Chapter 1

Introduction

1.1 A Simple Economy

Think of any society. People in the society need many goods and services[1] in their everyday life including food, clothing, shelter, transport facilities like roads and railways, postal services and various other services like that of teachers and doctors. In fact, the list of goods and services that any individual[2] needs is so large that no individual in society, to begin with, has all the things she needs. Every individual has some amount of only a few of the goods and services that she would like to use. A family farm may own a plot of land, some grains, farming implements, maybe a pair of bullocks and also the labour services of the family members. A weaver may have some yarn, some cotton and other instruments required for weaving cloth. The teacher in the local school has the skills required to impart education to the students. Some others in society may not have any resource[3] excepting their own labour services. Each of these decision making units can produce some goods or services by using the resources that it has and use part of the produce to obtain the many other goods and services which it needs. For example, the family farm can produce corn, use part of the produce for consumption purposes and procure clothing, housing and various services in exchange for the rest of the produce. Similarly, the weaver can get the goods and services that she wants in exchange for the cloth she produces in her yarn. The teacher can earn some money by teaching students in the school and use the money for obtaining the goods and services that she wants. The labourer also can try to fulfill her needs by using whatever money she can earn by working for someone else. Each individual can thus use her resources to fulfill her needs. It goes without saying that no individual has unlimited resources compared to her needs. The amount of corn that the family farm can produce is limited by the amount of resources it has, and hence, the amount of different goods

[1]By goods we means physical, tangible objects used to satisfy people's wants and needs. The term 'goods' should be contrasted with the term 'services', which captures the intangible satisfaction of wants and needs. As compared to food items and clothes, which are examples of goods, we can think of the tasks that doctors and teachers perform for us as examples of services.

[2]By individual, we mean an individual decision making unit. A decision making unit can be a single person or a group like a household, a firm or any other organisation.

[3]By resource, we mean those goods and services which are used to produce other goods and services, e.g. land, labour, tools and machinery, etc.

and services that it can procure in exchange of corn is also limited. As a result, the family is forced to make a choice between the different goods and services that are available. It can have more of a good or service only by giving up some amounts of other goods or services. For example, if the family wants to have a bigger house, it may have to give up the idea of having a few more acres of arable land. If it wants more and better education for the children, it may have to give up some of the luxuries of life. The same is the case with all other individuals in society. Everyone faces scarcity of resources, and therefore, has to use the limited resources in the best possible way to fulfill her needs.

In general, every individual in society is engaged in the production of some goods or services and she wants a combination of many goods and services not all of which are produced by her. Needless to say that there has to be some compatibility between what people in society collectively want to have and what they produce[4]. For example, the total amount of corn produced by family farm along with other farming units in a society must match the total amount of corn that people in the society collectively want to consume. If people in the society do not want as much corn as the farming units are capable of producing collectively, a part of the resources of these units could have been used in the production of some other good or services which is in high demand. On the other hand, if people in the society want more corn compared to what the farming units are producing collectively, the resources used in the production of some other goods and services may be reallocated to the production of corn. Similar is the case with all other goods or services. Just as the resources of an individual are scarce, the resources of the society are also scarce in comparison to what the people in the society might collectively want to have. The scarce resources of the society have to be allocated properly in the production of different goods and services in keeping with the likes and dislikes of the people of the society.

Any allocation[5] of resources of the society would result in the production of a particular combination of different goods and services. The goods and services thus produced will have to be distributed among the individuals of the society. The allocation of the limited resources and the distribution of the final mix of goods and services are two of the basic economic problems faced by the society.

In reality, any economy is much more complex compared to the society discussed above. In the light of what we have learnt about the society, let us now discuss the fundamental concerns of the discipline of economics some of which we shall study throughout this book.

1.2 Central Problems of an Economy

Production, exchange and consumption of goods and services are among the basic economic activities of life. In the course of these basic economic activities, every society has to face **scarcity** of resources and it is the scarcity of resources that gives rise to the problem of **choice**. The scarce resources of an economy have competing usages. In other words, every society has to decide on how to use its scarce resources. The problems of an economy are very often summarised as follows:

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[4]Here we assume that all the goods and services produced in a society are consumed by the people in the society and that there is no scope of getting anything from outside the society. In reality, this is not true. However, the general point that is being made here about the compatibility of production and consumption of goods and services holds for any country or even for the entire world.

[5]By an allocation of the resources, we mean how much of which resource is devoted to the production of each of the goods and services.

What is produced and in what quantities?

Every society must decide on how much of each of the many possible goods and services it will produce. Whether to produce more of food, clothing, housing or to have more of luxury goods. Whether to have more agricultural goods or to have industrial products and services. Whether to use more resources in education and health or to use more resources in building military services. Whether to have more of basic education or more of higher education. Whether to have more of consumption goods or to have investment goods (like machine) which will boost production and consumption tomorrow.

How are these goods produced?

Every society has to decide on how much of which of the resources to use in the production of each of the different goods and services. Whether to use more labour or more machines. Which of the available technologies to adopt in the production of each of the goods?

For whom are these goods produced?

Who gets how much of the goods that are produced in the economy? How should the produce of the economy be distributed among the individuals in the economy? Who gets more and who gets less? Whether or not to ensure a minimum amount of consumption for everyone in the economy. Whether or not elementary education and basic health services should be available freely for everyone in the economy.

Thus, every economy faces the problem of allocating the scarce resources to the production of different possible goods and services and of distributing the produced goods and services among the individuals within the economy. *The allocation of scarce resources and the distribution of the final goods and services are the central problems of any economy.*

Production Possibility Frontier

Just as individuals face scarcity of resources, the resources of an economy as a whole are always limited in comparison to what the people in the economy collectively want to have. The scarce resources have alternative usages and every society has to decide on how much of each of the resources to use in the production of different goods and services. In other words, every society has to determine how to allocate its scarce resources to different goods and services.

An allocation of the scarce resource of the economy gives rise to a particular combination of different goods and services. Given the total amount of resources, it is possible to allocate the resources in many different ways and, thereby achieving different mixes of all possible goods and services. The collection of all possible combinations of the goods and services that can be produced from a given amount of resources and a given stock of technological knowledge is called the **production possibility set** of the economy.

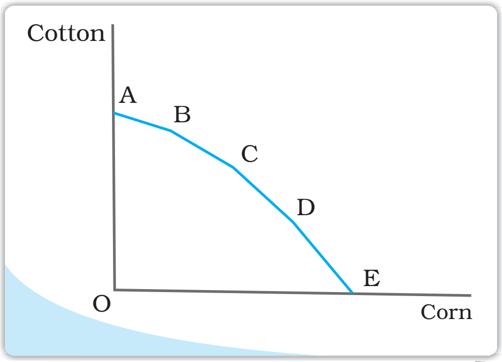
EXAMPLE 1

Consider an economy which can produce corn or cotton by using its resources. Table 1.1 gives some of the combinations of corn and cotton that the economy can produce.

Table1.1: **Production Possibilities**

Possibilities	*Corn*	*Cotton*
A	0	10
B	1	9
C	2	7
D	3	4
E	4	0

If all the resources are used in the production of corn, the maximum amount of corn that can be produced is 4 units and if all resources are used in the production of cotton, at the most, 10 units of cotton can be produced. The economy can also produce1 unit of corn and 9 units of cotton or 2 units of corn and 7 units of cotton or 3 units of corn and 4 units of cotton. There can be many other possibilities. The figure illustrates the production possibilities of the economy. Any point on or below the curve represents a combination of corn and cotton that can be produced with the economy's resources. The curve gives the maximum amount of corn that can be produced in the economy for any given amount of cotton and vice-versa. This curve is called the **production possibility frontier**.



