average total cost curve, LATC. It is also referred to as an "envelope" curve because it envelopes the sequence of ATC curves.[3]

The LATC curve of Figure C6-3 is an idealized representation of production conditions in the long run because, given its U-shape, it contains ranges representing both scale economies (the down-sloping portion) and scale diseconomies (the up-sloping portion). Other shapes for the LATC curve are possible, and empirical data for a variety of industries suggests that some of the other shapes may be more common than the theoretical U-shape. Figure C6-4 illustrates three possible alternate shapes. That shown in panel (a) suggests possible early (small-plant) scale economies, but after a rather small least-cost plant size has been reached, diseconomies of scale if the company attempts to build larger-scale plants. These long-run cost conditions are conducive to the development of a market populated by a rather larger number of smaller firms (or firms with a multiplicity of small-capacity plants). Alternately, a market populated by a large number of small firms will likely be characterized by a long-run cost curves similar to that depicted in panel (a).

Figure C6-4. Possible Shapes of the Long Run Average Total Cost Curve.



Panel (b) of Figure C6-4 depicts long-run cost conditions characterized by the progressive, though gradual, exploitation of economies of scale which never seem to reach exhaustion. A

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market characterized by these long-run cost conditions will tend to be populated by a rather smaller number of larger-sized firms, and perhaps ever fewer firms as time passes and competition ensues. Economists classify such a market as oligopolistic. The ultimate end of competitive evolution in such a market might be a single, very large surviving firm, a so-called "natural monopoly." Real-world industries with a small number of large firms are likely have reached such a state by exploiting scale economies while realizing no significant diseconomies of more growth.

The LATC curve illustrated in panel (c) of Figure C6-4 may have involved a few minor scale economies as firms grew from very small size at start-up, and could eventually reach a range of diseconomies of large scale if existing firms grow much larger. But the salient characteristic of the panel (c) LATC curve is that it is flat-bottomed, i.e., there are no significant scale economies to be exploited or diseconomies to be suffered over a very wide range of plant sizes. Another way to say this is that there appears to be no purely cost-related incentives or penalties to further growth.

The significant implication of a flat-bottomed LATC curve is that small-sized firms (or firms with small plants) may coexist with and thrive along side of much larger firms (or firms with very large plants). It is not possible to predict with confidence whether such a market will be populated by many or few firms with large or small plants, but many economists believe that the growth pressures felt by managerial personnel in such industries likely militate in favor of an evolution toward a smaller number of larger firms. These long-run cost conditions may be even more favorable to the oligopolistic evolution than are those depicted in panel (b). Empirical data for a variety of industries suggest that many are in fact characterized by flat-bottomed LATC curves.

The functional-notation representation of a cost function can be given as ;

(1) $C = f(X_1, X_2, \ldots, X_n)$,

where C is cost, Q is output, and X_1 through X_n are possible independent variables which the analyst feels may be significant to the explanation of the behavior of costs. One obvious candidate for inclusion as an independent variable in time series data is t, a time period counter to indicate trend if the productive capacity of the capital equipment is thought to diminish due to weathering or obsolescence. Other independent variables to be included may be dummy variables (values of 0 or 1) to indicate the presence or absence of some condition, for example, whether or not the work force in each plant is unionized.

The analyst may attempt to model short- or long-run cost conditions. If the objective is analysis of the short-run, then the analyst may choose to model a total variable cost, an average variable cost, or a marginal cost. It really does not matter which form is chosen to model since it is possible by algebraic manipulation to derive the other two forms. For short-run analysis, if the enterprise produces only one product, the analyst could just as well model the TC relationship as the TVC relationship since TC and TVC have the same shapes (i.e., they are parallel along verticals) and share a common MC. However, if (as is usually the

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case) the enterprise produces a multiplicity of products, some of which may be jointly produced, there is a problem of how to allocate the overhead costs to the various products. This problem can be avoided by choosing to analyze only direct costs, i.e., the TVC relationship, and this is entirely appropriate since overhead costs are not relevant to short-run decision making anyway. If the object is to model the long-run cost relationship, then the appropriate focus of attention should be upon TC (i.e., including both direct and overhead costs) since in the long run all costs are variable and there is no difference between TC and TVC.

The usual statistical-estimation procedure is to subject the available data to regression analysis assuming a higher-order relationship than is expected. Then, if the highest-ordered terms are not statistically significant, the next lower-ordered regression equation may be tested. The highest-ordered total cost equation tested usually is cubic (the conceptual sense of an equation of higher-order than 3 is obscure) of form

$$TVC = b_0 + b_1Q + b_2Q^2 + b_3Q^3,$$

from which may be derived

$$MC = dTC/dQ = b_1 + 2\,b_2Q + 3\,b_3Q^2$$

and

$$AVC = TVC/Q = b_0/Q + b_1 + b_2Q + b_3Q^2.$$

If b_3 turns out not to be statistically significant but both b_1 and b_2 are significant, the model may be respecified as a quadratic of form

$$TVC = b_0 + b_1Q + b_2Q^2,$$

from which may be derived

$$MC = dTVC/dQ = b_1 + 2\,b_2Q$$

and

$$AVC = TVC/Q = b_0/Q + b_1 + b_2Q.$$

And if upon regression analysis of the quadratic form the coefficient b_2 appears not to be statistically significant, the equation may be re-specified as a linear form,

$$TVC = b_0 + b_1Q,$$

from which may be derived

$$MC = dTVC/dQ = b_1,$$

and

$$AVC = TVC/Q = b_0/Q + b_1.$$

If none of the coefficients, b_1, or b_2, or b_3 are statistically significant, then the effort to model the cost relationship by statistical means has failed.

Figure C6-4 illustrated the theoretically expected shapes of the TVC, AVC, and MC functions for a cubic (3rd order) relationship. Figures C6-5 and C6-6 illustrate the expected shapes of the quadratic (second order) and linear (first order) cost functions, respectively. Since so many real total cost functions turn out to be approximately linear over the range of

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data that are available, we should point out the fact that if TVC is linear, MC is constant (a horizontal line), and AVC falls to converge upon MC. The significance of this fact is that it may be possible to base output decisions upon the readily available average cost data (rather than the difficult-to-compute marginal costs) since average and marginal costs are approximately equal beyond some level of output.

Figure C6-5. Marginal and Average Costs for a Quadratic Total Cost Curve.

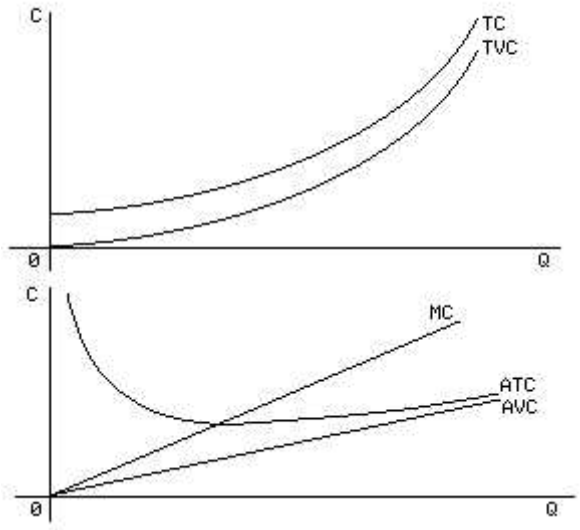
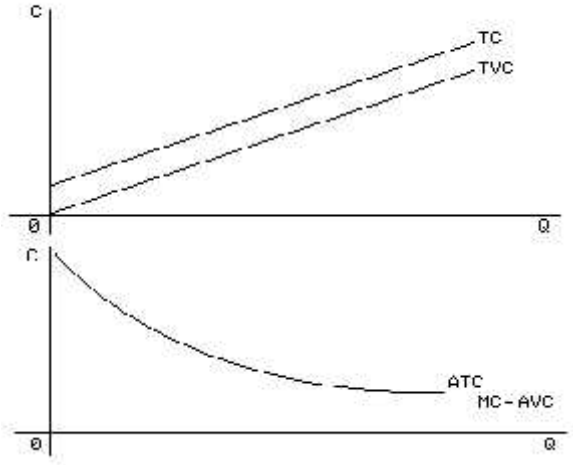


Figure C6-6. Marginal and Average Costs for a Linear Total Cost Curve.



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7.4. Economies and Diseconomies of Scale

Economies of scale exist when long-run average costs decline as output expands. Labor specialization often gives rise to economies of scale. In small firms, workers generally do several jobs, and proficiency sometimes suffers from a lack of specialization. Labor productivity can be higher in large firms, where individuals are hired to perform specific tasks. This can reduce unit costs for large-scale operations. Technical factors can also lead to economies of scale. Large-scale operation permits the use of highly specialized equipment, as opposed to the more versatile but less efficient machines used in smaller firms. Also, the productivity of equipment frequently increases with size much faster than its cost. A 500,000-kilowatt electricity generator costs considerably less than two 250,000-kilowatt generators, and it also requires less fuel and labor when operated at capacity. These economies extend to the cost of capital when large firms have easy access to capital markets and can acquire funds at lower rates.

At some output level, economies of scale are typically exhausted and average costs level out and begin to rise. Increasing average costs at high output levels are often attributed to limitations in the ability of management to coordinate large-scale organizations. Staff overhead also tends to grow more than proportionately with output, again raising unit costs. The current trend toward small to medium-sized businesses indicates that diseconomies limit firm sizes in many industries.

In the bottom panel of Figures 1 and 2, the LAC curve has been drawn as U-shaped. This is based on the assumption that economies of scale prevail at small levels of output and diseconomies of scale prevail at larger levels of output. As pointed out earlier, "economies of scale" refers to the situation in which output grows proportionately faster than inputs. For example, output more than doubles with a doubling of inputs. With input prices remaining constant, this leads to lower costs per unit. Thus, increasing returns of scale are reflected in a declining LAC Curve. On the other hand, decreasing returns to scale refers to the situation where output grows at a proportionately slower rate than the use of inputs. With input prices constant, this leads to higher costs per unit. Thus, decreasing returns to scale are reflected in an LAC curve that is rising. The lowest point on the LAC curve occurs at the output level at which the forces for increasing returns to scale are just balanced by the forces for decreasing returns to scale.

Increasing returns to scale or decreasing costs arise because of technological and financial reasons. At the technological level, economies of scale arise because as the scale of operation increases, a greater division of labor and specialization can take place and more specialized and productive machinery can be used. Specifically, with a large scale operation, each worker can be assigned to perform a repetitive task rather than numerous different ones. This results in increased proficiency and the avoidance of the time lost moving from one machine to another.

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Besides the technological reasons for increasing returns to scale or decreasing costs, there are financial reasons that arise as the size of the firm increases. Because of bulk purchases, larger firms are more likely to receive quantity discounts in purchasing raw materials and other intermediate (i.e., semi-processed) inputs than smaller firms. Large firms can usually sell bonds and stocks more favorably and receive bank loans at lower interest rates than smaller firms.

Large firms can also achieve economies of scale or decreasing costs in advertising and other promotional efforts. For all these technological and financial reasons, the LAC curve of a firm is
likely to decline as the firm expands and becomes larger. Decreasing returns to scale, on the other hand, arise primarily because as the scale of operation increases, it becomes ever more difficult to manage the firm effectively and coordinate the various operations and divisions of the firm. The number of meetings the paper work and telephone bills increases more than proportionately to the increase in the scale of operation, and it becomes increasingly difficult for top management to ensure that their directives and guidelines are properly carried out by their subordinates. Thus, efficiency decreases and costs per unit tend to rise.

It is often easy to calculate scale economies by considering cost elasticities. **Cost elasticity**, **εC,**
measures the percentage change in total cost associated with a 1 percent change in output. Algebraically, the elasticity of cost with respect to output is

$$\varepsilon_C = \frac{\text{Percentage Change in Total Cost (TC)}}{\text{Percentage Change in Output (Q)}}$$

$$\varepsilon_C = \partial TC/TC \div \partial Q/Q$$

$$\varepsilon_C = \partial TC/\partial Q * Q/TC$$

Cost elasticity is related to economies of scale as follows:

If	Then	Which Implies
Percentage change in TC < Percentage change in Q	$\varepsilon_C < 1$	Economies of scale (decreasing AC)
Percentage change in TC = Percentage change in Q	$\varepsilon_C = 1$	No Economies of scale (Constant AC)
Percentage change in TC > Percentage change in Q	$\varepsilon_C > 1$	Economies of scale (Increasing AC) i-e Diseconomies of scale are implied

With a cost elasticity of less than one (**εC** < 1), costs increase at a slower rate than output. Given constant input prices, this implies higher output-to-input ratios and economies of scale.

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If $\boldsymbol{\varepsilon C} = 1$, output and costs increase proportionately, implying no economies of scale. Finally, if $\boldsymbol{\varepsilon C} > 1$, for

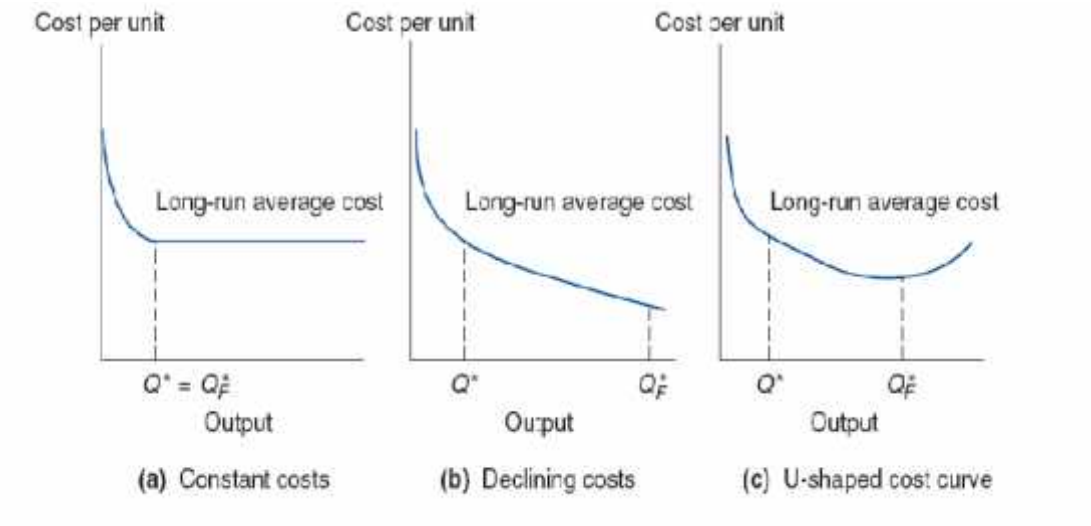
any increase in output, costs increase by a greater relative amount, implying decreasing returns to scale. To prevent confusion concerning cost elasticity and returns to scale, remember that an inverse relation holds between average costs and scale economies but that a direct relation holds between resource usage and returns to scale. Thus, although $\boldsymbol{\varepsilon C} < 1$ implies falling *AC* and economies of scale, because costs are increasing more slowly than output, recall from previous chapter that an output elasticity greater than 1 ($\boldsymbol{\varepsilon} Q > 1$) implies increasing returns to scale, because output is increasing faster than input usage. Similarly, diseconomies of scale are implied by $\boldsymbol{\varepsilon C} > 1$, diminishing returns are indicated when $\boldsymbol{\varepsilon} Q < 1$.

7.4.1. MULTI-PLANT ECONOMIES AND DISECONOMIES OF SCALE

Multi-plant economies of scale are cost advantages that arise from operating multiple facilities in the same line of business or industry. **Multi-plant diseconomies of scale** are cost disadvantages that arise from managing multiple facilities in the same line of business or industry. To illustrate, assume a U-shaped long-run average cost curve for a given plant, as shown in Figure 2, bottom panel. If demand is sufficiently large, the firm will employ in plants, each of optimal size and producing Q* units of output.

In this case, what is the shape of the firm's long-run average cost curve? Figure 5 shows three possibilities. Each possible long-run average cost curve has important implications for the minimum efficient firm size, Q*F. First, the long-run average cost curve can be L-shaped, as in Figure 5(a), if no economies or diseconomies result from combining plants. Second, costs could decline throughout the entire range of output, as in Figure 5(b), if multi-plant firms are more efficient than single-plant firms. When they exist, such cases are caused by economies of multiplant operation. For example, all plants may use a central billing service, a common purchasing or distribution network, centralized management, and so on. The third possibility, shown in Figure 5(c), is that costs first decline beyond Q*, the output of the most efficient plant, and then begin to rise. In this case, multi-plant economies of scale dominate initially, but they are later weighed down by the higher costs of coordinating many operating units.

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In the real world, the forces for increasing and decreasing returns to scale often operate side by side, with the former prevailing ,at small levels of output (so that the LAC curve declines) and the latter tending to prevail at much larger levels of output (so that the LAC curve rises). The lowest point on the LAC curve occurs when the forces for, increasing and decreasing returns to scale just balance each other. In the real world, however, the LAC curve is often found to have a nearly flat bottom and to be L-shaped rather than U-shaped. This implies that economies of scale are rather quickly exhausted and constant or near constant returns to scales prevail over a considerable range of outputs in many industries. In these industries, small firms coexist with much larger firms.

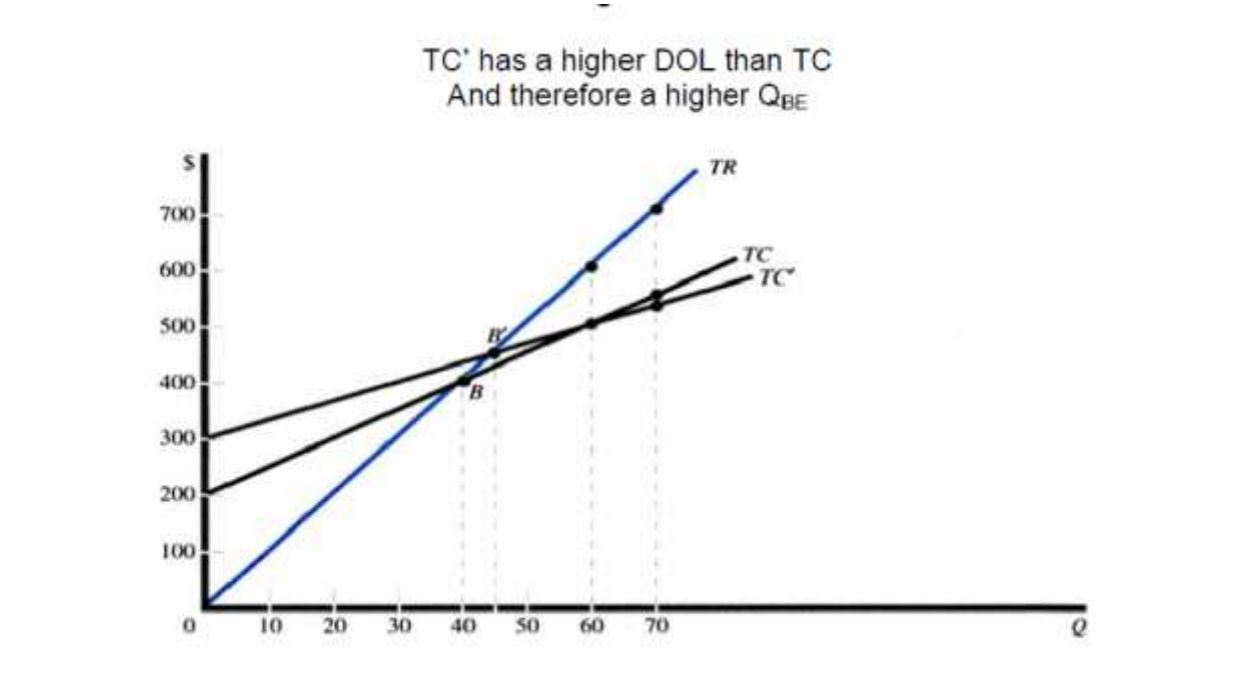
There are some industries, however, in which the LAC curve declines continuously as the firm expands output, to the point where a single firm could satisfy the total market for the product or service more efficiently than two or more firms. These cases are usually referred to as "natural monopolies" and often arise in case of such utilities as electricity and public transportation.