The **production possibility frontier** gives the combinations of corn and cotton that can be produced when the resources of the economy are fully utilised. Note that a point lying strictly below the production possibility frontier represents a combination of corn and cotton that will be produced when all or some of the resources are either underemployed or are utilised in a wasteful fashion.

If more of the scarce resources are used in the production of corn, less resources are available for the production of cotton and vice versa. Therefore, if we want to have more of one of the goods, we will have less of the other good. Thus, there is always a cost of having a little more of one good in terms of the amount of the other good that has to be forgone. This is known as the **opportunity cost**[a] of an additional unit of the goods.

Every economy has to choose one of the many possibilities that it has. In other words, one of the central problems of the economy is to choose from one of the many production possibilities.

[a]Note that the concept of opportunity cost is applicable to the individual as well as the society. The concept is very important and is widely used in economics. Because of its importance in economics, sometimes, opportunity cost is also called the economic cost.

1.3 Organisation of Economic Activities

Basic problems can be solved either by the free interaction of the individuals pursuing their own objectives as is done in the market or in a planned manner by some central authority like the government.

1.3.1 The Centrally Planned Economy

In a centrally planned economy, the government or the central authority plans all the important activities in the economy. All important decisions regarding production, exchange and consumption of goods and services are made by the government. The central authority may try to achieve a particular allocation of resources and a consequent distribution of the final combination of goods and services which is thought to be desirable for society as a whole. For example, if it is found that a good or service which is very important for the prosperity and well-being of the economy as a whole, e.g. education or health service, is not produced in adequate amount by the individuals on their own, the government might try to induce the individuals to produce adequate amount of such a good or service or, alternatively, the government may itself decide to produce the good or service in question. In a different context, if some people in the economy get so little a share of the final mix of goods and services produced in the economy that their survival is at stake, then the central authority may intervene and try to achieve an equitable distribution of the final mix of goods and services.

1.3.2 The Market Economy

In contrast to a centrally planned economy, in a **market economy**, all economic activities are organised through the market. A **market**, as studied in economics, is an institution[6] which organises the free interaction of individuals pursuing their respective economic activities. In other words, a market is a set of arrangements where economic agents can freely exchange their endowments or products with each other. It is important to note that the term 'market' as used in economics is quite different from the common sense understanding of a market. In particular, it has nothing as such to do with the marketplace as you might tend to think of. For buying and selling commodities, individuals may or may not meet each other in an actual physical location. Interaction between buyers and sellers can take place in a variety of situations such as a village-chowk or a super bazaar in a city, or alternatively, buyers and sellers can interact with each other through telephone or internet and conduct the exchange of commodities. The arrangements which allow people to buy and sell commodities freely are the defining features of a market.

For the smooth functioning of any system, it is imperative that there is coordination in the activities of the different constituent parts of the system. Otherwise, there can be chaos. You may wonder as to what are the forces which bring the coordination between the activities of millions of isolated individuals in a market system.

In a market system, all goods or services come with a price (which is mutually agreed upon by the buyers and sellers) at which the exchanges take place. The price reflects, on an average, the society's valuation of the good or service in question. If the buyers demand more of a certain good, the price of that good will rise. This will send a signal to the producer of that good to the effect that the society as a whole wants more of that good than is currently being produced and the producers of the good, in their turn, are likely to increase their production. In this way, prices of goods and services send important information to all the individuals across the market and help achieve coordination in a market system. Thus, in a market system, the central problems regarding how much and what to produce are solved through the coordination of economic activities brought about by the price signals.

In reality, all economies are mixed economies where some important decisions are taken by the government and the economic activities are by and large conducted through the market. The only difference is in terms of the extent of the role of the government in deciding the course of economic activities. In the United States of America, the role of the government is minimal. The closest example of a centrally planned economy is the Soviet Union for the major part of the twentieth century. In India, since Independence, the government has played a major role in planning economic activities. However,

[6]An institution is usually defined as an organisation with some purpose.

the role of the government in the Indian economy has been reduced considerably in the last couple of decades.

1.4 Positive and Normative Economics

It was mentioned earlier that in principle there are more than one ways of solving the central problems of an economy. These different mechanisms in general are likely to give rise to different solutions to those problems, thereby resulting in different allocations of the resources and also different distributions of the final mix of goods and services produced in the economy. Therefore, it is important to understand which of these alternative mechanisms is more desirable for the economy as a whole. In economics, we try to analyse the different mechanisms and figure out the outcomes which are likely to result under each of these mechanisms. We also try to evaluate the mechanisms by studying how desirable the outcomes resulting from them are. Often a distinction is made between **positive economic analysis** and **normative economic analysis** depending on whether we are trying to figure out how a particular mechanism functions or we are trying to evaluate it. In positive economic analysis, we study how the different mechanisms function, and in normative economics, we try to understand whether these mechanisms are desirable or not. However, this distinction between positive and normative economic analysis is not a very sharp one. The positive and the normative issues involved in the study of the central economic problems are very closely related to each other and a proper understanding of one is not possible in isolation to the other.

1.5 Microeconomics and Macroeconomics

Traditionally, the subject matter of economics has been studied under two broad branches: **Microeconomics** and **Macroeconomics**. In microeconomics, we study the behaviour of individual economic agents in the markets for different goods and services and try to figure out how prices and quantities of goods and services are determined through the interaction of individuals in these markets. In macroeconomics, on the other hand, we try to get an understanding of the economy as a whole by focusing our attention on aggregate measures such as total output, employment and aggregate price level. Here, we are interested in finding out how the levels of these aggregate measures are determined and how the levels of these aggregate measures change over time. Some of the important questions that are studied in microeconomics are as follows: What is the level of total output in the economy? How is the total output determined? How does the total output grow over time? Are the resources of the economy (eg labour) fully employed? What are the reasons behind the unemployment of resources? Why do prices rise? Thus, instead of studying the different markets as is done in microeconomics, in macroeconomics, we try to study the behaviour of aggregate or macro measures of the performance of the economy.

1.6 Plan of the Book

This book is meant to introduce you to the basic ideas in microeconomics. In this book, we will focus on the behaviour of the individual consumers and producers of a single commodity and try to analyse how the price and the quantity is determined in the market for a single commodity. In Chapter 2, we shall study the consumer's behaviour. Chapter 3 deals with basic ideas of production and cost. In Chapter 4, we study the producer's behaviour. In Chapter 5, we shall study how price and quantity is determined in a perfectly competitive market for a commodity. Chapter 6 studies some other forms of market.

Key Concepts

Consumption	Production	Exchange
Scarcity	Production possibilities	Opportunity cost
Market	Market economy	Centrally planned economy
Mixed economy	Positive analysis	Normative analysis
Microeconomics	Macroeconomics	

Exercises

1. Discuss the central problems of an economy.
2. What do you mean by the production possibilities of an economy?
3. What is a production possibility frontier?
4. Discuss the subject matter of economics.
5. Distinguish between a centrally planned economy and a market economy.
6. What do you understand by positive economic analysis?
7. What do you understand by normative economic analysis?
8. Distinguish between microeconomics and macroeconomics.

Chapter 2

Theory of Consumer Behaviour

In this chapter, we will study the behaviour of an individual consumer in a market for final goods[1]. The consumer has to decide on how much of each of the different goods she would like to consume. Our objective here is to study this choice problem in some detail. As we see, the choice of the consumer depends on the alternatives that are available to her and on her tastes and preferences regarding those alternatives. To begin with, we will try to figure out a precise and convenient way of describing the available alternatives and also the tastes and preferences of the consumer. We will then use these descriptions to find out the consumer's choice in the market.

Preliminary Notations and Assumptions

A consumer, in general, consumes many goods; but for simplicity, we shall consider the consumer's choice problem in a situation where there are only two goods.[2] We will refer to the two goods as good 1 and good 2. Any combination of the amount of the two goods will be called a consumption bundle or, in short, a bundle. In general, we shall use the variable x_1 to denote the amount of good 1 and x_2 to denote the amount of good 2. x_1 and x_2 can be positive or zero. (x_1, x_2) would mean the bundle consisting of x_1 amount of good 1 and x_2 amount of good 2. For particular values of x_1 and x_2, (x_1, x_2), would give us a particular bundle. For example, the bundle (5,10) consists of 5 units of good 1 and 10 units of good 2; the bundle (10, 5) consists of 10 units of good 1 and 5 units of good 2.

2.1 The Consumer's Budget

Let us consider a consumer who has only a fixed amount of money (income) to spend on two goods the prices of which are given in the market. The consumer cannot buy any and every combination of the two goods that she may want to consume. The consumption bundles that are available to the consumer depend on the prices of the two goods and the income of the consumer. Given her fixed

[1]We shall use the term goods to mean goods as well as services.

[2]The assumption that there are only two goods simplifies the analysis considerably and allows us to understand some important concepts by using simple diagrams.

Spoilt for Choice

income and the prices of the two goods, the consumer can afford to buy only those bundles which cost her less than or equal to her income.

2.1.1 Budget Set

Suppose the income of the consumer is M and the prices of the two goods are p_1 and p_2 respectively.[3] If the consumer wants to buy x_1 units of good 1, she will have to spend p_1x_1 amount of money. Similarly, if the consumer wants to buy x_2 units of good 2, she will have to spend p_2x_2 amount of money. Therefore, if the consumer wants to buy the bundle consisting of x_1 units of good 1 and x_2 units of good 2, she will have to spend $p_1x_1 + p_2x_2$ amount of money. She can buy this bundle only if she has at least $p_1x_1 + p_2x_2$ amount of money. Given the prices of the goods and the income of a consumer, she can choose any bundle as long as it costs less than or equal to the income she has. In other words, the consumer can buy any bundle (x_1, x_2) such that

$$p_1x_1 + p_2x_2 \leq M \qquad (2.1)$$

The inequality (2.1) is called the consumer's **budget constraint**. The set of bundles available to the consumer is called the **budget set**. The budget set is thus the collection of all bundles that the consumer can buy with her income at the prevailing market prices.

EXAMPLE 2.1

Consider, for example, a consumer who has Rs 20, and suppose, both the goods are priced at Rs 5 and are available only in integral units. The bundles that this consumer can afford to buy are: (0, 0), (0, 1), (0, 2), (0, 3), (0, 4), (1, 0), (1, 1), (1, 2), (1, 3), (2, 0), (2, 1), (2, 2), (3, 0), (3, 1) and (4, 0). Among these bundles, (0, 4), (1,3), (2, 2), (3, 1) and (4, 0) cost exactly Rs 20 and all the other bundles cost less than Rs 20. The consumer cannot afford to buy bundles like (3, 3) and (4, 5) because they cost more than Rs 20 at the prevailing prices.

[3]Price of a good is the amount of money that the consumer has to pay per unit of the good she wants to buy. If rupee is the unit of money and quantity of the good is measured in kilograms, the price of good 1 being p_1 means the consumer has to pay p_1 *rupees per kilograms of good 1 that she wants to buy*.

2.1.2 Budget Line

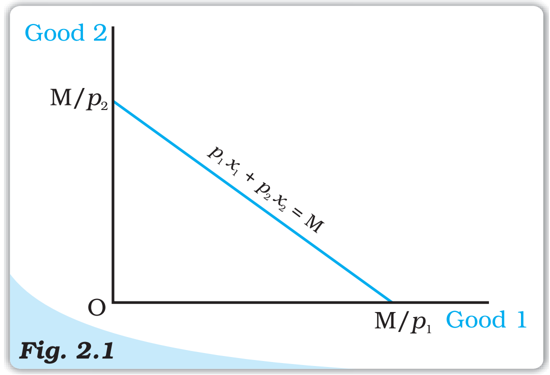


Fig. 2.1

Budget Set. *Quantity of good 1 is measured along the horizontal axis and quantity of good 2 is measured along the vertical axis. Any point in the diagram represents a bundle of the two goods. The budget set consists of all points on or below the straight line having the equation* $p_1x_1 + p_2x_2 = M$.

If both the goods are perfectly divisible[4], the consumer's budget set would consist of all bundles (x_1, x_2) such that x_1 and x_2 are any numbers greater than or equal to 0 and $p_1x_1 + p_2x_2 \leq M$. The budget set can be represented in a diagram as in Figure 2.1.

All bundles in the positive quadrant which are on or below the line are included in the budget set. The equation of the line is

$$p_1x_1 + p_2x_2 = M \qquad (2.2)$$

The line consists of all bundles which cost exactly equal to M. This line is called the budget line. Points below the budget line represent bundles which cost strictly less than M.

The equation (2.2) can also be written as[5]

$$x_2 = \frac{M}{p_2} - \frac{p_1}{p_2}x_1 \qquad (2.3)$$

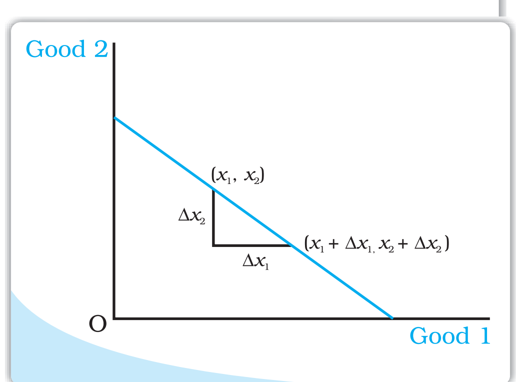
The budget line is a straight line with horizontal intercept $\frac{M}{p_1}$ and vertical intercept $\frac{M}{p_2}$. The horizontal intercept represents the bundle that the consumer can buy if she spends her entire income on good 1. Similarly, the vertical intercept represents the bundle that the consumer can buy if she spends her entire income on good 2. The slope of the budget line is $-\frac{p_1}{p_2}$.

Derivation of the Slope of the Budget Line

The slope of the budget line measures the amount of change in good 2 required per unit of change in good 1 along the budget line. Consider any two points (x_1, x_2) and $(x_1 + \Delta x_1, x_2 + \Delta x_2)$ on the budget line.[a]
It must be the case that

$$p_1x_1 + p_2x_2 = M \qquad (2.4) \text{ and}$$

$$p_1(x_1 + \Delta x_1) + p_2(x_2 + \Delta x_2) = M \qquad (2.5)$$



[4]The goods considered in Example 2.1 were not divisible and were available only in integer units. There are many goods which are divisible in the sense that they are available in non-integer units also. It is not possible to buy half an orange or one-fourth of a banana, but it is certainly possible to buy half a kilogram of rice or one-fourth of a litre of milk.

[5]In school mathematics, you have learnt the equation of a straight line as $y = c + mx$ where c is the vertical intercept and m is the slope of the straight line. Note that equation (2.3) has the same form.