7.5. Breakeven Analysis and Operating Leverage-An Application of Cost

Theory operating leverage refers to the ratio of the firm's total fixed costs to total variable costs. The higher is this ratio, the more leveraged the firm is said to be. As the firm becomes more automated or more leveraged (i.e., substitutes fixed for variable costs), its total fixed costs rise but its average variable costs fall. Because of higher overhead costs, the breakeven output of the firm increases. This is shown in Figure 3. Cost-volume-profit analysis is also a useful tool for analyzing the financial characteristics of alternative production systems. This analysis focuses on how total costs and profits vary with operating leverage or the extent to

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which fixed production facilities versus variable production facilities are employed. The absolute slope of TC' > TC that is 5 > 3.33.



The degree of operating leverage is the percentage change in profit from a 1 unit change in units sold:

(9) $$DOL = \frac{\%\Delta \pi}{\%\Delta Q} = \frac{\Delta \pi / \pi}{\Delta Q / Q} = \frac{\Delta \pi}{\Delta Q} \cdot \frac{Q}{\pi}$$

But $\pi = Q(P - AVC) - TFC$ and $\Delta\pi = \Delta Q(P - AVC)$. Substituting these values into Equation (9), we get

(10) $$DOL = \frac{\Delta Q\,(P - A\,VC)\,Q}{\Delta Q[Q(P - A\,VC) - TFC]} = \frac{Q(P - A\,VC)}{Q(P - A\,VC) - TFC}$$

The numerator in Equation (10) is the total contribution to fixed costs, and profits of all units sold by the firm, and the denominator is total (economic) profit.

In terms of calculus:

$$DOL = \frac{\delta \pi}{\delta Q} \cdot \frac{Q}{\pi}$$

For example, for an increase in output from 60 to 70 units, the degree of operating leverage with TC is:

$$DOL = \frac{60(\$10 - \$5)}{60(\$10 - \$5) - \$200} = \frac{\$300}{\$100} = 3$$

With TC' (i.e., when the firm becomes more leveraged), the degree of operating leverage becomes

$$DOL' = \frac{60(\$10 - \$3.33)}{60(\$10\ \$3.33) - \$300\ \$100} = \frac{\$400}{} = 4$$

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Thus, the degree of operating leverage (DOL) increases as the firm becomes more leveraged or capital intensive. It is also higher the closer we are to the breakeven point because the base in measuring the percentage change in profits (the denominator in Equation 9) is close to zero near the breakeven point. The denominator becomes smaller and smaller so that DOL is higher. Note that when the firm's sales and output, are high (greater than 60 units in Figure 3), the firm makes larger profits when it is more leveraged (i.e., with TC'). But it also incurs losses sooner and these losses rise more rapidly than when the firm is less highly leveraged (i.e., with TC). The larger profits of the more highly leveraged firm when output is high (greater than 60 units in Figure 3) cant thus be regarded as the return for its greater risk.

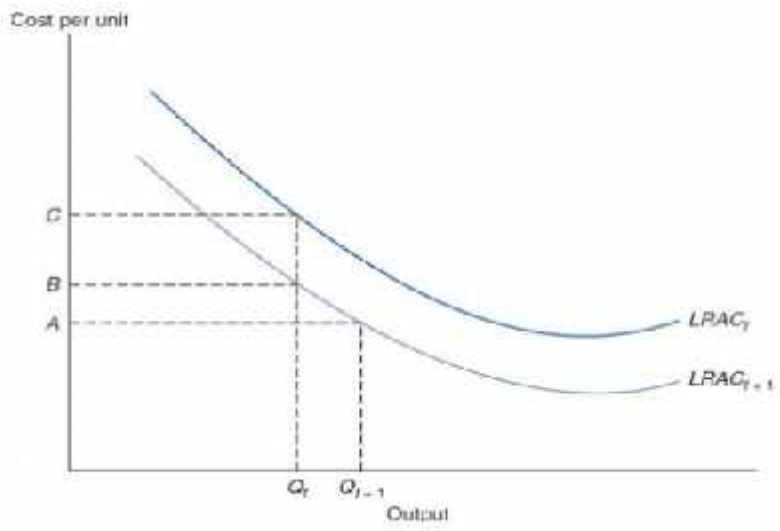
7.6. The Learning Curve

For many manufacturing processes, average costs decline substantially as *cumulative* total output increases. Improvements in the use of production equipment and procedures are important in this process, as are reduced waste from defects and decreased labor requirements as workers become more proficient in their jobs.

When knowledge gained from manufacturing experience is used to improve production methods, the resulting decline in average costs is said to reflect the effects of the firm's learning curve. The learning curve or experience curve phenomenon affects average costs in a way similar to that for any technical advance that improves productive efficiency. Both involve a downward shift in the long-run average cost curve at all levels of output. Learning through production experience permits the firm to produce output more efficiently at each and every output level. To illustrate, consider Figure 4, which shows hypothetical long-run average cost curves for period's t and t + 1. With increased knowledge about production methods gained through the experience of producing Qt units in period t, long-run average costs have declined for every output level in period t + 1, which means that Qt units could be produced during period t + 1 at an average cost of B rather than the earlier cost of C.

The learning curve cost savings is BC. If output were expanded from Qt to Qt+1 between these periods, average costs would fall from C to A. This decline in average costs reflects both the learning curve effect, BC, and the effect of economies of scale, AB.

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To isolate the effect of learning or experience on average cost, it is necessary to identify carefully that portion of average-cost changes over time that is due to other factors. One of the most important of these changes is the effect of economies of scale. As seen before, the change in average costs experienced between periods t and t + 1 can reflect the effects of both learning and economies of scale. Similarly, the effects of important technical breakthroughs, causing a downward shift in LRAC curves, and input-cost inflation, causing an upward shift in LRAC curves, must be constrained to examine learning curve characteristics. Only when output scale, technology, and input prices are all held constant can the learning curve phenomenon be identified.

Because the **learning curve** concept is often improperly described as a cause of economies of scale, it is worth repeating that the two are distinct concepts. **Scale economies** relate to cost differences associated with different output levels along a single LRAC curve. Learning curves relate cost differences to total cumulative output. They are measured by shifts in LRAC curves over time. These shifts result from improved production efficiencies stemming from knowledge gained through production experience. Care must be exercised to separate learning and scale effects in cost analysis.

Research in a number of industries, ranging from aircraft manufacturing to semiconductor memory-chip production, has shown that learning or experience can be very important in some
production systems. Learning or experience rates of 20 percent to 30 percent are sometimes reported. These high learning rates imply rapidly declining manufacturing costs as cumulative total output increases. It should be noted, however, that many learning curve studies fail to account adequately for the expansion of production. Therefore, reported

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learning or experience rates sometimes include the effects of both learning and economies of scale. Nevertheless, managers in a wide variety of industries have found that the learning curve concept has considerable strategic implications.

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Define cost and cost functions		
Describe different types of costs		
Explain short run and long run cost curves		
Explain economies and diseconomies of scale		
Describes learning curve		
Describe strategic implications of learning curve		

Summary

Economic theory postulates an S-shaped (cubic) TVC curve as indicated in the left panel of Figure 1, with corresponding U-shaped AVC and MC curves. The general equations for these functions are, respectively,

Cubic TVC Function

$$TVC = a(Q) + bQ^2 + cQ^3$$

$$AVC = \frac{TVC}{Q} = a + Q + cQ^2$$

$$MC = a + 2bQ + 3cQ^2$$

Where conditions for U-shape cost functions are: a > 0, b < 0 and c > 0 The right panel of Figure 1 shows a linear approximation to the cubic TVC curve, which often gives a good empirical fit of the data points over the observed range of outputs. The estimated equations of the linear approximation to the S-shaped or cubic TVC curve and of its corresponding AVC and MC curves are

Linear TVC Function

$$TVC = a + bQ$$

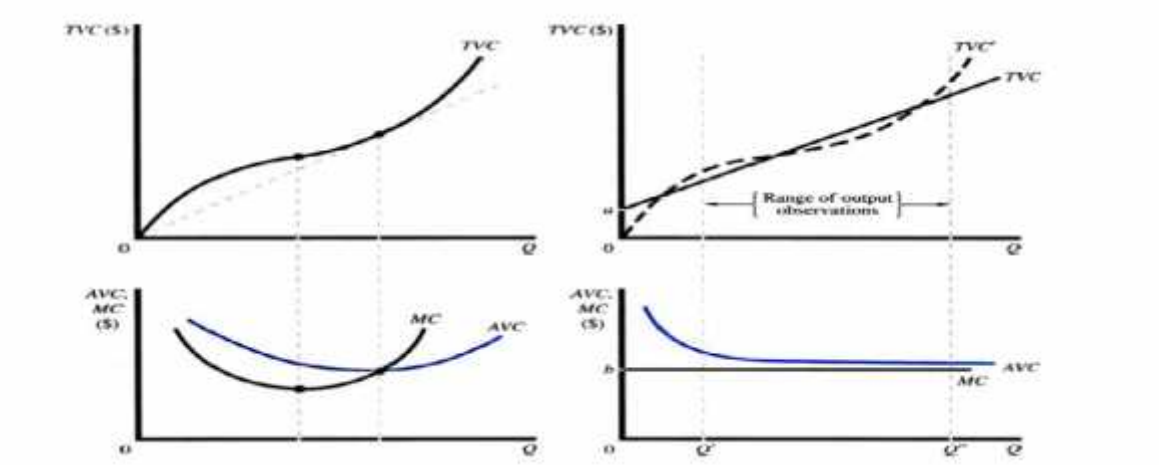
$$AVC = a/Q + b$$

$$MC = b$$

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Quadratic TC Function

$TC = a + bQ + cQ^2$
$AC = a/Q + b + cQ$
$MC = b + 2cQ$
Where $a > 0$, $c > 0$ and $b < 0$



Having estimated the parameters of the ***TVC*** curves (i.e; the value of a and b in Equation 5), we can use these estimated parameters to derive the corresponding AVC and MC functions of the firm, as indicated in Equations (6) and (7). We might note that estimated parameter ***a*** (the constant in estimated Regression 5) cannot be interpreted as the fixed cost of the firm since we are estimating the ***TVC*** function. Since ***Q = 0*** is usually far removed from the actual observed data points on the ***TVC*** curve (from ***Q' to Q"*** in the right panel of Figure1, no economic significance can be attached to the estimated parameter ***a***. We might also note that the ***AVC*** curve in the right panel becomes quite flat, approaching the value of (the horizontal MC curve).

This i ***b*** s often observed in the actual empirical estimation. Another nonlinear theoretical from of

the TVC curve that is often closely approximated by a linear ***TVC*** is the quadratic form. The quadratic ***TVC*** curve rises at an increasing rate (i.e., faces diminishing returns) throughout (and so do the corresponding ***AVC*** and ***MC*** curves). One possible explanation for this is that while the amount of capital (say the number of machines) that the firm has is fixed in the short run, they may keep some machines idle when output is low and bring them into operation by hiring more labor when it wants to increase output. Since the ratio of machines to output as well as machines to labor tends to remain constant in the face of changes in output, the firm's ***AVC*** and ***MC*** to remain approximately constant.

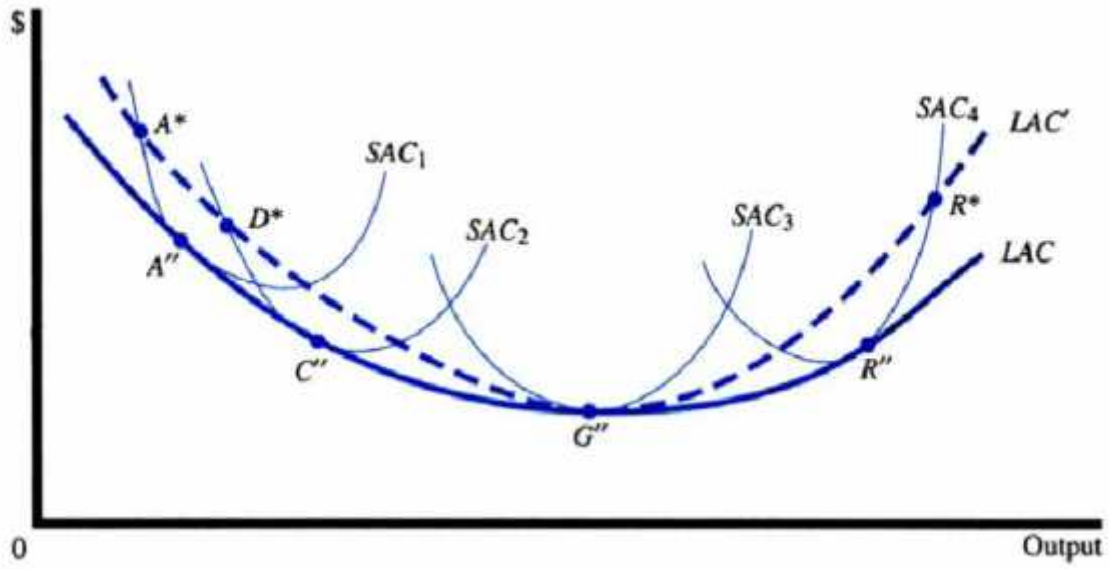
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Three different specifications of cost functions are: cubic, quadratic and Linear. Each represents a possible shape of the cost curves. The economist, after collecting and adjusting the data, will use one of these specifications to measure the relationship between cost and output. Other statistical functions could be employed (e.g; the Cobb-Douglas power function), but the three shapes are the ones most frequently encountered in statistical studies, that is, cubic, quadratic or Linear.

It may also be very difficult to determine if each firm is operating the optimal scale of plant at the optimal level of output (i.e; at the point on its ***SAC*** curve which forms part of its ***LAC*** curve).Specifically, in order to be able to estimate ***LAC*** curve ***A'' C'' G'' R''*** in Figure 2, the firms represented by ***SAC1, SAC2, SAC3 and SAC4*** must operate at points ***A'', C'', G'', and R'',*** respectively. If in fact the four firms are producing at points A****, C*, G*, and R*,*** respectively, we would be estimating the dashed ***LAC'*** curve, which overestimates the degree of both the economies and diseconomies of scale. The estimated long-run average cost curves seem to indicate sharply increasing returns to scale (falling ***LAC*** curve) at low levels of output followed by near-constant returns to scale at higher levels of output (i.e; the ***LAC*** curve seems to be L shaped or nearly so).

Figure 2

Actual LAC versus empirically estimated LAC'



? ? Self Test exercise

1. Consider an Electronics Company XYZ that manufactures industrial control panels. Presently it is producing at a single plant but a multi-plant alternative is being considered. Estimated demand, marginal revenue, and single-plant production plus transportation cost curves for the firm are:

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$P = 940 - 0.02Q$
$TR = P^*Q = (940 - 0.02Q)\,Q = 940Q - 0.02Q^2$
$MR = \partial TR/\partial Q = 940 - 0.04Q$
$TC = 250{,}000 + 40Q + 0.01Q^2$
$MC = \partial TC/\partial Q = 40 + 0.02Q$

The firm total profit function is:

$\pi = TR - TC = (940 - 0.02Q)\,Q - 250{,}000 - 40Q - 0.01Q^2$
$\pi = -0.03Q^2 + 900Q - 250{,}000$

Setting marginal revenue = marginal cost and solving for the related output quantity gives:

$MR = MC$
$940 - 0.04Q = 40 + 0.02Q$
$0.06Q = 900$
$Q = 15{,}000$
At $Q = 15{,}000$ $P = 940 - 0.02(15{,}000)$
$= \$640$ &
$\pi = \$6{,}500{,}000$ or \$6.5 million

Profits are maximized at Q = 15,000 output level under the assumption of single-plant. In order to get insight regarding the possible advantages of multi-plant operation, the AC function for a single-plant must be examined. To simply matters, we assume that multi-plant production is possible under the same cost conditions. Also assume that there are no other multi-plant economies or diseconomies of scale. The activity level at which AC is minimized is found by setting MC = AC and solving for Q:

$AC = TC/Q = 250{,}000 + 40Q + 0.01Q^2/Q$
$AC = 250{,}000/Q + 40 + 0.01Q$

$MC = AC$
$40 + 0.02Q = 250{,}000/Q + 40 + 0.01Q$
$Q^2 = 250{,}000/0.01$

So $Q = \sqrt{250{,}000} = 5{,}000$
At Q = 5,000 AC-minimizing activity level might suggest multi-plant production at 3 facilities (plants) will be optimum as:

$$\text{Optimal No of Plants} = \frac{\text{Optimal Multi Plant Activity level}}{\text{Optimal Production per Plant}}$$

$= 15{,}000/5000 = 3$

But previously MR = MC = \$640, however, with multi-plant production, MC will be lowered:
$MC = 40 + 0.02Q = 40 + 0.02(5{,}000) = \$140$
$MR = MC$
$940 - 0.04Q = 140$
$Q = 20{,}000$

$$\text{Optimal No of Plants} = \frac{\text{Optimal Multi Plant Activity level}}{\text{Optimal Production per Plant}}$$
$= 20{,}000/5{,}000 = 4$ Plants

At $Q = 20{,}000$ $P = 940 - 0.02(20{,}000)$
$= \$540$
And $\pi = TR - TC = P^*Q - 4^*$ TC per plant
$= 540(20{,}000) - 4[250{,}000 + 40(5000) + 0.01(5{,}000)\,2]$
$= \$8{,}000{,}000$ or \$8 million

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CHAPTER EIGHT
PRICING AND OUTPUT DECISIONS

Learning objectives;

Upon successful completion of this chapter students will be able to:

- ***Explain the role of price in different market structure***
- ***Describe output and price determination under perfect completion***
- ***Explain pure monopoly market structure***
- ***Identify oligopoly and cartel market structures***

Introduction

In previous chapters, we studied the behavior of individual consumers and firms, describing optimal behavior when markets prices were fixed and beyond the agent's control. Here, we explore the consequences of that behavior when consumers and ¯rms come to- gether in markets. We will consider equilibrium price and quantity determination in a single market or group of closed related markets by the actions of the individual agents for different markets structures.

This equilibrium analysis is called a partial equilibrium analysis because it focus on a single market or group of closed related markets, implicitly assuming that changes in the markets under consideration do not change prices of other goods and upset the equilibrium that holds in those markets. We will treat all markets simultaneously in the general equilibrium theory. We will concentrate on modelling the market behavior of the ¯rm. How do ¯rmsdetermine the price at which they will sell their output or the prices at which they are willing to purchase inputs? We will see that in certain situations the \price-taking behavior" might be a reasonable approximation to optimal behavior, but in other situations we will have to explore models of the price-setting process. We will ¯first consider the ideal (benchmark) case of perfect competition. We then turn to the study of settings in which some agents have market power. These settings include markets structures of pure monopoly, monopolistic competition, oligopoly, and monopsony.

8.1. Individual, Firm, and Market Demand Curves

Let us start to consider the case of pure competition in which there are a large number of independent sellers of some uniform product. In this situation, when each ¯rm sets the price in which it sells its output, it will have to take into account not only the behavior of the consumers but also the behavior of the other producers.