Subtracting (2.4) from (2.5), we obtain

$$p_1\Delta x_1 + p_2\Delta x_2 = 0 \qquad (2.6)$$

By rearranging terms in (2.6), we obtain

$$\frac{\Delta x_2}{\Delta x_1} = -\frac{p_1}{p_2} \qquad (2.7)$$

[a]Δ (delta) is a Greek letter. In mathematics, Δ is sometimes used to denote 'a change'. Thus, Δx_1 stands for a change in x_1 and Δx_2 stands for a change in x_2.

Price Ratio and the Slope of the Budget Line

Think of any point on the budget line. Such a point represents a bundle which costs the consumer her entire budget. Now suppose the consumer wants to have one more unit of good 1. She can do it only if she gives up some amount of the other good. How much of good 2 does she have to give up if she wants to have an extra unit of good 1? It would depend on the prices of the two goods. A unit of good 1 costs p_1. Therefore, she will have to reduce her expenditure on good 2 by p_1 amount. With p_1, she could buy $\frac{p_1}{p_2}$ units of good 2. Therefore, if the consumer wants to have an extra unit of good 1 when she is spending all her money, she will have to give up $\frac{p_1}{p_2}$ units of good 2. In other words, in the given market conditions, the consumer can substitute good 1 for good 2 at the rate $\frac{p_1}{p_2}$. The absolute value[6] of the slope of the budget line measures the rate at which the consumer is able to substitute good 1 for good 2 when she spends her entire budget.

Points Below the Budget Line

Consider any point below the budget line. Such a point represents a bundle which costs less than the consumer's income. Thus, if the consumer buys such a bundle, she will have some money left over. In principle, the consumer could spend this extra money on either of the two goods, and thus, buy a bundle which consists of more of, at least, one of the goods, and no less of the other as compared to the bundle lying below the budget line. In other words, compared to a point below the budget line, there is always some bundle on the budget line which contains more of at least one of the goods and no less of the other. Figure 2.2 illustrates this fact. The point C lies below the budget line while points A and B lie on the budget line. Point A contains more of good 2 and the same amount of good

A Point below the Budget Line. *Compared to a point below the budget line, there is always some bundle on the budget line which contains more of at least one of the goods and no less of the other.*

[6]The absolute value of a number x is equal to x if $x \geq 0$ and is equal to $-x$ if $x < 0$. The absolute value of x is usually denoted by $|x|$.

1 as compared to point C. Point B contains more of good 1 and the same amount of good 2 as compared to point C. Any other point on the line segment 'AB' represents a bundle which has more of both the goods compared to C.

2.1.3 Changes in the Budget Set

The set of available bundles depends on the prices of the two goods and the income of the consumer. When the price of either of the goods or the consumer's income changes, the set of available bundles is also likely to change. Suppose the consumer's income changes from M to M' but the prices of the two goods remain unchanged. With the new income, the consumer can afford to buy all bundles (x_1, x_2) such that $p_1x_1 + p_2x_2 \leq M'$. Now the equation of the budget line is

$$p_1x_1 + p_2x_2 = M' \qquad (2.8)$$

Equation (2.8) can also be written as

$$x_2 = \frac{M'}{p_2} - \frac{p_1}{p_2}x_1 \qquad (2.9)$$

Note that the slope of the new budget line is the same as the slope of the budget line prior to the change in the consumer's income. However, the vertical intercept has changed after the change in income. If there is an increase in the income, i.e. if $M' > M$, the vertical intercept increases, there is a parallel outward shift of the budget line. If the income increases, the consumer can buy more of the goods at the prevailing market prices. Similarly, if the income goes down, i.e. if $M' < M$, the vertical intercept decreases, and hence, there is a parallel inward shift of the budget line. If income goes down, the availability of goods goes down. Changes in the set of available bundles resulting from changes in consumer's income when the prices of the two goods remain unchanged are shown in Figure 2.3.

Changes in the Set of Available Bundles of Goods Resulting from Changes in the Consumer's Income. *A decrease in income causes a parallel inward shift of the budget line as in panel (a). An increase in income causes a parallel outward shift of the budget line as in panel (b).*

Now suppose the price of good 1 changes from p_1 to p'_1 but the price of good 2 and the consumer's income remain unchanged. At the new price of good 1, the consumer can afford to buy all bundles (x_1,x_2) such that $p'_1x_1 + p_2x_2 \leq M$. The equation of the budget line is

$$p'_1x_1 + p_2x_2 = M \qquad (2.10)$$

Equation (2.10) can also be written as

$$x_2 = \frac{M}{p_2} - \frac{p'_1}{p_2} x_1 \qquad (2.11)$$

Note that the vertical intercept of the new budget line is the same as the vertical intercept of the budget line prior to the change in the price of good 1. However, the slope of the budget line has changed after the price change. If the price of good 1 increases, ie if $p'_1 > p_1$, the absolute value of the slope of the budget line increases, and the budget line becomes steeper (it pivots inwards around the vertical intercept). If the price of good 1 decreases, i.e., $p'_1 < p_1$, the absolute value of the slope of the budget line decreases and hence, the budget line becomes flatter (it pivots outwards around the vertical intercept). Changes in the set of available bundles resulting from changes in the price of good 1 when the price of good 2 and the consumer's income remain unchanged are represented in Figure 2.4.

Changes in the Set of Available Bundles of Goods Resulting from Changes in the Price of Good 1. *An increase in the price of good 1 makes the budget line steeper as in panel (a). A decrease in the price of good 1 makes the budget line flatter as in panel (b).*

A change in price of good 2, when price of good 1 and the consumer's income remain unchanged, will bring about similar changes in the budget set of the consumer.

2.2 Preferences of the Consumer

The budget set consists of all bundles that are available to the consumer. The consumer can choose her consumption bundle from the budget set. But on what basis does she choose her consumption bundle from the ones that are available to her? In economics, it is assumed that the consumer chooses her consumption bundle on the basis of her tastes and preferences over the bundles in the budget set. It is generally assumed that the consumer has well-defined preferences over the set of all possible bundles. She can compare any two bundles. In other words, between any two bundles, she either prefers one to the other or she is indifferent between the two. Furthermore, it is assumed that the consumer can rank[7] the bundles in order of her preferences over them.

[7]The simplest example of a ranking is the ranking of all students according to the marks obtained by each in the last annual examination.

EXAMPLE 2.2

Consider the consumer of Example 2.1. Suppose the preferences of the consumer over the set of bundles that are available to her are as follows:

The consumer's most preferred bundle is (2, 2).

She is indifferent to (1, 3) and (3, 1). She prefers both these bundles compared to any other bundle except (2, 2).

She is indifferent to (1, 2) and (2, 1). She prefers both these bundles compared to any other bundle except (2, 2), (1, 3) and (3, 1).

The consumer is indifferent to any bundle which has only one of the goods and the bundle (0, 0). A bundle having positive amounts of both goods is preferred to a bundle having only one of the goods.

The bundles that are available to this consumer can be ranked from the best to the least preferred according to her preferences. Any two (or more) indifferent bundles obtain the same rank while the preferred bundles are ranked higher. The ranking is presented in the Table 2.1.

Table 2.1: Ranking of the bundle available to the consumer in Example 2.1

Bundle	*Ranking*
(2, 2)	First
(1, 3), (3, 1)	Second
(1, 2), (2, 1)	Third
(1, 1)	Fourth
(0, 0), (0, 1), (0, 2), (0, 3), (0, 4), (1, 0), (2, 0), (3, 0), (4, 0)	Fifth

2.2.1 Monotonic Preferences

Consumer's preferences are assumed to be such that between any two bundles (x_1, x_2) and (y_1, y_2), if (x_1, x_2) has more of at least one of the goods and no less of the other good compared to (y_1, y_2), then the consumer prefers (x_1, x_2) to (y_1, y_2). Preferences of this kind are called **monotonic preferences**. Thus, a consumer's preferences are monotonic if and only if between any two bundles, the consumer prefers the bundle which has more of at least one of the goods and no less of the other good as compared to the other bundle.