Perfect competition exists when individual producers have no influence on market prices; they are price takers as opposed to price makers. This lack of influence on price typically requires.

• Large numbers of buyers and sellers. Each firm produces a small portion of industry output, and each customer buys only a small part of the total.

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• Product homogeneity. The output of each firm is essentially the same as the output of any other firm in the industry.
• Free entry and exit. Firms are not restricted from entering or leaving the industry.
• Perfect dissemination of information. Cost, price, and product quality information is known by all buyers and all sellers.
• Opportunity for normal profit in long run equilibrium. Fierce price competition keeps
P = MC and P =AR = AC.
• Non price competition not possible.

There is a great number of buyers and sellers of the product, and each seller and buyer is too small in relation to the market to be able to affect the price of the product. This means that a change in the output of a single firm will not affect the market price of the product. Similarly, each buyer of the product is too small to be able to extract from the seller such things as quantity discounts and special credit terms.

The product of each competitive firm is homogeneous, identical, or perfectly standardized. An example of this might be grading of wheat and cotton crops. As a result buyers cannot distinguish between the output of one firm and the output of another, so they are indifferent from
which firm they buy the product. Under perfect competition, there is perfect mobility of resources. That is, workers and other inputs can easily move geographically from one job to another and can respond quickly to monetary incentives. That is, there are no patents or copyrights, "vast amounts" of capital are not necessary to enter the market, and already established firms do not have any lasting cost advantage over new entrants because of experience or size.

Finally, under perfect competition, consumers, resource owner, and firms in the market have perfect knowledge as to present and future prices, costs, and economic opportunities in general. Thus, consumers will not pay a higher price than necessary for the product. Price differences are quickly eliminated, and a single price will prevail throughout the market for the product. Perfect competition, as defined above, has never really existed. Perhaps the closest we might come today to a perfectly competitive market is the stock market. Another example is the market for such agricultural commodities as wheat, cotton and corn. The natural gas industry and the trucking industries also approach perfect competition. In the milk market, each dairy farmer produces the milk that is essentially identical to that offered by other dairy farmers.

A competitive ¯rm is one that takes the market price of output as being given. Let ¹p be the market price. Then the demand curve facing an ideal competitive ¯rm takes the form

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$$D(p) = \begin{cases} 0 & \text{if } p > \bar{p} \\ \text{any amount} & \text{if } p = \bar{p} \\ \infty & \text{if } p < \bar{p} \end{cases}$$

A competitive ¯rm is free to set whatever price it wants and produce whatever quantity it is able to produce. However, if a ¯rm is in a competitive market, it is clear that each ¯rm that sells the product must sell it for the same price: for if any ¯rm attempted to set its price at a level greater than the market price, it would immediately lose all of its customers. If any ¯rm set its price at a level below the market price, all of the consumers would immediately come to it. Thus, each ¯rm must take the market price as given, exogenous variable when it determines its supply decision.

Since the competitive ¯rm must take the market price as given, its pro¯t maximization problem is simple. The ¯rm only needs to choose output level *y* so as to solve

$$\max_{y} py - c(y) \qquad (8.1)$$

How is the market price determined? It is determined by the requirement that the total amount of output that the ¯rms wish to supply will be equal to the total amount of output that the consumers wish to demand. Formerly, we have A *partial equilibrium price p*¤ is a price where the aggregate quantity demanded equals the aggregate quantity supplied. That is, it is the solution of the following equation:

$$\sum_{i=1}^{n} x_i(p) = \sum_{j=1}^{J} y_j(p) \qquad (6.11)$$

Once this equilibrium price is determined, we can go back to look at the individual supply schedules of each ¯rm and determine the ¯rms level of output, its revenue, and itspro¯ts. In Figure 8.2, we have depicted cost curves for three ¯rms. The ¯rst has positivepro¯ts, the second has zero pro¯ts, and the third has negative pro¯ts. Even though thethird ¯rm has negative pro¯ts, it may make sense for it to continue to produce as long as its revenues cover its variable costs.

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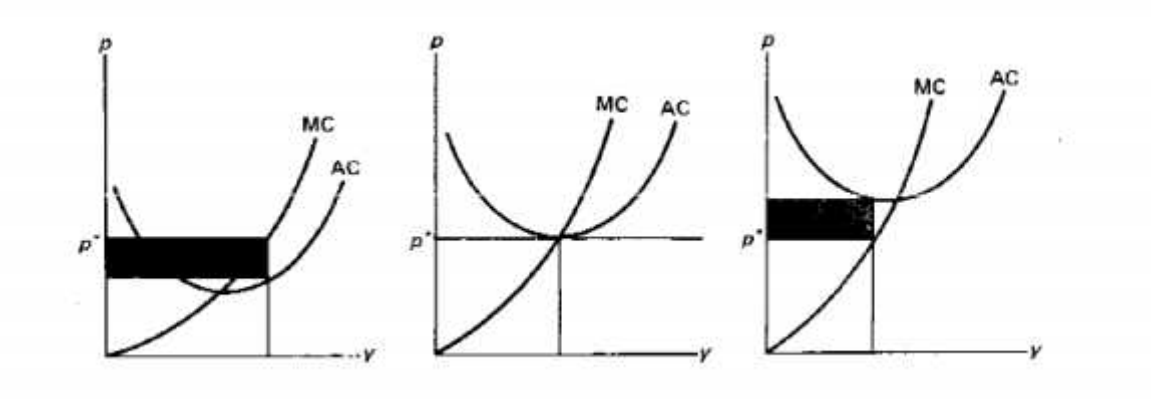
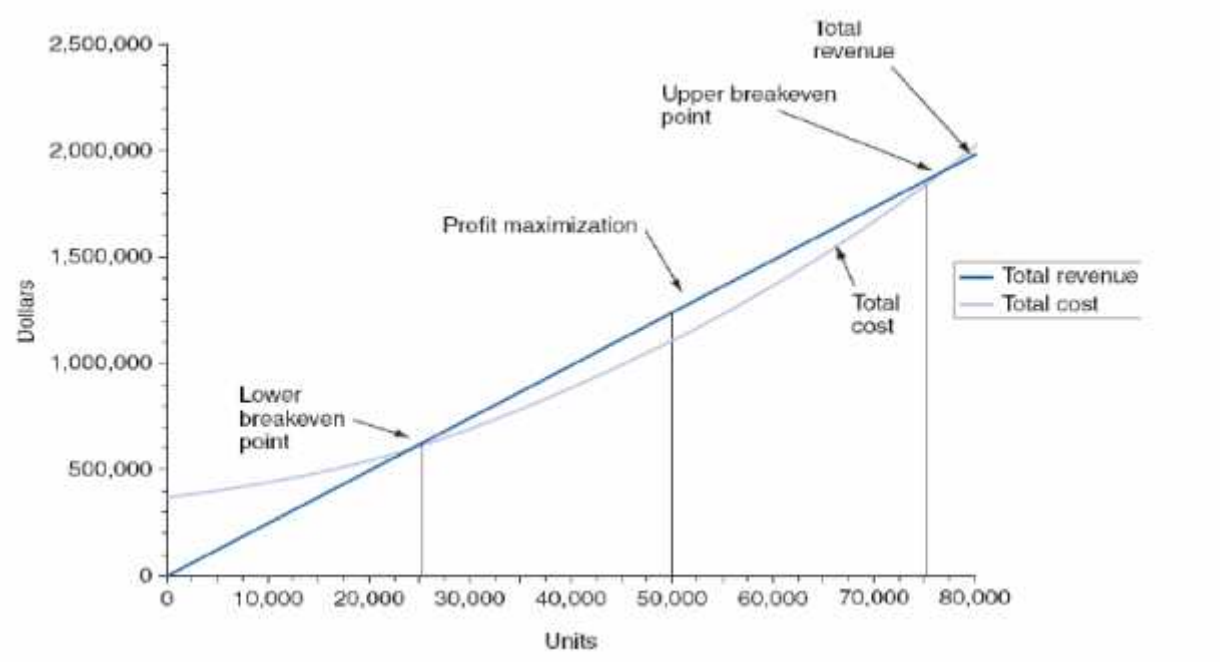


Figure 8.2: Positive, zero, and negative pro¯ts.

8.2. Price-Output Determination under Pure Competition

In Figure 1, the Total cost and total revenue curves of a perfectly competitive firm are shown. The TR curve is a straight line through the origin showing that price is constant at all levels of output. The firm is a price taker and can sell any amount of output at the given market price, with its TR increasing proportionately with its sales. The slope of the TR curve is the MR. It is constant and equal to the prevailing market price, since all units are sold at the same price. Thus P = MR = AR. The shape of the TC curve reflects the U shape of the AC and MC curves. The firm maximizes its profit at Q = $50,000 units, where the distance between the TR and TC is the greatest.



The TR-TC approach is awkward to use when firms are combined together in study of the industry. The alternative approach which is based on marginal cost- marginal revenue, uses

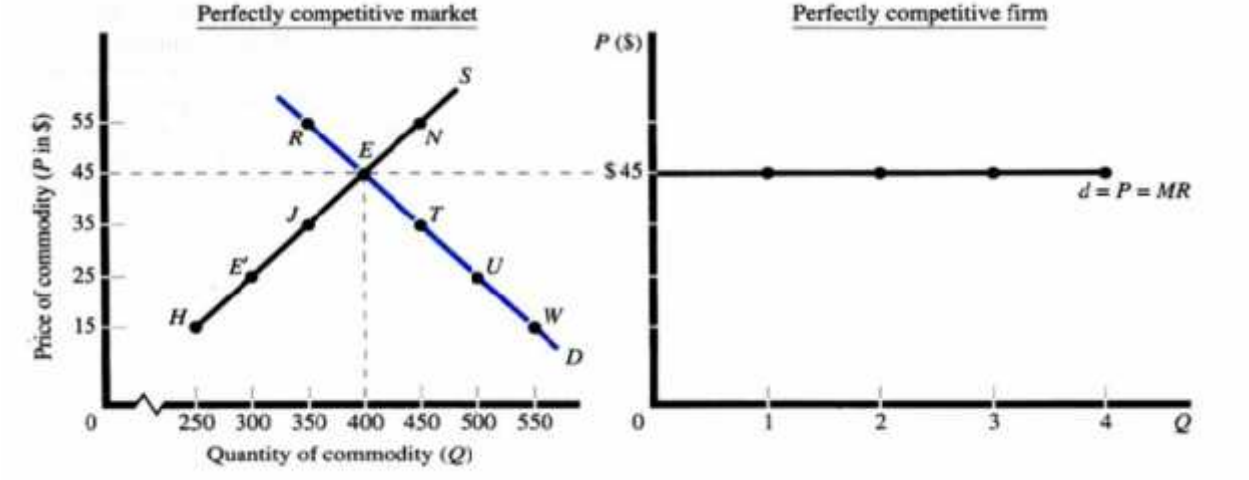
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price as an explicit variable, and shows clearly the behavioral rule leads to profit maximization. Under perfect competition, the price of a product is determined at the intersection of the market demand curve and the market supply curve of the product. The market demand curve for product is simply the horizontal summation of the demand curves of all the consumers in the market. The market supply curve of a product is similarly obtained from the horizontal summation of the supply curve of the individual producers of the product.

Given that the market price of a product is determined at the intersection, of the market demand and supply curves of the product, the perfectly competitive firm is a price taker. That is, the perfectly competitive firm takes the price of the product as given and has no perceptible effect on that price by varying its own level of output and sales of the product. Since the products of all firms are homogeneous, a firm cannot sell at a price higher than the market price of the product; otherwise the firm would lose all its customers. On the other hand, there is no reason for the firm to sell at a price below the market price, since it can sell any quantity of the product at the given market price. As a result, the firm faces a horizontal or infinitely elastic demand curve for the product at the market price determined at the intersection of the market demand and supply curves of the product. For example, a small wheat farmer can sell any amount of wheat at the given market price of wheat. This is shown in Figure 2.

Figure 2

Perfect Competition: Price Determination



Role of Marginal Analysis

Set Mπ = MR – MC = 0 to maximize profits.

MR= MC when profits are maximized.

Normal Profit Equilibrium

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There are no economic profits in competitive equilibrium; firms earn a normal rate of return.

With a horizontal market demand curve, MR = P, so **P = MR = MC = ATC**.

Given the equilibrium price of P = $45, a perfectly competitive firm producing, the product faces the horizontal or infinitely elastic demand curve shown by d at P = $45 in Figure 2. The perfectly

competitive firm only determines what quantity of the product to produce at P = $45 in order to maximize its total profits. When the product price is constant, the change in the total revenue per unit change in output or marginal revenue (MR) is also constant and is equal to the product price. That is, for a perfectly competitive firm, **P = MR**

The equilibrium price and quantity can be determined algebraically by setting the market demand and supply functions equal to each other and solving for the equilibrium price. Substituting the equilibrium price into the demand or supply functions and solving for Q, we then get the equilibrium quantity. For example, the equations for the market demand and supply curves for the product in Figure 2 are:

QD = 625 – 5P

QS = 175 + 5P

QD = QS

625 – 5P = 175 + 5P

Solving for P, we have

450 = 10P

P = $45

Substituting P = $45 into the demand function and solving for Q, we have

QD = 625 – 5P = 625 – 5(45) = 400 units

PROFIT MAXIMIZATION WITH CALCULUS

$\pi = TR - TC$

$d\pi/dQ = dTR/dQ - dTC/dQ = 0$

so that $dTR/dQ = dTC/dQ$

Since $dTR/dQ = MR$ and $dTC/dQ = MC$

The above condition becomes MR = MC. But under perfect competition, the price is given to the

firm and is constant. Therefore,

dTR/dQ = d(PQ)/dQ = P = MR

So that the **FOC** for maximization under perfect competition becomes P = MR = MC. (The product Rule of differentiation will not apply as under perfect competition P (price) is constant so d(PQ)/dQ = P)

The second order condition for profit maximization requires that the second derivative of Π with

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respect to Q be negative. That is,

SOC

$d^2 \pi / Dq^2 = d^2 TR / dq^2 - d^2 TC / dq^2 < 0$

$d^2 TR / dq^2 < d^2 TC / dq^2$

So verbally, Slope of MR curve < Slope of MC curve, thus MC must have a steeper slope than the MR curve or the MC curve must cut the MR curve from below.

Under perfect competition, t he slope of MR curve is zero, hence the SOC is simplified as follows :

$0 < d^2 TC / dq^2$

MC must have a +tive slope, or the MC must be rising.

SHORT-RUN ANALYSIS OF A PERFECTLY COMPETITIVE FIRM

In the short run, some inputs are fixed, and these give rise to fixed costs, which go on whether the firm produces or not. Thus, it pays for the firm to stay in business in the short run even if it incurs losses, as long as these losses are smaller than its fixed costs. Thus, the best level of output of the firm in the short run is the one at which the firm maximizes profits or minimizes losses.

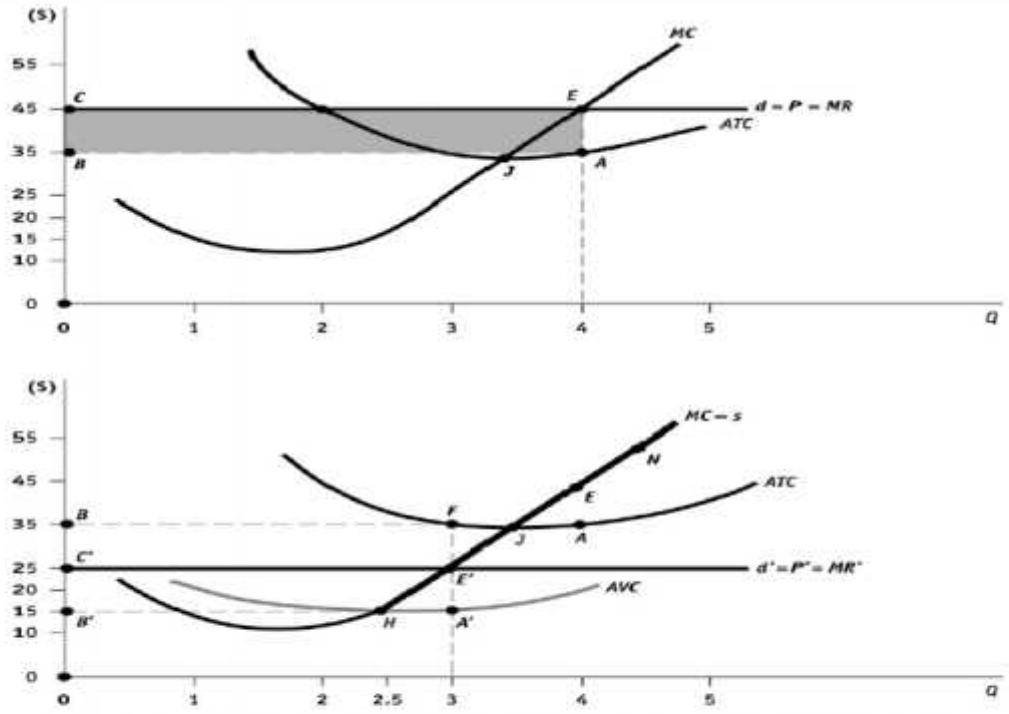


FIGURE 8-2 Short-Run Analysis of a Perfectly Competitive Firm With *d* the best level of output is 4 units and is shown in the top panel by point *E*, at which $P = MR = MC$, and the firm earns profit $EA = \$10$ per unit, and $EABC = \$40$ in total. With *d* in the bottom panel, the best level of output is 3 units and is given by point *E'* at which the firm incurs a loss of $E'E = \$10$ per unit, and $E'E'C'B = \$30$ in total. At point *E'* the firm minimizes losses. The shut-down point is at point *H*. The rising portion of the *MC* curve above the *AVC* curve (shut-down point) is the firm's short-run supply curve (the heavy portion of the *MC* curve in the bottom panel).

The best level of output of the firm in the short run is the one at which the marginal revenue (MR) of the firm equals its short run marginal cost (MC). As long as MR exceeds MC, it pays for the firm to expand output because by doing so the firm would add more to its total revenue than to its total costs (so that its total profits increase or its total losses decrease). On

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the other hand, as long as MC exceeds MR, it pays for the firm to reduce output because by doing so the firm will reduce its total costs more than its total revenue (so that, once again, its total profits increase or its total losses decrease). Thus, the best level of output of any firm (not just a perfectly competitive firm) is the one at which MR = MC. Since a perfectly competitive firm faces a horizontal or infinitely elastic demand curve, P = MR, so that the condition for the best level of output can be restated as the one at which P = MR = MC. This can be seen in Figure 3.

In the top panel of Figure 3, d is the demand curve for the output of the perfectly competitive firm and the marginal and average total cost (i.e., MC and ATC) curves are also drawn. The best level of output of the firm is given at point E, where the MC curve intersects the firm's d or MR curve. At point E, the firm produces 4 units of output at P = MR = MC = $45. Since at point E, P = $45 and ATC = $35, the firm earns a profit of EA = $10 per unit and EABC = $40 in total (the shaded area). This is the largest total profit that the firm can earn. Thus, the best level of output for the firm is **QX = 4**, at which **MR = P = MC** and the total profits of the firm are maximized.

The bottom panel of Figure 3 shows that if the market price of the product is $25 instead of $45,
so that the demand curve faced by the perfectly competitive firm is d', the best level of output of
the firm is 3 units, as indicated by point **E'**, where **P'= MR' = MC** At **QX** = 3, **P** = $25 and **ATC** = $35, so that the firm incurs the loss of FE' = $10 per unit and FE'C'B = $30 in total. If the firm stopped producing the product and left the market, however, it would incur the greater loss of FA' =' $20 per unit and FA'B'B = $60 (its total fixed costs). Another way of looking at this is to say that at the best level of output of Q = 3, the excess of P = $25 over the firm's average variable cost (AVC) of $15 can be applied to cover part of the firm's fixed costs (FA' per unit and
FA'B'B in total). Thus, the firm minimizes its losses by continuing to produce its best level of output. If the market price of the product declined to slightly below $15, so that the demand curve facing the firm crossed the MC curve at point H (see the bottom panel of Figure 3), the firm would be indifferent whether to produce or not. The reason is that at point H, P = AVC and the total losses of the firm would be equal to its total fixed costs whether it produce or not. Thus, point H is the shut down point of the firm. Below point H, the firm would not even cover its variable costs, and so by going out of business, the firm would limit its losses to be equal to its total fixed costs.

SHORT-RUN SUPPLY CURVE OF THE COMPETITIVE FIRM

The rising portion of the firm's MC curve above the AVC curve or shut-down point is or represents the short run supply curve of the perfectly competitive firm (the heavier portion of

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the MC curve labeled **s** in the bottom panel of Figure 1. The reason for this is that the perfectly competitive firm always produces where P = MR = MC, as long as P > AVC. Thus, at P = $55, the firm produces 4.5 units (point N); at P = $45, Q = 4; at P = $25, Q = 3; and at P = $15, Q = 2.5. That is, given P, we can determine the output supplied by the perfectly competitive firm by the point where P = MC. Thus, the rising portion of the competitive firm's MC curve above AVC shows a unique relationship between P and Q, which is the definition of the supply curve

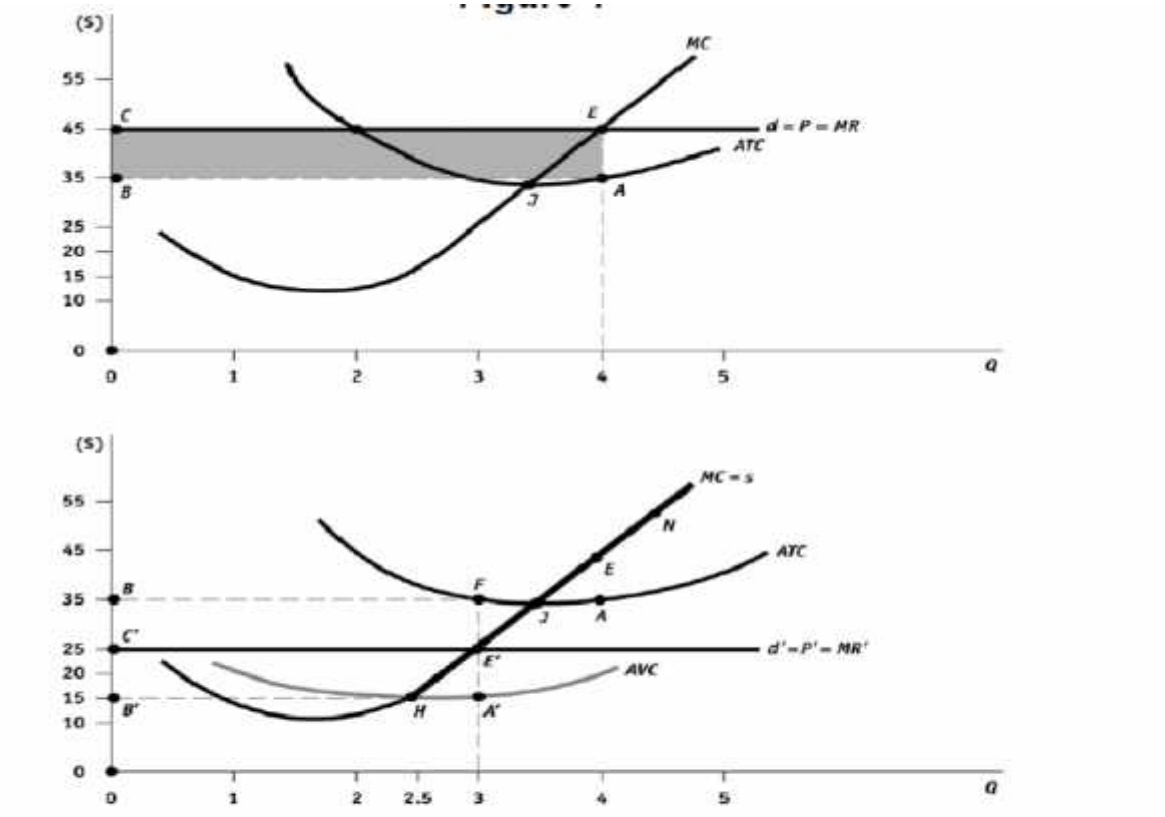


FIGURE 8-2 Short-Run Analysis of a Perfectly Competitive Firm With *d* the best level of output is 4 units and is shown in the top panel by point *E*, at which $P = MR = MC$, and the firm earns profit EA = $10 per unit, and $EABC$ = $40 in total. With *d* in the bottom panel, the best level of output is 3 units and is given by point E' at which the firm incurs a loss of FE' = $10 per unit, and $FE'C'B'$ = $30 in total. At point E' the firm minimizes losses. The shut-down point is at point *H*. The rising portion of the *MC* curve above the *AVC* curve (shut-down point) is the firm's short-run supply curve (the heavy portion of the *MC* curve in the bottom panel).

Example

A competitive firm **short-run supply curve** is the marginal cost curve, so long as **P > AVC.**

Given:

TC = 361,250 + 5Q + 0.0002Q2

TR = 25Q

MR = MC

25 = 5 + 0.0004Q

Q = 50,000

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Since the firm is price taker: P = MR = $25

$\pi = TR - TC$

$= 25(50,000) - 361,250 - 5(50,000) - 0.0002(50,000)^2$

$\Pi = \$138,750$

MC = ATC

$$5 + 0.0004Q = \frac{361,250 + 5Q + 0.0002Q^2}{Q}$$

Q = 42,500

It is clear that the point of minimum AVC is reached in the output range between 15,000 to 20,000, where $AVC = 50,000 + 5Q + 0.0002Q^2$. The minimum point on the AVC occurs at Q = 15,811 and AVC = $11.32, and is found by setting MC = AVC and solving for Q:

P = $25

MC = AVC

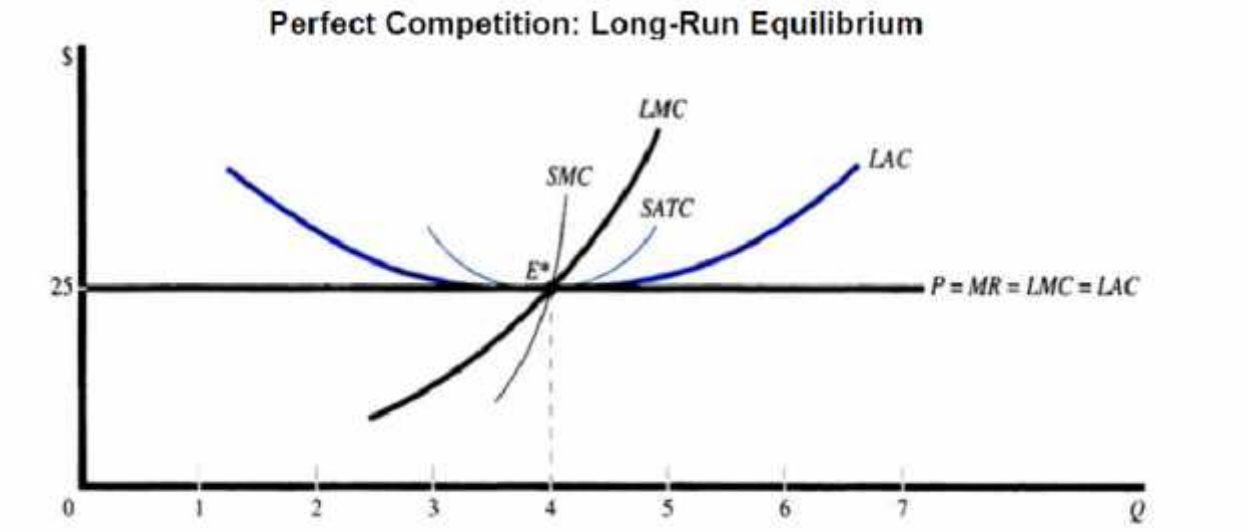
$$5 + 0.0004Q = \frac{50,000 + 5Q + 0.0002Q^2}{Q}$$

Q = 15,811

LONG-RUN ANALYSIS OF A PERFECTLY COMPETITIVE FIRM

In the long run all inputs and costs of production are variable, and the firm can construct the optimum or most appropriate scale of plant to produce the best level of output. The best level of output is the one at which price equals the long-run marginal cost (LMC) of the firm. The optimum scale of plant is the one with the short run average total cost (SATC) curve tangent to the long-run average cost of the firm at the best level of output. On one hand, if existing firms earn profits, more firms enter the market in the long run. This increases (i.e., shifts to the right) the market supply of the product and results in a lower product price until all profits are squeezed out. On the other hand, if firms in the market incur losses, some firms will leave the market in, the long run. This reduces the market supply of the product until all firms remaining in the market just break even. Thus, when a competitive market is in long run equilibrium all firms produce at the lowest point on their long-run average cost (LAC) curve and break even. This is shown by point E* in Figure 2. Figure 2 shows that at p = $25, the best level of output of the perfectly competitive firm is 4 units and is given by point E*, at which P = LAC. Because of free or easy entry into the market, all profits and losses have been eliminated, so that P = LMC = lowest LAC. Thus, for a competitive market to be in long run equilibrium, all firms in the industry must produce where P = MR = LMC = lowest LAC so that all firms break even. The perfectly competitive firm operates the scale of plant represented by SATC at its lowest point (point E*), so that its short run marginal cost (SMC) equals LMC also.

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MARGINAL COST AND FIRM SUPPLY

Short-run Firm Supply

Competitive market price (P) is shown as a horizontal line because P=MR.

Marginal cost schedule is the short-run supply curve so long as P > AVC.

Long-run Firm Supply

Profit. P=MR = MC

Marginal cost curve is the long-run supply curve so long as P > ATC.

Perfect Competition and Efficiency

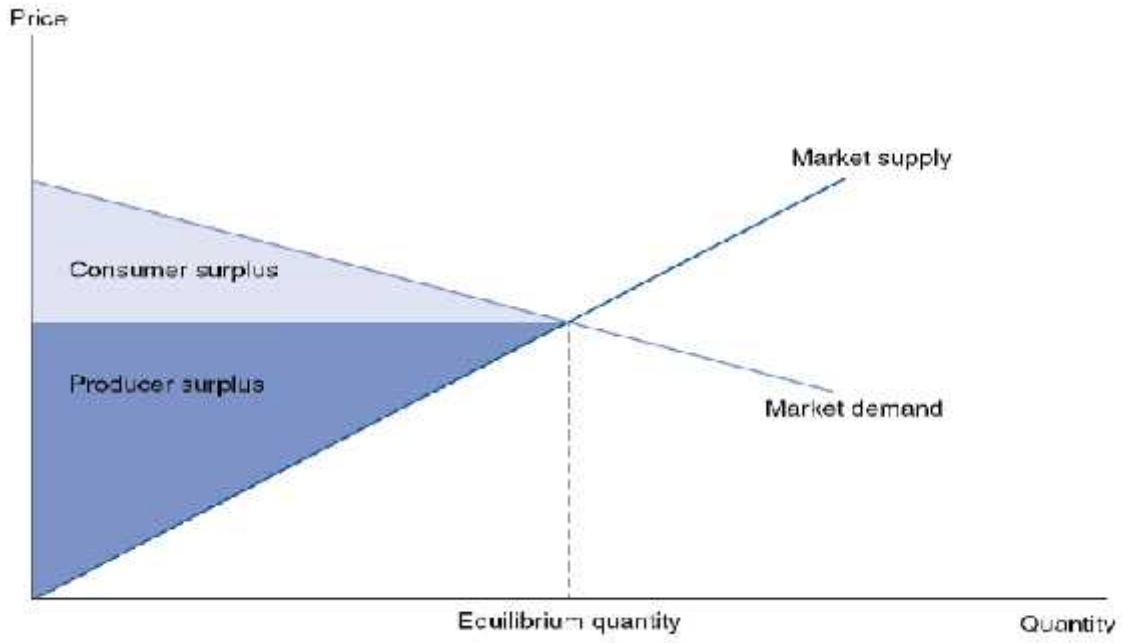
The model of perfect competition achieves efficiency in two ways:

Allocative efficiency: Price = MC and therefore consumer and producer surpluses are maximised

Productive efficiency: In the long run in perfect competition equilibrium output is produced where average costs are at their lowest point Welfare economics is the study of how the allocation of economic resources affects the material well-being of consumers and producers. Competitive markets creates balance between supply and demand, also maximize the total social welfare of the society derived from such activity.

The measurement of social welfare is closely related to consumer and producer surpluses. Consumer surplus is the amount that consumers are willing to pay for a given good or service minus the amount that they are required to pay. Producer surplus is the net benefit derived by producers from production. Figure 3 shows consumer and producer surpluses.In long run, firm must cover all necessary costs of production and earn a normal.

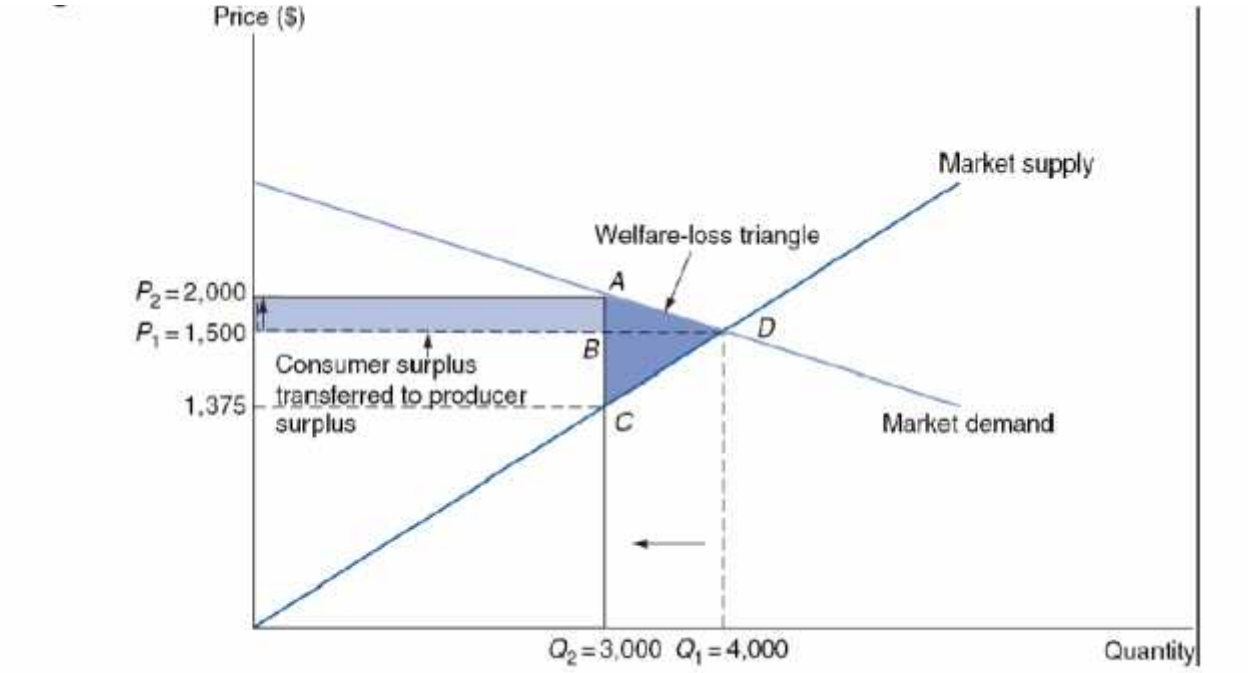
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DEADWEIGHT LOSS PROBLEM

There is deadweight loss problem associated with deviations from competitive market equilibrium. A deadweight loss is any loss suffered by consumers or producers that is not transferred but is instead simply lost due to market imperfections or government policies. Because deadweight losses are shown as triangles (shown in Figure 4) when linear demand and supply curves are used, deadweight losses are often described as welfare loss triangles. Deadweight losses occur when market imperfections reduce transaction volume.

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DEADWEIGHT LOSS ILLUSTRATION

Supply **Q = -8000 + 8P**
or P = 1000 + 0.125Q
Demand **Q = 7000 – 2P**
or P = 3500 – 0.5Q

Supply = Demand
-8000 + 8P = 7000 – 2P
10P = 15000
P = $1,500 Per ton

Supply = Demand
1000 + 0.125Q = 3500 – 0.5Q
0.625Q = 2500
Q = 4,000 (000) tons

Total Deadweight Loss

Consumer Deadweight Loss
= ½ [(4000 – 3000) * (2000 – 1500)]
= $250,000 (000)
Producer Deadweight Loss
= ½ [(4000 – 3000) * (1500 – 1375)]
= $62,500 (000)
Total Deadweight Loss = Consumer Loss + Producer Loss
= $250,000 (000) + $62,500 (000)
= $312,500 (000)

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8.4. Pure Monopoly

Perfect monopoly is the opposite extreme of perfect competition. Monopoly exists when a single firm is the sole producer of a good that has no close substitutes. In other words, there is a single firm in the industry. Perfect monopoly, like perfect competition, is quite rare in the real world. Monopoly exists when an individual producer has the ability to set market prices. Monopoly firms are price makers, not price takers.

A single seller.
Unique product.
Blockaded entry and/or exit.
Imperfect dissemination of information.
Opportunity for long-run economic profits.

Classic examples include electricity utilities, gas, sanitary services, transportation and telecommunication services.

SOURCES OF MONOPOLY

Monopoly is the form of market organization in which a single firm sells a product for which there are no close substitutes. Thus, the monopolist represents the market and faces the market negatively sloped demand curve for the product. As opposed to a perfectly competitive firm, a monopolist can earn profits in the long run because entry into the industry is essentially blocked. Thus monopoly is at the opposite extreme from perfect competition in the range of market organizations.

There are four basic reasons that can give rise to monopoly. First, the firm may control the entire supply of raw materials required to produce the product. Second, the firm may own a patent or copyright that precludes other firms from using a particular production process or producing the same product. For example, Xerox had a monopoly on copying machines and Polaroid on instant cameras. Patents are granted by the government for a period of 17 years as an incentive to inventors in the US while in Pakistan it is granted for a period of 20 years. Third, in some industries, economies of scale may operate over a sufficiently large range of outputs as to leave only one firm supplying the entire market. Such a firm is called a natural monopoly. Examples of these are public utilities (electrical, gas, water, and local transportation
and telecommunication companies). To have more than one such firm in a given market would lead to duplication of supply lines and to much higher costs per unit. To avoid this, governments
usually allow a single firm to operate in the market but regulate the price of the services provided, so as to allow the firm only a normal return on investment.

Fourth, a monopoly may be established by a government franchise. In this case, the firm is set up as the sole producer and distributor of a product or service but is subjected to

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governmental regulation. The best example of a monopoly established by government franchise is the post office, railways, airlines. Local governments also require a license to operate many types of businesses, such as taxis, broadcasting, TV channels, medical units, and private health care clinics.

8.4.1. MONOPOLY PRICE/OUTPUT DECISIONS

Under monopoly, the industry demand curve is identical to the firm demand curve. Because industry demand curves slope downward, monopolists also face a downward-sloping demand curve. The monopolist can set either price or quantity, but not both. Given one, the value of the
other is determined along the demand curve.