EXAMPLE 2.3

For example, consider the bundle (2, 2). This bundle has more of both goods compared to (1, 1); it has equal amount of good 1 but more of good 2 compared to the bundle (2, 1) and compared to (1, 2), it has more of good 1 and equal amount of good 2. If a consumer has monotonic preferences, she would prefer the bundle (2, 2) to all the three bundles (1, 1), (2, 1) and (1, 2).

2.2.2 Substitution between Goods

Consider two bundles such that one bundle has more of the first good as compared to the other bundle. If the consumer's preferences are monotonic, these two bundles can be indifferent only if the bundle having more of the first good has less of good 2 as compared to the other bundle. Suppose a consumer is indifferent between two bundles (x_1, x_2) and $(x_1 + \Delta x_1, x_2 + \Delta x_2)$. Monotonicity of preferences implies that if $\Delta x_1 > 0$ then $\Delta x_2 < 0$, and if $\Delta x_1 < 0$ then $\Delta x_2 > 0$; the consumer can move from (x_1, x_2) to $(x_1 + \Delta x_1, x_2 + \Delta x_2)$ by substituting one good for the other. The **rate of substitution** between good 2 and good 1 is given by the absolute value of $\frac{\Delta x_2}{\Delta x_1}$. The rate of substitution is the amount of good 2 that the consumer is willing to give up for an extra unit of good 1. It measures the consumer's willingness to pay for good 1 in terms of good 2. Thus, the rate of substitution between the two goods captures a very important aspect of the consumer's preference.

EXAMPLE 2.4

Suppose a consumer is indifferent to the bundles (1, 2) and (2, 1). At (1, 2), the consumer is willing to give up 1 unit of good 2 if she gets 1 extra unit of good 1. Thus, the rate of substitution between good 2 and good 1 is 1.

2.2.3 Diminishing Rate of Substitution

The consumer's preferences are assumed to be such that she has more of good 1 and less of good 2, the amount of good 2 that she would be willing to give up for an additional unit of good 1 would go down. The consumer's willingness to pay for good 1 in terms of good 2 would go on declining as she has more and more of good 1. In other words, as the amount of good 1 increases, the rate of substitution between good 2 and good 1 diminishes. Preferences of this kind are called convex preferences.

2.2.4 Indifference Curve

A consumer's preferences over the set of available bundles can often be represented diagrammatically. We have already seen that the bundles available to the consumer can be plotted as points in a two-dimensional diagram. The points representing bundles which are considered indifferent by the consumer can generally be joined to obtain a curve like the one in Figure 2.5. Such a curve joining all points representing bundles among which the consumer is indifferent is called an **indifference curve**.

Indifference Curve. *An indifference curve joins all points representing bundles which are considered indifferent by the consumer.*

Consider a point above the indifference curve. Such a point has more of at least one of the goods and no less of the other good as compared to at least one point on the indifference curve. Consider the Figure 2.6. The point C lies above the indifference curve while points A and B lie on the indifference curve. Point C contains more of good 1 and the same amount of good 2 as compared to A. Compared to point B, C contains more of good 2 and the same amount of good 1. And it has more of both the goods compared to any other point on the segment AB of the indifference curve. If preferences are monotonic, the bundle represented by the point C would be preferred to bundles represented by points on the segment AB, and hence, it would be preferred to all bundles on the indifference curve. Therefore, monotonicity of preferences implies that any point above the indifference curve represents a bundle which is preferred to the bundles on the indifference curve. By a similar argument, it can be established that if the consumer's preferences are monotonic, any point below the indifference curve represents a bundle which is inferior to the bundles on the indifference curve. Figure 2.6 depicts the bundles that are preferred and the bundles that are inferior to the bundles on an indifference curve.

Points Above and Points Below the Indifference Curve*. Points above the indifference curve represent bundles which are preferred to bundles represented by points on the indifference curve. Bundles represented by points on the indifference curve are preferred to the bundles represented by points below the indifference curve.*

2.2.5 Shape of the Indifference Curve

The Rate of Substitution and the Slope of the Indifference Curve

Think of any two points (x_1, x_2) and $(x_1 + \Delta x_1, x_2 + \Delta x_2)$ on the indifference curve. Consider a movement from (x_1, x_2) to $(x_1 + \Delta x_1, x_2 + \Delta x_2)$ along the indifference curve. The slope of the straight line joining these two points gives the change in the amount of good 2 corresponding to a unit change in good 1 along the indifference curve. Thus, the absolute value of the slope of the straight line joining these two points gives the rate of substitution between (x_1, x_2) and $(x_1 + \Delta x_1, x_2 + \Delta x_2)$. For very small changes, the slope of the line joining the two points (x_1, x_2) and $(x_1 + \Delta x_1, x_2 + \Delta x_2)$ reduces to the slope of the indifference curve at (x_1, x_2). Thus, for very small changes, the absolute value of the slope of the indifference curve at any point measures the rate of substitution of the consumer at that point. Usually, for small changes, the rate of substitution between good 2 and good 1 is called the **marginal rate of substitution (MRS)**.

If the preferences are monotonic, an increase in the amount of good 1 along the indifference curve is associated with a decrease in the amount of good 2. This implies that the slope of the indifference curve is negative. Thus, *monotonicity of preferences implies that the indifference curves are downward sloping*. Figure 2.7 illustrates the negative slope of an indifference curve.

Figure 2.8 illustrates an indifference curve with diminishing marginal rate of substitution. The indifference curve is convex towards the origin.

Slope of the Indifference Curve*. The indifference curve slopes downward. An increase in the amount of good 1 along the indifference curve is associated with a decrease in the amount of good 2. If $\Delta x_1 > 0$ then $\Delta x_2 < 0$.*

Diminishing Rate of Substitution. *The amount of good 2 the consumer is willing to give up for an extra unit of good 1 declines as the consumer has more and more of good 1.*

Indifference Map. *A family of indifference curves. The arrow indicates that bundles on higher indifference curves are preferred by the consumer to the bundles on lower indifference curves.*

2.2.6 Indifference Map

The consumer's preferences over all the bundles can be represented by a family of indifference curves as shown in Figure 2.9. This is called an indifference map of the consumer. All points on an indifference curve represent bundles which are considered indifferent by the consumer. Monotonicity of preferences imply that between any two indifference curves, the bundles on the one which lies above are preferred to the bundles on the one which lies below.

2.2.7 Utility

Often it is possible to represent preferences by assigning numbers to bundles in a way such that the ranking of bundles is preserved. Preserving the ranking would require assigning the same number to indifferent bundles and higher numbers to preferred bundles. The numbers thus assigned to the bundles are called the utilities of the bundles; and the representation of preferences in terms of the **utility** numbers is called a utility function or a utility representation. Thus, a utility function assigns a number to each and every available bundle in a way such that between any two bundles if one is preferred to the other, the preferred bundle gets assigned a higher utility number, and if the two bundles are indifferent, they are assigned the same utility number.

It is important to note that the preferences are basic and utility numbers merely represent the preferences. The same preferences can have many different utility representations. Table 2.2 presents two different utility representations U_1 and U_2 of the preferences of Example 2.2.