MONOPOLY OUTPUT RULE

A monopoly uses the same profit-maximization rule as does any other firm: It operates at the output level at which marginal revenue equals marginal cost. A profit-maximizing monopolist should produce the output, Q, such that marginal revenue equals marginal cost:

MR = MC

Because the demand (average revenue) curve is negatively sloped and hence declining, the marginal revenue curve must lie below it. When a monopoly equates marginal revenue and marginal cost, it simultaneously determines the output level and the market price for its product.

Profit maximization always require that firms operate at the output level at which MR = MC.

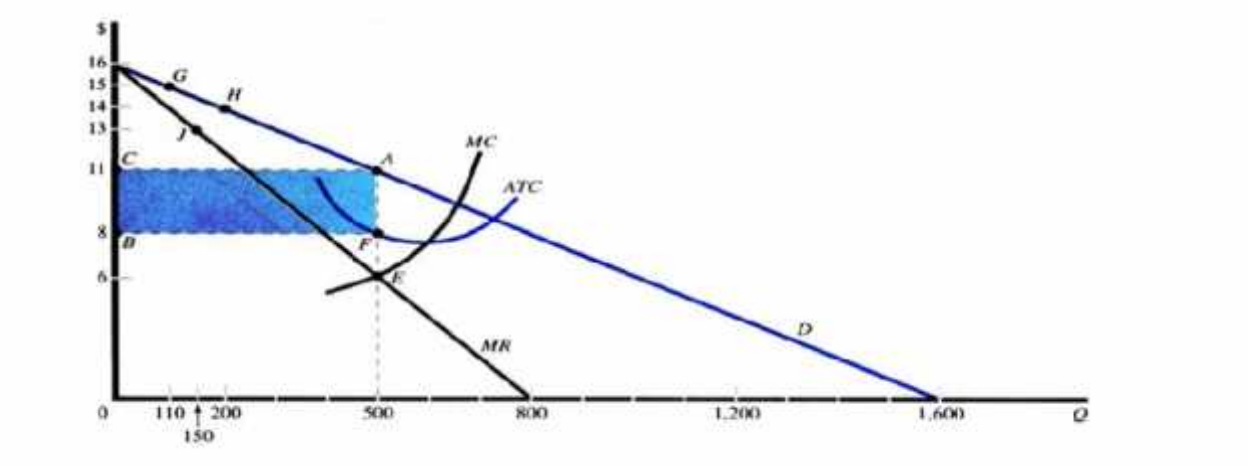
MONOPOLY PRICING RULE

Given the level of output, Q, that maximizes profits, the monopoly price is the price on the demand curve corresponding to the Q units produced: ***p = p (Q)*** Given a downward sloping monopoly demand curve, price always exceeds marginal revenue under monopoly. This is due to the fact that price is average revenue, and a downward-sloping demand curve requires that marginal revenue be less than average revenue. In a competitive market, P = MR = MC = AC in long-run equilibrium. In monopoly markets, profit-maximization requires MR = MC, but barrier to entry make above-normal profits possible, and P > AC in long run equilibrium.

SHORT-RUN PRICE AND OUTPUT DETERMINATION UNDER MONOPOLY

In Figure 1, D is the market demand curve faced by the monopolist, and MR is the corresponding marginal revenue curve. Profit maximizing output level is Q = 500 units, at this level of output AR = P = $11; AC = $8. At this level the monopolist earns a profit of AF = $3 per unit and AFBC = $1,500 in total (the shaded area in Figure 1)

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Since MR = MC =$6

So that P = AR > MR, since P > MR, P is also > MC.

As MC cuts MR from below i.e. beyond the point E, MC > MR and since P = AR > MR, P > MC. While the monopolist of Figure 1 is earning short run profit a monopolist (just like a perfect

competitor) could also break even or incur losses in the short run. It all depends on the height of the ATC at the best level of output. If ATC = P at best level of output, the monopolist breaks even, and if ATC > P at the best level of output, the monopolist incur a loss. Again, as in the case of perfect competition, it pays for a monopolist to remain in business in the short run even if it incurs losses, as long as P > AVC. Assume that the monopoly firm total revenue and total cost functions are:

π = TR – TC

We can re-write this as:

π = (TR/Q – TC/Q) * Q

π = (P – AC) * Q

π = ($37.50 - $22.23) * 50,000

= $15.27* 50,000

= $763,750

Finding the marginal revenue and marginal cost functions from the given TR and TC functions,

we get:

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$M\pi = MR - MC = 0$

$MR = MC$

$P = AR > MR$

$TR = 50Q - 0.00025Q^2$

$MR = 50 - 0.0005Q$

$TC = 361,250 + 5Q + 0.0002Q^2$

$MC = 5 + 0.0004Q$

The optimal price/output combination can be determined by setting marginal revenue equal to marginal cost and solving for Q:

$MR = MC$

$50 - 0.0005Q = 5 + 0.0004Q$

$Q = 50,000$

At this output level, maximum economic profits are:

$\pi = TR - TC$

$= 50Q - 0.00025Q^2 - (361,250 + 5Q + 0.0002Q^2)$

$= \$763,750$

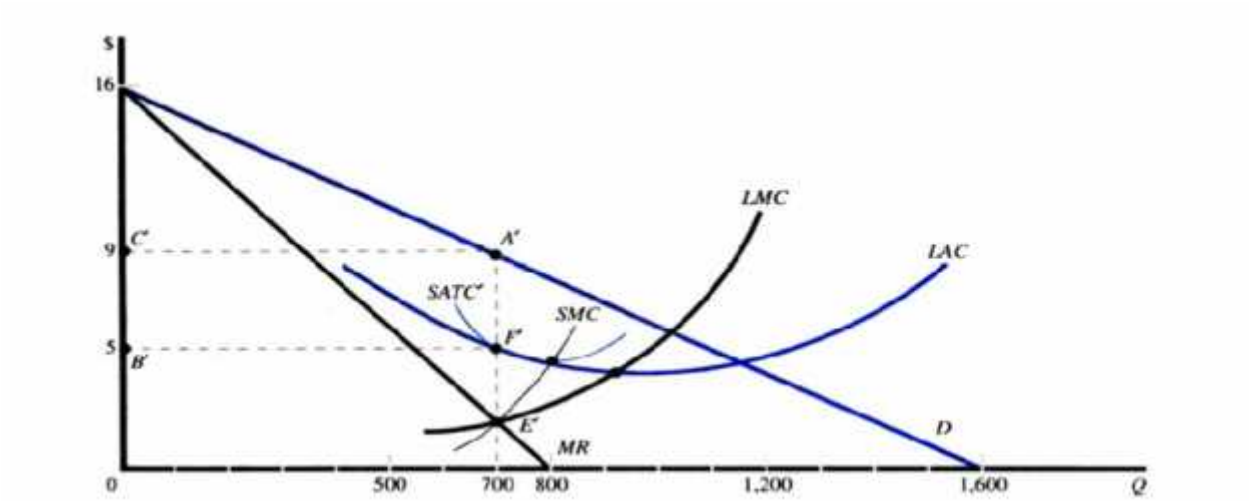
LONG-RUN PRICE AND OUTPUT DETERMINATION UNDER MONOPOLY

In the long run, all inputs and costs of production are variable, and the monopolist can construct the optimal scale of plant to produce the best level of output. As in the case of perfect competition, the best level of output of the monopolist is given at the point at which P = LMC, and the optimum scale of plant is the one with the SATC curve tangent to the LAC curve at the best level of output. As contrasted with perfect competition, however, entrance into the market is blocked under monopoly, and so the monopolist can earn economic profits in the long run. Because of blocked entry, the monopolist is also not likely to produce at the lowest point on its LAC curve. This is shown in Figure 2.

Figure 2 shows that the best level of output for the monopolist in the long run is 700 units and is given by point E', at which MR = LMC. At Q = 700, P = \$9 (point A' on the D curve). The monopolist has had time in the long run to build the optimum scale of plant given by the SATC curve tangent to the LAC curve at Q = 700 (point F' in Figure 2). Operating the optimum scale of plant at F' at the best level of output of Q = 700, the monopolist has SATC = LAC = \$5 (point F'). Thus, the monopolist is earning a long run profit of A'F' = \$4 per unit and A'F'B'C' = \$2,800

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in total (as compared to $1,500 in the short run). Because entry into the market is blocked, the monopolist will continue to earn these profits in the long run as long as his demand and cost conditions remain unchanged.



SOCIAL COSTS OF MONOPOLY

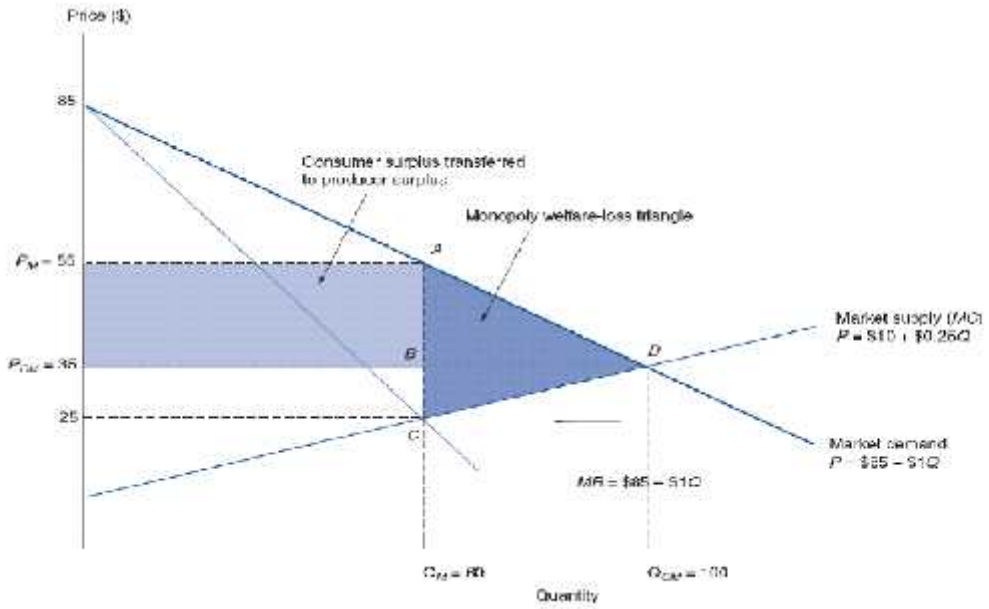
Monopolies have an incentive to under produce and earn economic profits. Underproduction results when a monopoly curtails output to a level at which the value of resources employed, as measured by the marginal cost of production, is less than the social benefit derived, where social benefit is measured by the price that customers are willing to pay for additional output. Under monopoly, marginal cost is less than price at the profit-maximizing output level. Although resulting economic profits serve the useful functions of providing incentives and helping allocate resources, it is difficult to justify above-normal profits that result from market power rather than from exceptional performance.

DEADWEIGHT LOSS FROM MONOPOLY

Monopoly markets create a loss in social welfare due to the decline in mutually beneficial trade activity.

There is also a wealth transfer problem associated with monopoly; consumer surplus is transferred to producer surplus as shown in Figure 3.

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DEADWEIGHT LOSS FROM MONOPOLY (EXAMPLE)

Given QD and QS:

QS = -40 + 4p or, solving for price,

4p = 40 + QS

p = 10 + 0.25 QS

QD = 170 - 2p

or, solving for price,

2p = 170 - QD

p = 85 – 0.5 QD

Competitive Market

Supply = Demand

-40 + 4p = 170 - 2p

6p = 210

p = $35/month

Supply = Demand

10 + 0.25 Q = 85 – 0.5 Q

0.75Q = 75

Q = 100 (millions) Customers

Monopoly

MR = MC

85 – Q = 10 + 0.25Q

1.25Q = 75

Q = 60 (million)

At Q = 60

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P = 85 – 0.5 Q
P = 85 – 0.5(60)
P = $55/ month

The Area of ABD = Consumer Deadweight Loss
= ½[(100 – 60) * (55 – 35)]
= $400(million) per month
The Area of BCD = Producer Deadweight Loss
= ½[(100 – 60) * (25 – 35)]
= $200(million) per month
Total Deadweight Loss = C's + P's = $600(million)/ month
Area of Rectangle = Transfer to P'S = 60 * (55 – 35)
= $1,200(million) per month

8.5. Monopolistic Competition

A market structure that lies between the extreme of monopoly and perfect competition is *monopolistic competition*. The partly competitive, partly monopolistic market structure faced by the firms in the clothing, food, hotel, retailing, and consumer products industries is called monopolistic competition. Given the lack of perfect substitutes, monopolistically competitive firms have some discretion in setting prices—they are not price takers. However, given fierce competition from imitators offering close but not identical substitutes, such firms enjoy only a normal rate of return on investment in long-run equilibrium.

Monopolistic competition is similar to perfect competition in that there is large number of sellers this two market structure model. The major difference between these two market structure models is that consumers perceive important differences among the products offered by monopolistically competitive firms, whereas the output of perfectly competitive firms is homogeneous. This gives monopolistically competitive firms at least some discretion in setting prices.

MONOPOLISTIC COMPETITION CHARACTERISTICS

Many buyers and sellers.
Product heterogeneity.
Free entry and exit.
Perfect information.
Opportunity for normal profits in long-run equilibrium.

Monopolistic competition is defined as the form of market organization in which there are many sellers of a differentiated product and entry into and exit from the industry are rather

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easy in the long run. Differentiated products are those that are similar but not identical and satisfy the same basic need. Examples are the numerous brands of breakfast cereals, toothpaste, cigarettes, detergents, cold medicines and cosmetics. The differentiation may be real (for example, the various breakfast cereals may have greatly different nutritional and sugar contents) or imaginary (for example, all brands of aspirin contain the same basic ingredients).

As the name implies, monopolistic competition is a, blend of competition and monopoly. The competitive element results from the fact that in a monopolistically competitive market (as in a perfectly competitive market), there are many sellers of the differentiated product, each too small to affect others. The monopoly element arises from product differentiation (i.e., from the fact that the product sold by each seller is somewhat different from the product sold by any other seller). The resulting monopoly power is severely limited, however, by the availability of many close substitutes. Thus, if the seller of a particular brand of aspirin increased its price even moderately, it would expect to lose a great deal of its sales.

Monopolistic competition is most common in the retail and service sectors of our economy. Clothing, cotton textiles, bakers and food processing are the industries that come close to monopolistic competition at the national level. At the local level, the best examples of monopolistic competition are fast-food outlets, shoe stores, gasoline stations, beauty salons, drugstores, video rental stores, and pizza parlors.

Since each firm sells a somewhat different product under monopolistic competition, we cannot derive the market demand curve and the market supply curve of the product as we did under perfect competition and we do not have a single equilibrium price for the differentiated products but a cluster of prices. Our analysis must, therefore, necessarily be restricted to that of the typical" firm: The graphical analysis will also be greatly simplified by assuming (with Edward Chamberlin, the originator of the monopolistically competitive model) that all firms selling similar products face identical demand and cost curves. This is unrealistic because the production of differentiated products is likely to lead to somewhat different demand and cost curves. Making such an assumption, however, will greatly simplify the analysis.

As in perfectly competitive markets, a large number of competitors make independent decisions in monopolistically competitive markets. A price change by any one firm does not cause other firms to change prices. If price reactions did occur, then an oligopoly market structure would be present. The most distinctive characteristic of monopolistic competition is that each competitor offers a unique product that is an imperfect substitute for those offered by rivals.

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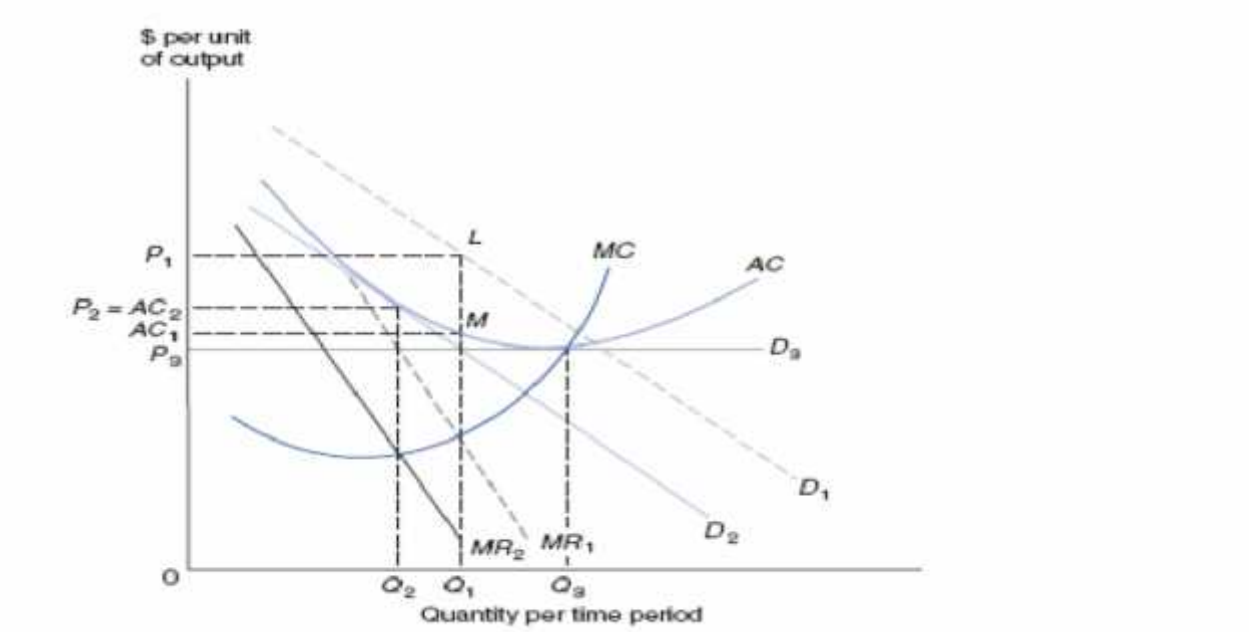
8.5.1. MONOPOLIST COMPETITION PRICE/OUTPUT DECISIONS

As its name suggests, monopolistic competition combines elements of both monopoly and perfect competition. The monopoly aspect is most forcefully observed in the short run. For example, consider Figure 4. With the demand curve, D1, and its related marginal revenue curve, MR1, the optimum output, Q1, is found at the point where MR1 = MC. Short-run monopoly profits equal to the area P1LMAC1 are earned. Such profits can be derived from new product introductions, product and process improvements, creative packaging and marketing, or other factors such as an unexpected rise in demand. Over time, short-run monopoly profits attract competition, and other firms enter the industry. This competitive aspect of monopolistic competition is seen most forcefully in the long run. As competitors emerge to offer close but imperfect substitutes, the market share and profits of the initial innovating firm diminish.

Firm demand and marginal revenue curves shift to the left as, for example, from D1 to D2 and from MR1 to MR2 in Figure 4. Optimal long-run output occurs at Q2, the point where MR2 = MC. Because the optimal price P2 equals ATC2, where cost includes a normal profit just sufficient to maintain capital investment, economic profits are zero.

The price/output combination (P2Q2) describes a monopolistically competitive market equilibrium characterized by a high degree of product differentiation. If new entrants offered perfect rather than close substitutes, each firm's long-run demand curve would become more nearly horizontal, and the perfectly competitive equilibrium, D3 with P3 and Q3, would be approached. Like the (P2Q2) high-differentiation equilibrium, the (P3Q3) no-differentiation equilibrium is something of an extreme case. In most instances, competitor entry reduces but does not eliminate product differentiation. An intermediate price/output solution, one between (P2Q2) and (P3Q3), is often achieved in long-run equilibrium. Indeed, it is the retention of at least some degree of product differentiation that distinguishes the monopolistically competitive equilibrium from that achieved in perfectly competitive markets.

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A firm will never operate at the minimum point on its average cost curve in monopolistically competitive equilibrium. Each firm's demand curve is downward sloping and is tangent to the ATC curve at some point above minimum ATC. However, this does not mean that a monopolistically competitive industry is inefficient. The very existence of a downward-sloping demand curve implies that consumers value an individual firm's products more highly than they do products of other producers. The higher prices and costs of monopolistically competitive industries, as opposed to perfectly competitive industries, reflect the economic cost of product variety. If consumers are willing to bear such costs, then such costs must not be excessive. The success of branded products in the face of generic competition, for example, is powerful evidence of consumer preferences for product variety.

Short-run Monopoly Equilibrium

Monopolistically competitive firms take full advantage of short-run monopoly.

In short run, MR = MC, P > AC, and $\pi > 0$.

Long-run High-price/Low-output Equilibrium

With differentiated products, MR = MC and P = AR = AC at a point above minimum LRAC.

No excess profits exist, so $\pi = 0$.

Long-run Low-price/High-output Equilibrium

With homogenous products, MR = MC and P=AC at minimum LRAC.

No excess profits exist, so $\pi = 0$. This is competitive market equilibrium.

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SHORT-RUN MONOPOLY EQUILIBRIUM (EXAMPLE)

Given $TR = 20{,}000Q - 15.6Q^2$
$TC = 400{,}000 + 4640Q + 10Q^2$
$MR = 20{,}000 - 31.2Q$
$MC = 4640 + 20Q$

$P = AR = 20{,}000 - 15.6Q$
$P = 20{,}000 - 15.6(300)$
$P = \$15{,}320$
$\pi = TR - TC$
$= 20{,}000Q - 15.6(300)^2 - 400{,}000 - 4640(300)Q - 10(300)^2$
$= -361{,}250 + 45Q - 0.00045Q^2$
$\pi = \$1{,}904{,}000$ or
$= \$1.9$ million
$MR = MC$
$20{,}000 - 31.2Q = 4640 + 20Q$
$51.2Q = 15{,}360$
$Q = 300$ units

$P = AR = 20{,}000 - 15.6Q$
$P = 20{,}000 - 15.6(300)$
$P = \$15{,}320$
$\pi = TR - TC$
$= 20{,}000Q - 15.6(300)^2 - 400{,}000 - 4640(300)Q - 10(300)^2$
$= -361{,}250 + 45Q - 0.00045Q^2$
$\pi = \$1{,}904{,}000$ or
$= \$1.9$ million

Therefore, the financial planning committee should recommend a $15,320 price and 300-unit output level to maximize short run profits.

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LONG-RUN HIGH-PRICE/LOW-OUTPUT EQUILIBRIUM

$AC = TC/Q = 400{,}000/Q + 4640Q/Q + 10Q^2/Q$
$= 400{,}000\,Q^{-1} + 4640 + 10Q$, the slope of this AC curve is given by the expression:
$AC = -400{,}000\,Q^{-2} + 10$
The slope of the new demand curve is given by:
$= -15.6$ (same as the original D-curve)
Slope of AC curve = Slope of Demand curve
$-400{,}000\,Q^{-2} + 10 = -15.6$
$Q = 125$ Units

$= 400{,}000/125 + 4640 + 10(125) = \$9{,}090$

$$\pi = P * Q - TC$$
$$= 9{,}090(125) - 400{,}000 - 4{,}640(125) - 10(125)^2$$
$$= \$0$$

LONG-RUN LOW-PRICE/HIGH-OUTPUT EQUILIBRIUM

The low-price/high-output (perfectly competitive) equilibrium combination occurs at the point where $P = MR = MC = AC$. This reflects that the firm's demand curve is perfectly horizontal, and average costs are minimized. To find the output level of minimum average costs.

Set $MC = AC$ and solve for Q:

$MC = AC$
$1{,}640 + 20Q = 400{,}000\,Q^{-1} + 4640 + 10Q$
$Q^2 = 40{,}000$
$Q = \sqrt{40{,}000}$
200 Units
$P = AC$
$400{,}000/200 + 4{,}640 + 10(200)$
$= \$8{,}640$

Under this low-price equilibrium scenario, ABC monopoly price falls in the long run from an original \$15,320 to \$8,640, and output falls from the monopoly level of 300 units to the competitive equilibrium level of 200 units per month. The company would earn only a risk adjusted normal rate of return, and economic profits would equal zero.

$$\pi = P * Q - TC$$
$$= 8{,}640(200) - 400{,}000 - 4{,}640(200) - 10(200)^2$$
$$= \$0$$

Following the onset of competition, the firm XYZ's will reduce its output from 300 units/month to a level between

$Q = 125$ and $Q = 200$ units/month.

S-Run profit-Max price = \$15,320 will fall between

P = \$ 9,090 (High-price/Low-output Equilibrium)

And P = \$8,640 (Low-price/High-output Equilibrium)

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8.6. Oligopoly

Oligopoly is the kind of market structure in which there are few sellers (usually less than 10) of a homogenous or differentiated product. If there are only two sellers, we have duopoly. If there are three sellers, we have Triopoly. If the product is homogenous, it is called pure oligopoly. If the product is differentiated, it is called differentiated oligopoly.

BASIC FEATURES OF OLIGOPOLY ARE:

Few sellers.
Homogenous or unique products.
Blockaded entry and exit.
Imperfect dissemination of information.
Opportunity for above-normal (economic) profits in long-run equilibrium.

SOURCES OF OLIGOPOLY ARE:

The sources of oligopoly are generally the same as for monopoly.

(1) Economies of scale, may operate over a sufficiently large range of outputs as to leave only a few firms supplying the entire market

(2) Huge capital investments and specialized inputs are usually required to enter an oligopolistic industry (say, automobiles, aluminum and similar industries), and this acts as an important natural barrier to entry

(3) A few firms may own a patent for the exclusive right to produce a commodity or to use a particular production process

(4) Established firms may have a loyal following of customers based on product quality and service (brands) that new firms would find very difficult to match

(5) A few firms may own or control the entire supply of a raw material required in the production of the product

(6) The government may give a franchise to only a few firms to operate in the market.

The above points are not only the sources of oligopoly but also represent the barriers to other firms entering the market in the long run. If entry were not so restricted, the industry could not remain oligopolistic in the long run. A further barrier to entry is provided by limit pricing, whereby existing firms charge a price low enough to discourage entry into the industry. By doing so, they voluntarily sacrifice short-run profits in order to maximize long-run profits.

ROLE OF STRATEGIC INTERDEPENDENCE

Since there are a few firms selling a homogenous or differentiated product in oligopolistic markets, the action of each firm affects the other firms in the industry. That is, your actions affect the profits of your rivals and your rivals' actions affect your profits. Having said that, it is clear that the distinguishing characteristic of oligopoly is the interdependence or rivalry among firms in the industry. This is the natural result of fewness. Each firm must take into account the expected reaction of other firms.

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Since an oligopolist knows that its own actions will have a significant impact on the other oligopolist in the industry, each oligopolist must consider the possible reaction of competitors in deciding its pricing policies, the degree of product differentiation to introduce, the level of advertising to undertake, the amount of service to provide, and so on. Since competitors can react in many ways, we do not have a single oligopoly model but many, each based on the particular behavioral response of competitors to the actions of the first. We must keep in mind, however, that each model is, at, best, incomplete and more or less unrealistic. So we can say that no single general model of oligopoly behavior exists.

Because of this interdependence, managerial decision making is much more complex under oligopoly than under any other forms of market structure. For example, if firm A and firm B sell differentiated products. How does the quantity demanded for firm A's product change when firm

A change its price? The effect of a price reduction on the quantity demanded of firm A's product depends upon whether its rival firm B responds by cutting its prices too. Similarly the effect of a price increase on the quantity demanded of firm A's product depends upon whether its rival firm B responds by raising its prices too.

The gist of the above discussion is that: Strategic interdependence: the rival firms aren't in complete control of their own destiny!

8.6.1.PROFIT MAXIMIZATION IN FOUR OLIGOPOLY SETTINGS

1. Cournot Model
2. Bertrand Model
3. Stackelberg Model
4. Sweezy (Kinked-Demand) Model

COURNOT OLIGOPOLY MODEL: OLIGOPOLY OUTPUT-SETTING MODELS

The earliest model of oligopoly was developed in 1838 by Augustin Cournot, a French economist. The basic features of Cournot model a Cournot model are:

A few firms produce goods that are either perfect substitutes (homogeneous) or imperfect substitutes (differentiated).

Firms set output, as opposed to price.

Each firm believes their rivals will hold output constant if it changes its own output (The output of rivals is viewed as given or "fixed").

Barriers to entry exist.

The Cournot model postulates that firms in oligopoly markets make simultaneous and independent output decisions. In other words Cournot model assumes that oligopoly demand curves are stable because each firm treats the *output* of the other firm as given, and then makes its own output decision. The relationship between an oligopoly firm's profit-

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maximizing output level and competitor output is called the oligopoly output- reaction curve because it shows how oligopoly firms react to competitor production decisions. A firm's reaction function shows how its optimal output varies with each possible action by its rival firm.

Cournot equilibrium output is found by simultaneously solving output-reaction curves for both competitors. Cournot equilibrium output exceeds monopoly output but is less than competitive output. Cournot equilibrium (Nash Equilibrium) is where the two reaction curves intersect. In Cournot model, a rival's action is its output choice. Cournot's model involves competition in quantities (or sales volume) and price is less explicit.

COURNOT MODEL: A NUMERICAL EXAMPLE

To illustrate the Cournot model and the concept of Cournot equilibrium, consider a two-firm **duopoly** facing a linear demand curve:

P = 1600 - Q

Where P is price and Q is total output in the market, thus Q= QA + QB ie industry output constitutes firm A and firm B's output respectively

Further, assume MCA = MCB = $100

and average (AC) and marginal cost (MC)

AC = MC = $100

To find the profit maximizing output of Firm A given Firm B's output we need to find Firm A's marginal revenue (MR) and set it equal to MC. So, Firm A's Total Revenue is

TRA = (1600 - Q) QA

= [1600 - (QA + QB)] QA

= 1600QA - QA2 - QAQB

Firm A's MR is thus

MRA =1600 - 2QA - QB

If MC=100 then equating: MRA= MC

1600 - 2QA – QB = 100

QA = 750 - 0.5QB

This is Firm A's Reaction Curve. We can see that the profit-maximizing level of output for firm A depends upon the level of output produced by itself and firm B. Similarly, the profit-maximizing level of output for firm B depends upon the level of output produced by itself and firm A. If we had begun by examining Firm B's profit maximising output we would find its reaction curve, i.e.

QB = 750 - 0.5QA

We can solve these 2 equations and find equilibrium quantity and price.

Solving for QA we find:

QA = 750 - 0.5QB

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QA = 750 - 0.5(750 - 0.5QA)
0.75QA = 75
QA = 500 units
Cournot equilibrium output = QA + QB
= 500 + 500 = 1000 units
Cournot equilibrium price = 1600 – Q
= 1600 – (1000)
= $600
π = TR – TC
= ($600 * 500) – (100* 500)
= $250,000 by each firm
Under perfect competition firms set prices equal to MC. So,
P= MC = $100
P = 1600 – Q ⇒ Q = 1500
And equilibrium quantity
Q= 750 units each
Under monopoly TR = P * Q
= (1600 – Q)Q
= 1600Q – Q2
MR = 1600 – 2 Q
Profit -Maximizing output level for monopoly firm:
MR = MC
1600 – 2 Q = 100
2Q = 1500
Q = 750
Profit –Maximizing monopoly price:
P = 1600 – Q
= 1600 – 750
= $850 &
π = $562,500

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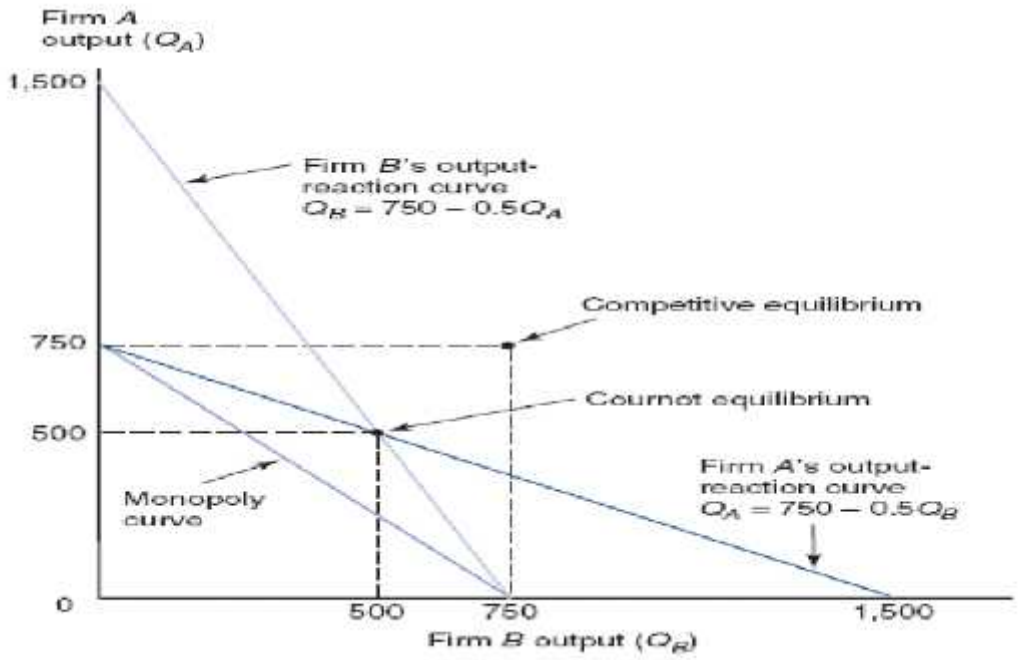


Figure 6 shows that in Cournot Equilibrium firms are maximizing profits simultaneously. The market is shared equally among the duopoly firm. Price is above the competitive equilibrium and below the monopoly equilibrium.

BERTRAND MODEL: OLIGOPOLY PRICE-SETTING MODELS

Joseph Bertrand, a French economist, presented his oligopoly model in 1883. Bertrand argued that a major problem with the Cournot model is that it failed to make price explicit. He showed that if firms compete on price when goods are homogenous, at least in consumer's eyes, then a price war will develop such that price approaches marginal cost. However, the introduction of differentiation leads to equilibrium closer in spirit to Cournot.

BERTRAND OLIGOPOLY: IDENTICAL PRODUCTS

The Bertrand model focuses on price reactions.

The Bertrand model predicts a competitive market price/output solution in oligopoly markets with identical products.

BERTRAND OLIGOPOLY: DIFFERENTIATED PRODUCTS

The Bertrand model demonstrates how price-setting oligopolies profit with differentiated products.

BASIC FEATURES OF BERTRAND MODEL

• Few firms that sell to many consumers.
• Firms produce identical products at constant marginal cost.
• Each firm independently sets its price in order to maximize profits.
• Barriers to entry.

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• Consumers enjoy
  Perfect information.
  Zero transaction costs.

BERTRAND EQUILIBRIUM

• Firms set P1 = P2 = MC! Why?
• Suppose MC < P1 < P2.
• Firm 1 earns (P1 - MC) on each unit sold, while firm 2 earns nothing.
• Firm 2 has an incentive to slightly undercut firm 1's price to capture the entire market. Firm 1 then has an incentive to undercut firm 2' price. This undercutting continues until each firm charges P1 = P2 = MC. in equilibrium. From the viewpoint of the manager, Bertrand model is undesirable. It leads to zero economic profit even if there are only two firms in the market. From the viewpoint of the consumers, Bertrand model is desirable: it leads to precisely the same outcome as a perfectly competitive market.

The Bertrand model shows that how price-setting oligopoly firms can profit by selling differentiated products. In the Bertrand model, the relationship between the profit-maximizing price level and competitor price is called the oligopoly price-reaction curve because it shows how the oligopoly firm reacts to competitor pricing decisions.

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BERTRAND MODEL: A NUMERICAL EXAMPLE

Firm A demand: QA = 60 – 2 PA + PB
Firm B demand: QB = 60 – 2 PB + PA
MCA + MCB = 0
TRA = PA * QA
= PA * (60 – 2 PA + PB)
= 60 PA – 2 PA2 + PA PB

- π A = PA* QA - TCA Since cost = 0, therefore
  = 60 PA – 2 PA2 + PA PB

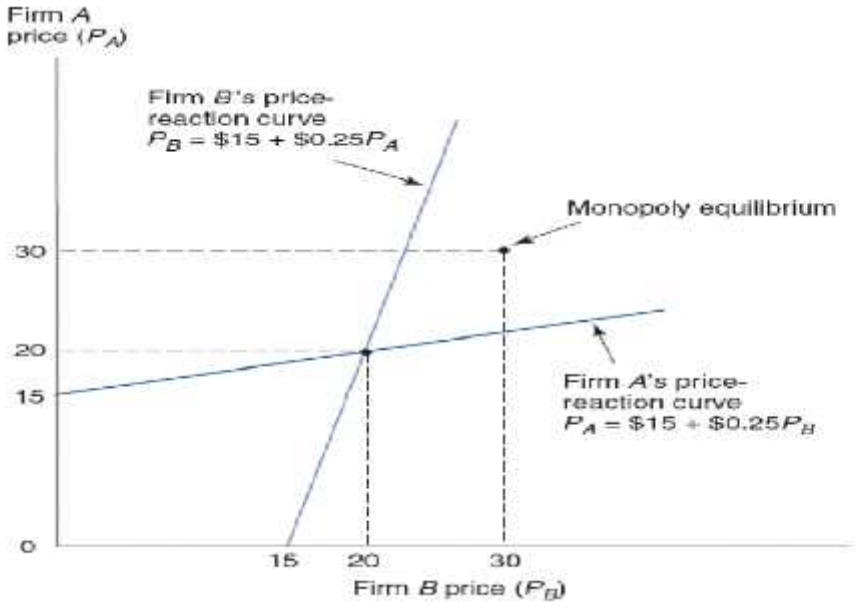
Since Price is the decision variable, firm A's profit-maximizing price is found by setting:

$\partial \pi A / \partial PA = 0$
60 – 4 PA + PB = 0
PA = 15 – 0.25 PB
Firm A price-reaction curve: PA = 15 – 0.25 PB
Firm B price-reaction curve: PB = 15 – 0.25 PA
PA = 15 – 0.25 (15 – 0.25 PA)
PA = 15 – 3.75 + 0.0625 PA

- monopoly market
- π = TR – TC where TR = P*Q

= P (60 -2P + p) – 0
= 60P – p2 since price is the decision variable:
$\partial \pi A / \partial PA = 0$
60 – 2P = 0 or P = $30
The profit-max monopoly output is:
Q = 60 – P or Q = 60 – 30 = 30 (000) units
Monopoly profits are: π = 60P - p2 = $900 (000)

Bertrand Equilibrium in a Two-Firm Duopoly



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With 40 units sold at a market price of $20, firm A and firm B will each generate revenues of $800(000). Using the simplifying assumptions of no fixed costs and MCa = MCb = 0, each firm will also generate profits of $800(000). This is a stable equilibrium because given the competitor price, neither firm has any incentive to change price. Figure 7 illustrates this Bertrand market equilibrium price/output solution and price-reaction curves for each competitor. In Bertrand, price competition is much "tougher." Hence, profits are lower. In Cournot, quantity commitments allow each firm to exclude buyers. Hence, they have some monopoly power.