Table 2.2: Utility Representation of Preferences

Bundles of the two goods	U_1	U_2
(2, 2)	5	40
(1, 3), (3, 1)	4	35
(1, 2), (2, 1)	3	28
(1, 1)	2	20
(0, 0), (0, 1), (0, 2), (0, 3), (0, 4), (1, 0), (2, 0), (3, 0), (4, 0)	1	10

2.3 Optimal Choice of the Consumer

In the last two sections, we discussed the set of bundles available to the consumer and also about her preferences over those bundles. Which bundle does she choose? In economics, it is generally assumed that the consumer is a rational individual. A rational individual clearly knows what is good or what is bad for her, and in any given situation, she always tries to achieve the best for herself. Thus, not only does a consumer have well-defined preferences over the set of available bundles, she also acts according to her preferences. From the bundles which are available to her, a rational consumer always chooses the one which she prefers the most.

EXAMPLE 2.5

Consider the consumer in Example 2.2. Among the bundles that are available to her, (2, 2) is her most preferred bundle. Therefore, as a rational consumer, she would choose the bundle (2, 2).

In the earlier sections, it was observed that the budget set describes the bundles that are available to the consumer and her preferences over the available bundles can usually be represented by an indifference map. Therefore, the consumer's problem can also be stated as follows: The rational consumer's problem is to move to a point on the highest possible indifference curve given her budget set.

If such a point exists, where would it be located? *The optimum point would be located on the budget line.* A point below the budget line cannot be the optimum. Compared to a point below the budget line, there is always some point on the budget line which contains more of at least one of the goods and no less of the other, and is, therefore, preferred by a consumer whose preferences are monotonic. Therefore, if the consumer's preferences are monotonic, for any point below the budget line, there is some point on the budget line which is preferred by the consumer. Points above the budget line are not available to the consumer. Therefore, the optimum (most preferred) bundle of the consumer would be on the budget line.

Equality of the Marginal Rate of Substitution and the Ratio of the Prices

The optimum bundle of the consumer is located at the point where the budget line is tangent to one of the indifference curves. If the budget line is tangent to an indifference curve at a point, the absolute value of the slope of the indifference curve (MRS) and that of the budget line (price ratio) are same at that point. Recall from our earlier discussion that the slope of the indifference curve is the rate at which the consumer is willing to substitute one good for the other. The slope of the budget line is the rate at which the consumer is able to substitute one good for the other in the market. At the optimum, the two rates should be the same. To see why, consider a point where this is not so. Suppose the MRS at such a point is 2 and suppose the two goods have the same price. At this point, the consumer is willing to give up 2 units of good 2 if she is given an extra unit of good 1. But in the market, she can buy an extra unit of good 1 if she gives up just 1 unit of good 2. Therefore, if she buys an extra unit of good 1, she can have more of both the goods compared to the bundle represented by the point, and hence, move to a preferred bundle. Thus, a point at which the MRS is greater, the price ratio cannot be the optimum. A similar argument holds for any point at which the MRS is less than the price ratio.

Where on the budget line will the optimum bundle be located? *The point at which the budget line just touches (is tangent to), one of the indifference curves would be the optimum.*[8] To see why this is so, note that any point on the budget line other than the point at which it touches the indifference curve lies on a lower indifference curve and hence is inferior. Therefore, such a point cannot be the consumer's optimum. The optimum bundle is located on the budget line at the point where the budget line is tangent to an indifference curve.

Figure 2.10 illustrates the consumer's optimum. At (x_1^*, x_2^*), the budget line is tangent to the black coloured indifference curve. The first thing to note is that the indifference curve just touching the budget line is the highest possible indifference curve given the consumer's budget set. Bundles on the indifference curves above this, like the grey one, are not affordable. Points on the indifference curves below this, like the blue one, are certainly inferior to the points on the indifference curve, just touching the budget line. Any other point on the budget line lies on a lower indifference curve and hence, is inferior to (x_1^*, x_2^*). Therefore, (x_1^*, x_2^*) is the consumer's optimum bundle.

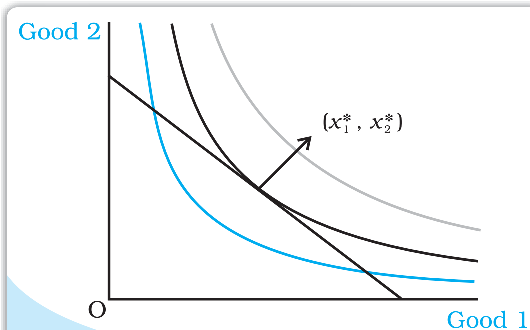


Fig. 2.10

Consumer's Optimum. *The point (x_1^*, x_2^*), at which the budget line is tangent to an indifference curve represents the consumers optimum bundle.*

Problem of Choice

The problem of choice occurs in many different contexts in life. In any choice problem, there is a feasible set of alternatives. The feasible set consists of the alternatives which are available to the individual. The individual is assumed to have well-defined preferences to the set of feasible alternatives. In other words, the individual is clear in her mind about her likes and dislikes, and hence, can compare any two alternatives in the feasible set. Based on her preferences, the individual can rank the alternatives in the order of preferences starting from the best. The feasible set and the preference relation defined over the set of alternatives together constitute the basis of choice. Individuals are generally assumed to be rational. They have well-defined preferences. In any given situation, a rational individual tries to do the best for herself.

In the text we studied, the choice problem applied to the particular context of the consumer's choice. Here, the budget set is the feasible set

[8] To be more precise, if the situation is as depicted in Figure 2.10 then the optimum would be located at the point where the budget line is tangent to one of the indifference curves. However, there are other situations in which the optimum is at a point where the consumer spends her entire income on one of the goods only.

and the different bundles of the two goods which the consumer can buy at the prevailing market prices are the alternatives. The consumer is assumed to be rational. Her preference relation to the budget set is well-defined and she chooses her most preferred bundle from the budget set. The consumer's optimum bundle is the choice she makes in the given situation.

2.4 Demand

In the previous section, we studied the choice problem of the consumer and derived the consumer's optimum bundle given the prices of the goods, the consumer's income and her preferences. It was observed that the amount of a good that the consumer chooses optimally, depends on the price of the good itself, the prices of other goods, the consumer's income and her tastes and preferences. Whenever one or more of these variables change, the quantity of the good chosen by the consumer is likely to change as well. Here we shall change one of these variables at a time and study how the amount of the good chosen by the consumer is related to that variable.

Functions

Consider any two variables x and y. A function

$$y = f(x)$$

is a relation between the two variables x and y such that for each value of x, there is an unique value of the variable y. In other words, $f(x)$ is a rule which assigns an unique value y for each value of x. As the value of y depends on the value of x, y is called the dependent variable and x is called the independent variable.

EXAMPLE 1

Consider, for example, a situation where x can take the values 0, 1, 2, 3 and suppose corresponding values of y are 10, 15, 18 and 20, respectively. Here y and x are related by the function $y = f(x)$ which is defined as follows: $f(0) = 10$; $f(1) = 15$; $f(2) = 18$ and $f(3) = 20$.

EXAMPLE 2

Consider another situation where x can take the values 0, 5, 10 and 20. And suppose corresponding values of y are 100, 90, 70 and 40, respectively. Here, y and x are related by the function $y = f(x)$ which is defined as follows: $f(0) = 100$; $f(10) = 90$; $f(15) = 70$ and $f(20) = 40$.