STACKELBERG OLIGOPOLY

Stackelberg model, developed by German economist H. Von Stackelberg in 1934 postulates a first-mover advantage for the oligopoly firm that initiates the process of determining market output. Up till now, we have analyzed oligopoly situations that are symmetric in that firm 2 is the "mirror image" of firm 1. In many oligopoly markets, however, firms differ from one another.

BASIC FEATURES OF THE MODEL

- Firms produce differentiated or homogeneous products.
- There are few firms selling serving many consumers.
- A single firm (the leader) chooses an output before all other firms choose their output. The leader commits to an output before all other firms.
- All other firms (the followers) take as given the output of the leader and choose outputs that maximize profits given the leader's output.
- Barriers to entry exist.

To illustrate Stackelberg first-mover advantages, we reconsider the Cournot model but now assume that firm A, as a leading firm, correctly anticipate the output–reaction of firm B, the following firm. With prior knowledge of firm B's output–reaction curve, **QB = 750 - 0.5QA**, firm A's total revenue curve becomes:

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P = 1600 - Q
Where Q= QA + QB
Further, assume MCA = MCB = $100
And average (AC) and marginal cost (MC)
AC = MC = $100
Firm A's Total Revenue is
TRA = (1600 - Q) QA
= [1600 - (QA + QB)] QA
= $1600QA - QA^2 - QAQB$

Substituting Firm B's output-reaction curve, QB = 750 - 0.5QA
= $1600QA - QA^2 - QA(750 - 0.5QA)$
TRA = $850QA - 0.5QA^2$
Marginal revenue for firm A is:
MRA = 850QA - QA
MRA = MCA
850QA – QA = 100
QA = 750 units

After firm A determined its output level, the amount produced by firm B is calculated from Firm B's output-reaction curve:
QB = 750 - 0.5QA
= 750 – 0.5(750) = 375
Stackelberg market Equilibrium level of output is:
Q = QA + QB
= 750 + 375
= 1,125 units

Stackelberg market Equilibrium Price is:
= 1600 – Q
= 1600 – (1,125)
= $ 475
ΠA = $356,250 and ΠB = $178,125
Cournot output = 1000 units
Cournot price = $600

We might notice that market output is greater in Stackelberg equilibrium than in Cournot equilibrium because the first mover, firm A, produces more output while the follower, firm B, produces less output. Stackelberg equilibrium also results in a lower market price than that observed in Cournot equilibrium.

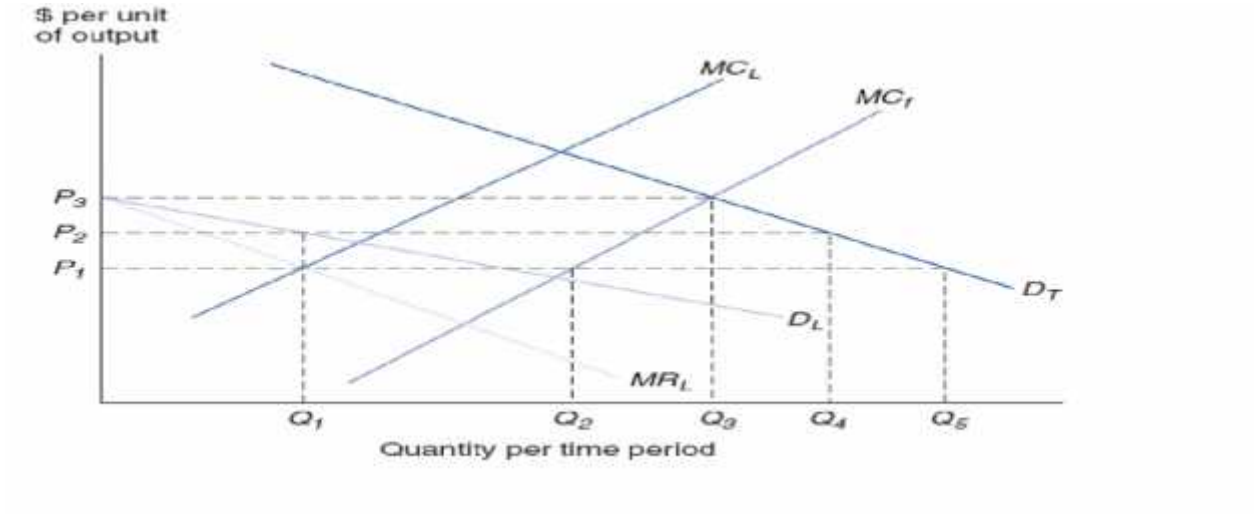
PRICE LEADER (BAROMETRIC FIRM)

• Largest, dominant, or lowest cost firm in the industry
• Demand curve is defined as the market demand curve less supply by the followers
• Followers
• Take market price as given and behave as perfect competitors

Price leadership occurs when one firm establishes itself as the industry leader and other firms follow its pricing policy. This leadership may result from the size and strength of the leading firm, from cost-efficiency, or as a result of the ability of the leader to establish prices that produce satisfactory profits throughout the industry. The leader faces a price / output problem similar to monopoly; other firms are price takers and face a competitive price / output

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problem. This is illustrated in Figure where the total market demand curve is DT, the marginal cost curve of the leader is MCL, and the horizontal summation of all of the follower firms is labeled MCf.



DL = DT – MCf

MCf = Sf found by setting P = MCf because DT and Sf are functions of price, DL is also a functions of price.

KINKED DEMAND CURVE MODEL (SWEEZY OLIGOPOLY)

BASIC FEATURES OF THE MODEL

• Few firms in the market serving many consumers.

• Firms produce differentiated products.

• Barriers to entry.

• Each firm believes rivals will match (or follow) price reductions, but won't match (or follow) price increases.

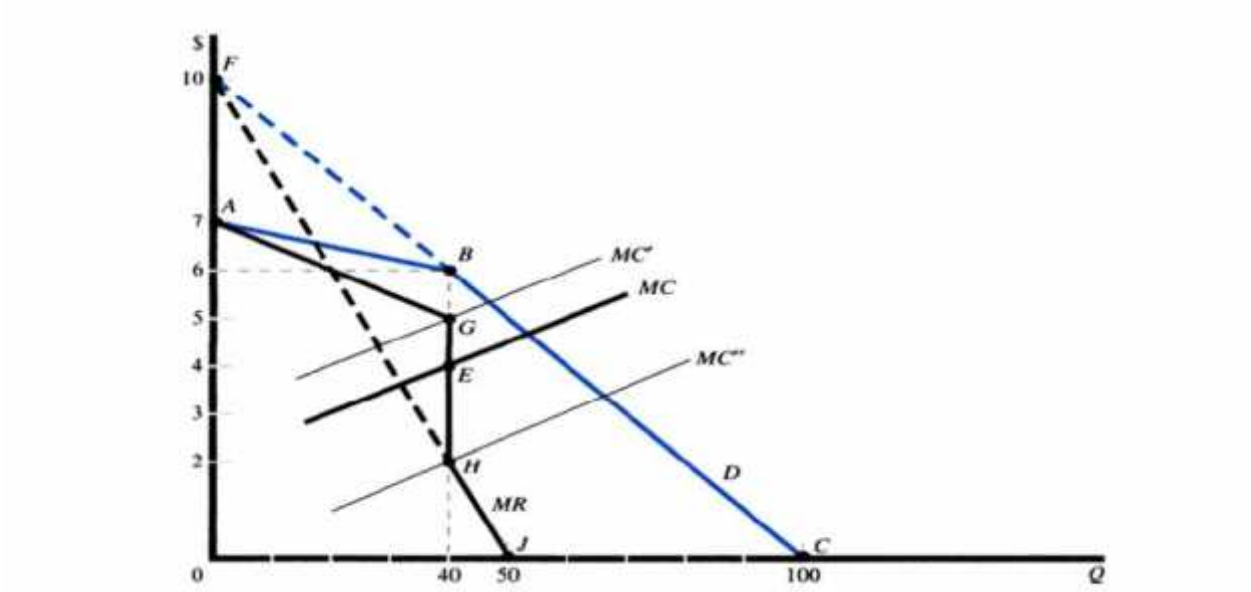
• If an oligopolist raises price, other firms will not follow, so demand will be elastic

• If an oligopolist lowers price, other firms will follow, so demand will be inelastic

• Implication is that demand curve will be kinked, MR will have a discontinuity, and oligopolist will not change price when marginal cost changes.

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KEY FEATURE OF SWEEZY MODEL
PRICE-RIGIDITY



The Kinked demand curve model was purposed by Paul Sweezy in 1939. This model basically explains the price rigidity. According to Sweezy, oligopolist faces a demand curve that has a kink at the prevailing price and is highly elastic for price increases but much less elastic for price cuts. In this model, oligopolist recognize their interdependence but act without collusion in keeping their prices constant, even in the face of changed cost and demand conditions--preferring instead to compete on the basis of quality, advertising, service, and other forms of non price competition. The Sweezy model is shown in Figure 2. As in other forms of market organization, the firm under oligopoly can earn profits, break even, or incur losses in the short run, and it will continue to produce as long as P > AVC. From Figure 2 we can also see that the oligopolist's marginal cost curve can rise or fall anywhere within the discontinuous portion of the MR curve (i.e., from MC' to MC") without inducing the oligopolist to change the prevailing price of $6 and sales of 40 units (as long as P> AVC). Only if the MC curve shifts above the MC' curve will the oligopolist be induced to increase its price and reduce quantity, or only if the MC curve shifts below MC" will the oligopolist lower price and increase quantity. With a rightward or a leftward shift in the demand curve, sales will increase or fall, respectively, but the oligopolist will keep the price constant as long as the kink on the demand curve will remain at the same price and the MC curve continues to intersect the discontinuous or vertical portion of the MR curve.

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SWEEZY OLIGOPOLY: A NUMERICAL EXAMPLE

The demand functions for price increases and price decreases are:

QA = 280 - 40PA or PA = 7 – 0.025QA
QB = 100 - 10PB or PB = 10 – 0.1QB
$TC = 2Q + 0.25\ Q^2$ and MC = 2 + 0.05Q
TRA = PA *QA = (7 – 0.025QA) QA
TRB = PB *QB = (10 – 0.1QB) QB
MRA = 7 – 0.05QA and
MRB = 10 – 0.02QB

To find the Kink in Demand Curve, we set
Q= QA + QB, since the two Demand Functions are:
PA = 7 – 0.025 Q
PB = 10 – 0.1Q
PA = PB and solving for Q
7 – 0.025 Q = 10 – 0.1Q
Q = 40 and P= 7 – 0.025(40) = $6
The upper and lower limit of the MR gap is:
MRA = 7 – 0.5(40) = 7 – 2 = 5
MRB = 10 – 0.2(40) = 10 – 8 = 2
Since MC = 2 + 0.05(40) = 4
The MC curve intersects the vertical portion of the MR curve. The total profit (Π) of the firm are:

$\Pi = TR - TC = PQ - 2Q - 0.025\ Q^2$
$= 6(40) - 2(40) - 0.025(40)^2$
= $120

8.6.2.CARTELS AND COLLUSIONS

In the kinked demand curve model, oligopolist did not collude to restrict or eliminate competition in order to increase profits. Collusion can be overt or explicit, as in centralized and market sharing cartels, or tacit or implicit, as in price leadership models. There are two types of cartels: the centralized cartels and market sharing cartels. Centralized cartels: cartels directly (although secretly) reach agreements among competitors to reduce the uncertainty arising from their mutual interdependence.

All firms in an oligopoly market benefit if they get together and set prices to maximize industry profits. A group of competitors operating under such a formal over (explicit) agreement is called

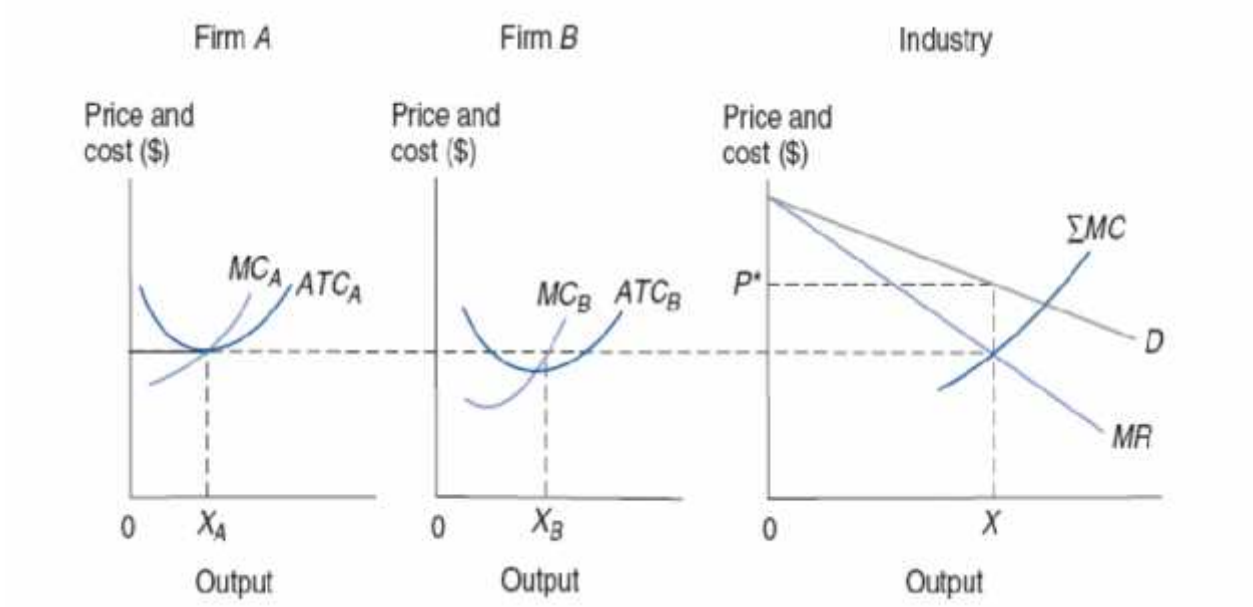
a **cartel**. If an informal covert or explicit agreement is reached, the firms are said to be operating in **collusion**. Both practices are illegal in the various countries. However, cartels are legal in some parts of the world. Several important domestic markets are also dominated by producer associations that operate like cartels and appear to flourish without interference from the government. Agricultural commodities such as milk are prime examples of products marketed under cartel-like arrangements.

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A cartel that has absolute control over all firms in an industry can operate as a monopoly. To illustrate, consider the situation shown in Figure 3. The marginal cost curves of each firm are summed horizontally to arrive at an industry marginal cost curve. Equating the cartel's total marginal cost with the industry marginal revenue curve determines the profit-maximizing output and the price, *P**, to be charged. Once this profit-maximizing price/output level has been determined, each individual firm finds its optimal output by equating its own marginal cost curve to the previously determined profit-maximizing marginal cost level for the industry.

Profits are often divided among firms on the basis of their individual level of production, but other allocation techniques can be employed. Market share, production capacity, and a bargained solution based on economic power have all been used in the past. For a number of reasons, cartels are typically rather short-lived. In addition to the long-run problems of changing products and of entry into the market by new producers, cartels are subject to disagreements among members. Although firms usually agree that maximizing joint profits is mutually beneficial, they rarely agree on the equity of various profit-allocation schemes. This problem can lead to attempts to subvert the cartel agreement.

Figure 3 Price / Output Determination of a Cartel



Cartel subversion can be extremely profitable. Consider a two-firm cartel in which each member serves 50 percent of the market. Cheating by either firm is very difficult, because any loss in profits or market share is readily detected.

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🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Explain the role of price in different market structure		
Describe perfectly competitive market		
Explain pure monopoly		
Describe monopolistic completion with practical examples		
Explain oligopoly		
Describe the major models under oligopoly		

Summary

Having studied the demand and supply, we know that market demand curve is the horizontal summation of the individual demand curves , and similarly the horizontal summation of the individual supply curves become market supply curve. The intersection of market demand curve and the market supply curve indicates the equality of quantity demanded by the consumers and that supplied by the producers. This equality of quantity demanded and quantity supplied is called equilibrium quantity and the price that occurs at this balancing point is called equilibrium price where the quantity demanded is equal to quantity supplied. When such condition prevails in the market, the market is said to be in equilibrium, because there are neither shortages nor surpluses of commodity.

Market price is determined by the equilibrium between demand and supply in market period or very short run. This market period may be an hour, a day or a few days or even a few weeks depending upon the nature of the product. The period being short, stock is limited and cannot be produced to meet the increase in demand. Therefore, the sellers have to confine to the produce available with them. Example: Perishable commodities like fish.

Market Structure : It refers to the size and design of the market. It relates to those organizational characteristics of a market which influence the nature of competition and pricing and affect the conduct of business firms. Monopsony is a market structure in which there is only one buyer instead of one seller. Oligopsony is a market structure in which there are only few buyers. Bilateral monopoly is a market structure in which a single seller faces a single buyers .

Markets are classified based on the degree of competition as perfect and imperfect market. Perfect market : A market is said to be perfect when all the potential sellers and buyers are promptly aware of the prices at which transaction take place and all the offers made by other sellers, and buyers, and when any buyer can purchase from any seller and conversely. Under

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such a condition, the price of a commodity will tend to be the same (after allowing far cost of transport including import duties) all over the market. Imperfect market : A market is said to be imperfect when some buyers or sellers or both are not aware of the offers being made by others. Different prices prevail for the same commodity at the same time.

Perfect competition market is the world of price-takers. A perfectly competitive firm sells a homogeneous product [one identical to the product sold by others in the industry]. It is so small relative to its market that it cannot affect the market price; it simply takes the price as given. Perfect competition market is a market under which no buyer or seller can affect Unilaterally **Features of Monopoly:** Monopoly is another traditional form of market. It is an extreme form, opposed to a competitive market structure. As against this, a competitive market is one with a large number of firms or producers.The word **OLIGOPOLY** is derived from the Greek words „olig" means a few and „poly" which means sellers. **Oligopolistic Market** refers to a market characterized by the presence of a small number of producers who often act together to control the supply of a particular good and its market price.

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CHAPTER NINE
LOCATING THE FIRM IN A GLOBAL ECONOMY

Learning objectives;
Up on successful completion of this chapter students will be able to:

- ***Explain the basic firm location principles***
- ***Describe locating industry in a linear market***
- ***Identify the procedures followed in market area determination***
- ***Explain the major factors that affect industrial location***

9.1. Basic location principles

Locational changes cause changes in international distribution such as in the volume of exports and imports. To accommodate these changes, it is essential to build an adequate logistics infrastructure that will form an efficient international distribution network. The development of ports as nodes for international transportation and improvement of roads as links for domestic and international transportation should be actively encouraged. Infrastructure can affect not only transportation costs but also lead time. Customs clearance and operations for international distribution should also be considered. Furthermore, logistics technologies such as unit load system and intermodal transportation systems could bring about an efficient international distribution. Therefore, this study presumes that infrastructure affects international location together with other factors.

International relocation is defined as the transfer of a company's operations from one country to another through *shift* and *withdrawal*. A company shifts its site of operations from its home country to a foreign country, and can withdraw back or withdraw to another country A foreign affiliate is defined as a foreign-located company that has Japanese capital investment, in the form of branches or firms. In this study, a foreign affiliate refers to a company which has more than 10% of investment portfolio.