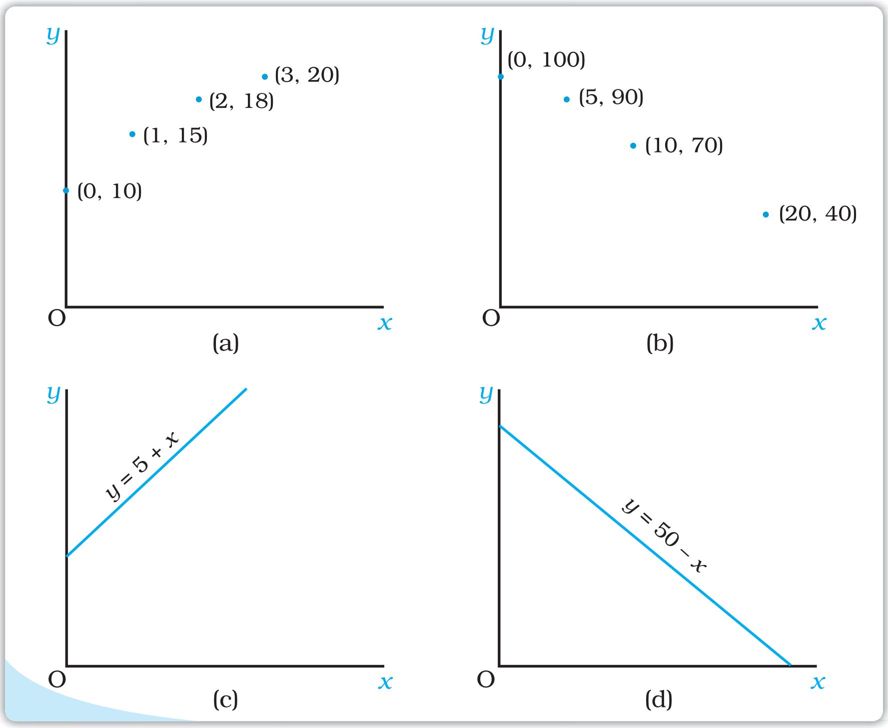
Very often a functional relation between the two variables can be expressed in algebraic form like

$$y = 5 + x \text{ and } y = 50 - x$$

A function $y = f(x)$ is an increasing function if the value of y does not decrease with increase in the value of x. It is a decreasing function if the value of y does not increase with increase in the value of x. The function in Example 1 is an increasing function. So is the function $y = x + 5$. The function in Example 2 is a decreasing function. The function $y = 50 - x$ is also decreasing.

Graphical Representation of a Function

A graph of a function $y = f(x)$ is a diagrammatic representation of the function. Following are the graphs of the functions in the examples given above.



Usually, in a graph, the independent variable is measured along the horizontal axis and the dependent variable is measured along the vertical axis. However, in economics, often the opposite is done. The demand curve, for example, is drawn by taking the independent variable (price) along the vertical axis and the dependent variable (quantity) along the horizontal axis. The graph of an increasing function is upward sloping or and the graph of a decreasing function is downward sloping. As we can see from the diagrams above, the graph of $y = 5 + x$ is upward sloping and that of $y = 50 - x$, is downward sloping.

2.4.1 Demand Curve and the Law of Demand

If the prices of other goods, the consumer's income and her tastes and preferences remain unchanged, the amount of a good that the consumer optimally chooses, becomes entirely dependent on its price. The relation between the consumer's optimal choice of the quantity of a good and its price is very important and this relation is called the demand function. Thus, the consumer's demand function for a good gives the amount of the good that the consumer chooses at different levels of its price when the other things remain unchanged. The consumer's demand for a good as a function of its price can be written as

$$q = d(p) \tag{2.12}$$

where q denotes the quantity and p denotes the price of the good.

The demand function can also be represented graphically as in Figure 2.11. The graphical representation of the demand function is called the **demand curve.**

The relation between the consumer's demand for a good and the price of the good is likely to be negative in general. In other words, the amount of a good that a consumer would optimally choose is likely to increase when the price of the good falls and it is likely to decrease with a rise in the price of the good.

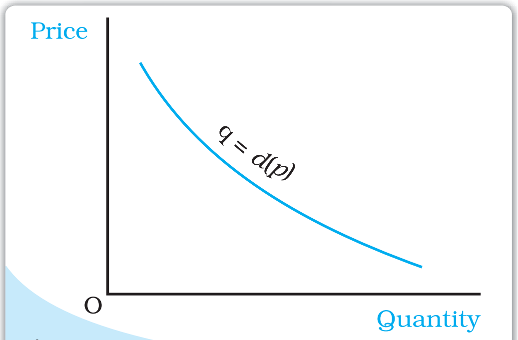


Fig. 2.11

Demand Curve. *The demand curve is a relation between the quantity of the good chosen by a consumer and the price of the good. The independent variable (price) is measured along the vertical axis and dependent variable (quantity) is measured along the horizontal axis. The demand curve gives the quantity demanded by the consumer at each price.*

To see why this is the case, consider a consumer whose income is M and let the prices of the two goods be p_1 and p_2. Suppose, in this situation, the optimum bundle of the consumer is (x_1^*, x_2^*). Now, consider a fall in the price of good 1 by the amount Δp_1. The new price of good 1 is $(p_1 - \Delta p_1)$. Note that the price change has two effects

(i) Good 1 becomes relatively cheaper than good 2 as compared to what it was before.

(ii) The purchasing power of the consumer increases. The price change, in general, allows the consumer to buy more goods with the same amount of money as before. In particular, she can buy the bundle which she was buying before by spending less than M.

Both these effects of the price change, the change in the purchasing power and the change in the relative price, are likely to influence the consumer's optimal choice. In order to find out how the consumer would react to the change in the relative price, let us suppose that her purchasing power is adjusted in a way such that she can just afford to buy the bundle (x_1^*, x_2^*).

At the prices $(p_1 - \Delta p_1)$ and p_2, the bundle (x_1^*, x_2^*) costs $(p_1 - \Delta p_1)\ x_1^* + p_2 x_2^*$

$$= p_1 x_1^* + p_2 x_2^* - \Delta p_1 x_1^*$$
$$= M - \Delta p_1 x_1^*.$$

Therefore, if the consumer's income is reduced by the amount $\Delta p_1 x_1^*$ after the fall in the price of good 1, her purchasing power is adjusted to the initial level.[9] Suppose, at prices $(p_1 - \Delta p_1)$, p_2 and income $(M - \Delta p_1 x_1^*)$, the consumer's optimum bundle is (x_1^{**}, x_2^{**}). x_1^{**} must be greater than or equal to x_1^*. To see why, consider the Figure 2.12.

The grey line in the diagram represents the budget line of the consumer when her income is M and the prices of the two goods are p_1 and p_2. All points

[9]Consider, for example, a consumer whose income is Rs 30. Suppose the price of good 1 is Rs 4 and that of good 2 is Rs 5, and at these prices, the consumer's optimum bundle is (5,2). Now suppose price of good 1 falls to Rs 3. After the fall in price, if the consumer's income is reduced by Rs 5, she can just buy the bundle (5, 2). Note that the change in the price of good 1 (Rs 1) times, the amount of good 1 that she was buying prior to the price change (5 units) is equal to the adjustment required in her income (Rs 5).