As indicated in Figure 9.1, a company's location strategy to locate its operational sites causes a change in its current logistics process. For example, consider a Japanese manufacturer that has its logistics processes within Japan, i.e. procurement, production and sales. The three processes are linked by domestic distribution. The company then exports its product to overseas countries to supply international demand. If this manufacturer decides to *shift* its production operation to a foreign country to supply its export market, as a matter of course, logistics processes have to be globalized. In this example, new demands for international procurement, production and sales emerge, and not only international distribution linking procurement and production becomes apparent but also international distribution linking production and sales. In case of a product demand in the home country, then the manufacturer exports the commodity to Japan.

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The manufacturer with a strategy to withdraw *from a recipient and come back to Japan has to* re-establish its logistics processes in Japan again. On the other hand, in the case of a manufacturer transferring to another country after *withdrawing* from the first recipient, there is no change in the global logistics process itself but change in logistics direction.

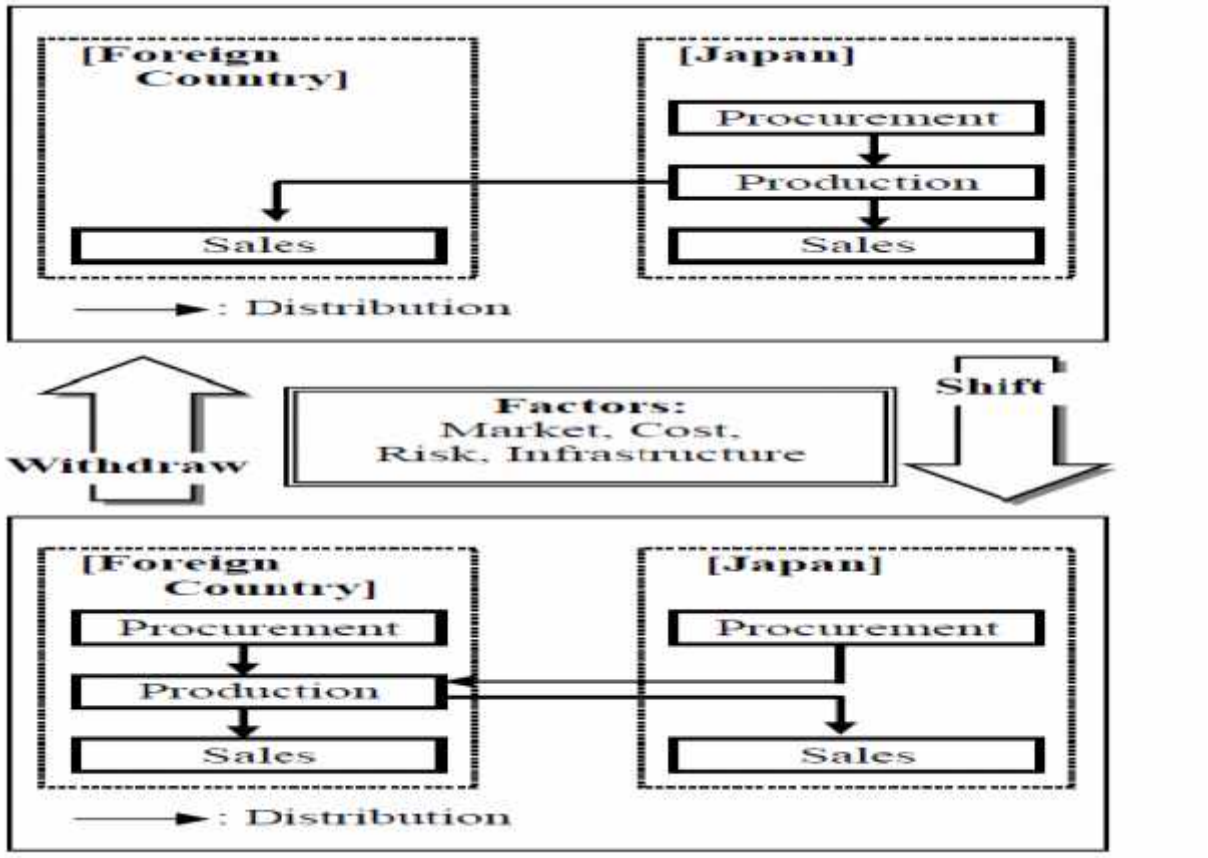


Figure 9.1.Global logistics

If a company shifts its production or sales site to a foreign country, logistics has to globalize its processes. It is thus essential to understand the relationship between logistics infrastructure and global logistics processes, particularly international distribution. For this reason, a company planning to *shift* its business operations needs to consider the availability of infrastructure in the foreign country before making any decision. For instance, the presence of ports (facility infrastructure), custom clearance systems (institutional infrastructure) and loading/unloading systems (technological infrastructure) affects transportation cost. Thus, a company needs to consider the availability of infrastructure, even if it plans to shift with the primary objective of reducing production cost.

Companies often aim of the benefits to be gained by being outside Japan. This is the reason why they directly consider market and cost factors when planning an international location strategy. However, it must be stressed that existing conditions in the foreign country should always be considered. Risk and the infrastructure factors should be included as well.

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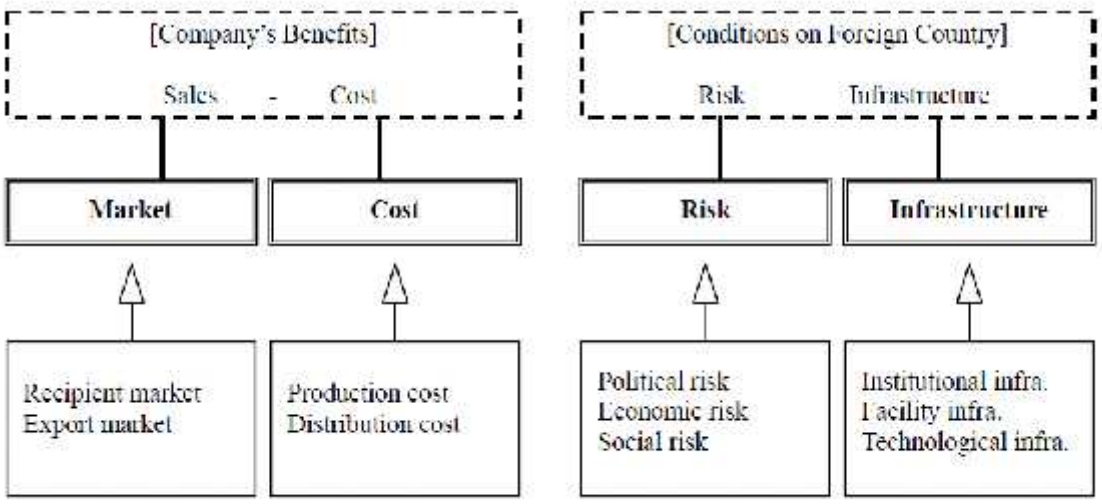


Figure 11. Factors of international location strategy

9.2. Locating in a linear market

Market, as one of the factors of international location strategy, can be classified into two: *recipient market* and *export market* related to the recipient. Recipient market means that the demand of products and services is within domestic or local areas where the Japanese company shifts to. The export market means that the demand of products and services are outside of recipient country but including Japan.

When companies shift their sites of production or sales to a foreign country to expand their sales, they mostly consider market factors. If in case their sales are less than they expected, they may decide to withdraw and they could either come back to Japan or transfer to another country.

Cost factors can be divided into *production cost* and *distribution cost*. Production costs refer to expenses for materials, labor and operations. Distribution costs refer to expenses incurred for transportation, storage, loading/unloading, package, and other distribution activities. To reduce costs, companies shift their production sites to foreign countries where labor and raw material costs are cheaper than in Japan. However, they could also withdraw owing to increased costs. Reducing production costs is one of the objectives for shifting to a foreign country. However, companies should not overlook the distribution costs, especially transportation cost.

For example, consider a Japanese company supplying demand commodities in Japan. This company shifted its production site to a foreign country with the primary objective of reducing production costs. However, if the distribution costs such as transportation costs from the foreign country to Japan are significantly high, then the company may not get

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benefits in this shift. It is therefore necessary to consider both production costs and distribution costs.

Risk factor in this study is classified into *political risk, economic risk* and s*ocial risk*. Political risk includes the probability of war or labor strikes that occur due to political reasons. Economic risk includes the probability of changes in the economic conditions, such as exchange rate fluctuation and disruption of financial investments. Social risk includes the probability of societal problems, such as crimes, disease, accidents and natural disasters. Generally, a company will not shift to a foreign country with high probability of risks happening, such as war or violence. A company could withdraw if unbearable risk occurs in the recipient country. Companies could shift to a foreign country to diversify their economic risk. In this case, companies should consider the probability of economic risk such as exchange fluctuation in the foreign country.

Infrastructure factor in this study refers to software and hardware that supports the industry. There are three kinds of infrastructure: *institutional, facility* and *technological* infrastructure. First, institutional infrastructure refers to the rules and regulations of the country, such as legal system and policy. Taxation system, contract law, business procedures and pricing systems are included under the legal system. For policy, several may be mentioned such as foreign funding promotion, import substitution, export promotion and domestic production policy. Second, facility infrastructure refers to the transportation system made up of nodes, modes and links as hardware infrastructure, and operation and control as software infrastructure. And third, technological infrastructure refers to the level of handling skill or automation that includes human, logistics and information technologies. Logistics technologies, such as unit-load system and multi-modal transportation system directly affect transportation cost.

There is rarely a case of shifts with the infrastructure objective. However, it is essential to consider the availability of infrastructure when companies shift to a foreign country. There are several cases when Japanese companies withdrew from the recipients because of the unbearable difference between the infrastructure of Japan and the foreign country. Companies preparing to establish international distribution centers have to take into consideration the available infrastructure in the foreign country in detail. This is because international distribution centers are required to maintain networks with other countries. For this reason, international distribution centers are mainly located in countries where good accessibility to other countries and good information platform are present.

9.3. Market area determination

The process of location choice is important to understanding the determinants of location because many important location factors emerge from the initial stages of the site selection process. Furthermore, an understanding of the decision process may improve a local

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economic development official's ability to intervene in that process. This section briefly describes the formal location process within large, Multiplan companies.

Perhaps the most important aspect of the location decision is that it is seldom only a location decision. It is part of a larger corporate planning process. A corporate planning office or a division of a multidivisional firm may begin the location process with a forecast regarding future capacity requirements. The forecast may be ad hoc or, more typically, part of a company's ongoing corporate planning process such as a rolling five-year plan. If a capacity shortage is anticipated, managers must decide how to address the problem. There are, of course, many alternatives including outsourcing and increasing price to reduce the quantity demanded. If a new facility is determined to be the best way to address the capacity shortfall, a site selection team will be formed. Expansion at one or more of the company's existing sites will also be an option at this stage.

The organization of the company determines the structure of the site selection team. Corporations with a centralized staff will generally form a team including representatives from key areas such as transportation, distribution, personnel, engineering, real estate, and planning. Companies with strong divisions and weaker corporate staffs may carry out the location studies at the divisional level. In this case, the corporate office would normally retain supervising authority. The site selection team will develop a list of characteristics that are important for the location of the new facility. A "must-and-want" list of site selection criteria may be derived based upon the economic and noneconomic aspects of the location choice. The role of the plant in the overall corporate strategy will be considered. Desires to penetrate new markets, to segregate (or integrate) corporate functions, or to increase a firm's visibility may be elements in the location decision. The "must-and-want" list will include both quantifiable and no quantifiable location factors. The location factors may be weighted to indicate which location features are most important.

The next step is to gather information about potential sites and to compare the features of each site against the "must-and-want" list. Sites will be eliminated in rounds as more detailed and difficult to obtain information is gathered after each elimination round. Table I shows principal information sources used by the site selection committee in this winnowing process.

McMillan, Kieschnich, and others pointed out that the location decision is normally made sequentially. The first stage is the choice of a state or region. Over half of all location studies make their "first cut" at a multistate level. Once the state or region has been selected, a more micro-focus will culminate in the selection of a specific community and site. The important location factors differ between the first stage when firms are seeking a general region in which to locate and the second, more geographically focused stage. In selecting a broad region, the site selection team will focus on labor, state tax variables, climate, proximity to markets, and other features that may have significant interregional variation, but are similar almost everywhere within the region.

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Location factors that vary at the micro-geographic level of detail such as land costs, access to major roads, and schools are generally available somewhere within all major regions. Hence, micro-factors become more important when selecting a specific site or specific community within a region. Unfortunately, many location studies do not distinguish between stages of the location process. A city may have many of the important micro-geographic features such as good education and inexpensive land that would be desirable, but because of its regional setting, the city may not be a feasible site for a particular firm.

As the location choices are narrowed, discussions with local public officials regarding potential problems and incentives may begin. Preliminary estimates of construction costs will be developed for inclusion in the corporation's capital budget. If high-level corporate decisions makers have been directing the site selection process, the capital expenditure decision is usually routine; however, in more decentralized corporate environments, divisions may compete vigorously for a share of the capital budget. A feasibility analysis must normally show that the proposed plan will earn a high enough rate of return to justify the construction costs.

9.4. Factors affecting industrial location

Economists initially viewed location decisions as a transportation cost-minimization problem. The best location was described as the point where the combined cost of (1) transporting raw materials to the plant and (2) transporting the output to the market was least. (In fact, a triangular board with strings tied together and weighted to reflect transportation costs—called a Varignon Frame—was a tool for determining the minimum cost point.)2 This approach would be appropriate only if no transport costs were equal at all locations.

Trade-Offs

Location analysts realized that cost factors other than transportation had to be considered if the profit-maximizing locations were to be determined. Trade-offs among such factors as wages, energy, and so forth on the one hand and transportation costs on the other had to be considered. If the savings due to say, low wages, could offset the extra transportation costs associated with a low-wage site, the firm would select the low-wage site. If the low wages were not a sufficient offset, the plant would remain at the minimum transport cost point. Implicit in the early location literature was the view that most industries were sensitive to transportation costs. Perhaps this was realistic between the early 1900s and the post-World War II period, but as will be shown in the third section, modern firms are influenced by a wide variety of other factors.

The early work on industrial location indicated the importance of location trade-offs. Low transportation costs were important but they could be forfeited for cost reductions in other areas. Today, an increasingly large share of industries can operate successfully in a variety of locations. Schmenner noted that firms often find several low-cost sites and "a seemingly inconsequential item tips the scale towards one site."

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Profit Maximization

The early literature assumed that firms located to maximize profits. Location was considered a long-term investment decision; the firm was assumed to locate where the discounted net present value of its output was greatest. (If output or sales were not affected by location, the profit-maximizing point would be the cost-minimizing site as discussed above.) The profit-maximizing assumption is still implicit in most approaches to location analysis. However, economists have become aware that many decisions, including location decisions, are not based on profit maximization. Often a manager may prefer a "safe" location with a high probability of generating satisfactory profits rather than a high-risk, high-return location. Personal preferences are also an increasingly recognized location factor.

New businesses are less sensitive to the profit-maximizing aspects of location choice than branch plants. Businesses in the formative stage appear to locate in the area where the founder lived, implying that personal factors take precedence over strict profit maximization. However, successful locations, even if initially based on personal factors, may rest on sound location determinants:

A good analogy is the scattering of... seeds by the wind... nothing makes them select spots particularly favorable for germination Because of the survival of those which happen to be well located, the resulting distribution of plants ... follows closely the distribution of favorable growing conditions. So in the location of economic activities, it is not strictly necessary to have both competition and wise business planning in order to have a somewhat rational location pattern emerge.

Thus, areas that appear to be lucky because they have been the home of successful new ventures probably have an underlying economic strength even if it is not immediately obvious. In spite of the recognition of personal factors, location decisions appear to be becoming more rational, particularly for branch plant decisions among large, Multiplan firms. Computer-assisted location models and mathematical programming techniques are widely used today.

Community Growth and Location

Concern among state and local planners about industrial location is primarily based upon the desire to create jobs and improve the tax base. Business relocations are frequently viewed as the most direct way to enhance an area's economic base. Recent studies, however, indicate that most local growth is attributable to differential growth rates of existing facilities. In other words, a high-growth community will normally be characterized by fast growth of existing facilities. The complete shutdown of a plant in one area in order to relocate to another area is rare. Furthermore, when relocations do occur, the vast majority are over very short distances, often within the same community.8 this perspective has caused local policymakers to increase the priority given to the expansion needs of existing facilities.

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Analysts have used two methods to describe why firms locate where they do: surveys and econometric studies. The most comprehensive analysis of the determinants of industrial location has been surveys because they allow researchers to probe the significance of long lists of variables, some of which may be qualitative. For instance, "quality of life" is important to many firms, but it is a concept that is difficult to quantify. Even a factor such as "access to market" may be more meaningful to respondents than a rigorous, quantitative definition of the same concepts. The principal drawbacks of surveys are (1) respondents may provide answers that they believe will influence policy in their favor, (2) only existing firms can be surveyed, and (3) the choices given by the survey researcher can affect the response. Econometric studies examine the determinants of where firms actually located or the differences in employment growth among regions. Usually they focus on the statistical significance of a few selected variables. After we review the survey findings, we examine the econometric literature giving specific relevance to the location influence of policy variables.

Relative Importance of Location Factors in 17 Surveys

Factor	*Number of Surveys in Which a Factor Was Described as of*		
	Primary Significance	*Some Significance*	*Little Significance*
Markets	16	1	0
Labor	10	7	0
Raw Materials	10	6	0
Transportation	7	10	0
Taxes	1	3	13
Financial Incentives	0	0	13

SOURCE: W. Morgan, "The Effects of State and Local Tax and Financial Inducements on Industrial Location" (Ph.D. diss., University of Colorado, 1964), Table 2.

🕮Check Lists

Read each of the points below and tick ☑for **yes** and☒ for **No**. If your answer is **yes**, go to the next point, but if your answer is **No** go back to that topic and read again until you have fully understood it!

I CAN	Yes	No
Define industry location decision		
Describe major factors that affect location		
Explain location principles		
Explain types of location decisions		
Describes locating firms in different location		
Describe negative consequences of wrong location		

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Summary

A review of the recent studies reveals that industrial location choices are governed to a lesser extent than in the past by access to markets, labor, transportation, and raw materials. While these traditional location factors still exert an important influence, the list of important location determinants has been expanded to include state and local taxes, education, business climate, labor skills, and state and local physical infrastructure. In fact at the high technology end of the industrial spectrum, these nontraditional location factors tend to dominate the location choices. Thus, it would appear that as the nation's economy continues to shift to advanced technologies to remain competitive, the overall importance of the nontraditional location factors will increase as the traditional location factors decline in significance. Of course, in general, the traditional location factors will undoubtedly continue to be quantitatively more significant in terms of their overall influence.

The tendency of industrial firms to become more footloose has important implications for industrial development policy. On the one hand, it would seem to indicate that selective industrial incentive programs—subsidies, tax concessions, and low-interest loans—would have a higher regional payoff than in the past. However, the inability of industrial researchers to find empirical support for this proposition suggests that this is not the case.

There is little evidence that a region or community can attract industry from other regions by offering location subsidies since comparable bundles of industrial incentives are now available in most states and regions. On the other hand, many of the nontraditional location factors that have become important are directly influenced by state and local government expenditure, tax, and regulatory policies. Rather than designing selective industrial development policies of benefit to only a few industries, a potentially more productive and equitable policy would be for government to focus its efforts on improving the overall location attractiveness of regions. This inward-looking strategy would place primary emphasis on developing and improving local markets in skilled labor, research, risk capital, education, recreation, and cultural amenities. It would also emphasize long-run tax policy, management-labor relations, and quality-of-life factors. Industrial development would largely be a by-product of an improved overall business climate and a better community in which to live. The selective industrial policies of the past would probably continue but the development strategy of the regions would be expanded to address overall competitiveness issues.

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