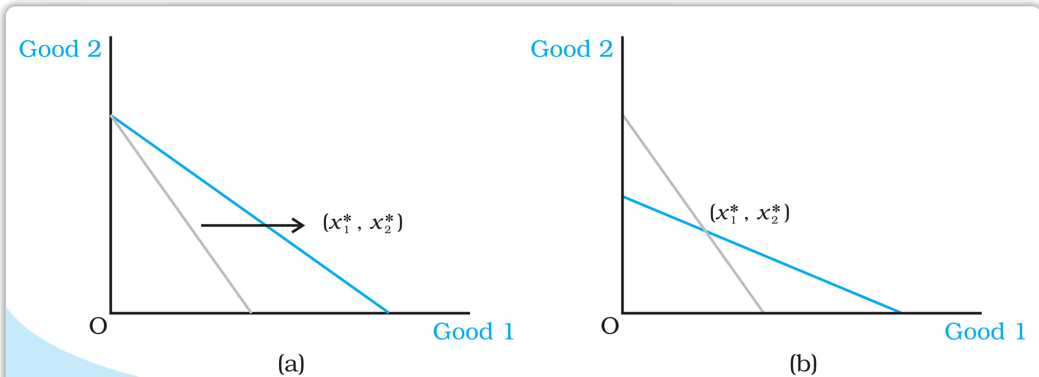


Fig. 2.12

Substitution Effect. *The grey line represents the consumer's budget line prior to the price change. The blue line in panel (a) represents the consumer's budget line after the fall in price of Good 1. The blue line in panel (b) represents the budget line when the consumer's income is adjusted.*

on or below the budget line are available to the consumer. As the consumer's preferences are monotonic, the optimum bundle (x_1^*, x_2^*) lies on the budget line. The blue line represents the budget line after the fall in the price of Good 1. If the consumer's income is reduced by an amount $\Delta p_1 x_1^*$, there would be a parallel leftward shift of blue budget line. Note that the shifted budget line passes through (x_1^*, x_2^*). This is because the income is adjusted in a way such that the consumer has just enough money to buy the bundle (x_1^*, x_2^*).

If the consumer's income is thus adjusted after the price change, which bundle is she going to choose? Certainly, the optimum bundle would lie on the shifted budget line. But can she choose any bundle to the left of the point (x_1^*, x_2^*)? Certainly not. Note that all points on this budget line which are to the left of (x_1^*, x_2^*) lie below the grey budget line, and therefore, were available prior to the price change. Compared to any of these points, there is at least one point on the grey budget line which is preferred by the consumer. Also note that since (x_1^*, x_2^*) was the optimum bundle prior to the price change, the consumer must consider (x_1^*, x_2^*) to be at least as good as any other bundle on the grey budget line. Therefore, it follows that all points on the shifted budget line which are to the left of (x_1^*, x_2^*) must be inferior to (x_1^*, x_2^*). It does not make sense for the rational consumer to choose an inferior bundle when the bundle (x_1^*, x_2^*) is still available. Bundles on the shifted budget line which are to the right of the point (x_1^*, x_2^*) were not available before the price change. If any of these bundles is preferred to (x_1^*, x_2^*) by the consumer, she can choose such a bundle, or else, she will continue to choose the bundle (x_1^*, x_2^*). Note that all those bundles on the shifted budget line which are to the right of (x_1^*, x_2^*), contain more than x_1^* units of good 1. Thus, if price of good 1 falls and the income of the consumer is adjusted to the previous level of her purchasing power, the rational consumer will not reduce her consumption of good 1. The change in the optimal quantity of a good when its price changes and the consumer's income is adjusted so that she can just buy the bundle that she was buying before the price change is called the **substitution effect**.

However, if the income of the consumer does not change, then due to the fall in the price of good 1 the consumer would experience a rise in the purchasing power as well. In general, a rise in the purchasing power of the consumer induces the consumer to consume more of a good. The change in the optimal quantity of a good when the purchasing power changes consequent upon a change in the price of the good is called the income effect. Thus, the two effects of a fall in the price of good 1 work together and there is a rise in the consumer's demand for good 1.[10] Thus, given the price of other goods, the consumer's income and her tastes and preferences, the amount of a good that the consumer optimally chooses, is inversely related to the price of the good. Hence, the demand curve for a good is, in general, downward sloping as represented in Figure 2.11. The inverse relationship between the consumer's demand for a good and the price of the good is often called the Law of Demand.

Law of Demand: *If a consumer's demand for a good moves in the same direction as the consumer's income, the consumer's demand for that good must be inversely related to the price of the good.*

Linear Demand

A linear demand curve can be written as

$$d(p) = a - bp;\ 0 \le p \le \frac{a}{b}$$
$$= 0;\ p > \frac{a}{b} \qquad (2.13)$$

where a is the vertical intercept, $-b$ is the slope of the demand curve. At price 0, the demand is a, and at price equal to $\frac{a}{b}$, the demand is 0. The slope of the demand curve measures the rate at which demand changes with respect to its price. For a unit increase in the price of the good, the demand falls by b units. Figure 2.13 depicts a linear demand curve.

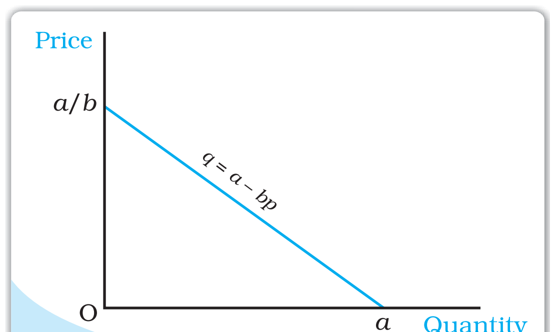


Fig. 2.13

Linear Demand Curve. *The diagram depicts the linear demand curve given by equation 2.13.*

2.4.2 Normal and Inferior Goods

The demand function is a relation between the consumer's demand for a good and its price when other things are given. Instead of studying the relation between the demand for a good and its price, we can also study the relation between the consumer's demand for the good and the income of the consumer. The quantity of a good that the consumer demands can increase or decrease with the rise in income depending on the nature of the good. For most goods, the quantity that a consumer chooses, increases as the consumer's income increases and decreases as the

[10] As we shall shortly discuss, a rise in the purchasing power (income) of the consumer can sometimes induce the consumer to reduce the consumption of a good. In such a case, the substitution effect and the income effect will work in opposite directions. The demand for such a good can be inversely or positively related to its price depending on the relative strengths of these two opposing effects. If the substitution effect is stronger than the income effect, the demand for the good and the price of the good would still be inversely related. However, if the income effect is stronger than the substitution effect, the demand for the good would be positively related to its price. Such a good is called a *Giffen good*.

consumer's income decreases. Such goods are called **normal goods.** Thus, a consumer's demand for a normal good moves in the same direction as the income of the consumer. However, there are some goods the demands for which move in the opposite direction of the income of the consumer. Such goods are called **inferior goods.** As the income of the consumer increases, the demand for an inferior good falls, and as the income decreases, the demand for an inferior good rises. Examples of inferior goods include low quality food items like coarse cereals.

A good can be a normal good for the consumer at some levels of income and an inferior good for her at other levels of income. At very low levels of income, a consumer's demand for low quality cereals can increase with income. But, beyond a level, any increase in income of the consumer is likely to reduce her consumption of such food items.

2.4.3 Substitutes and Complements

We can also study the relation between the quantity of a good that a consumer chooses and the price of a related good. The quantity of a good that the consumer chooses can increase or decrease with the rise in the price of a related good depending on whether the two goods are **substitutes** or **complementary** to each other. Goods which are consumed together are called complementary goods. Examples of goods which are complement to each other include tea and sugar, shoes and socks, pen and ink, etc. Since tea and sugar are used together, an increase in the price of sugar is likely to decrease the demand for tea and a decrease in the price of sugar is likely to increase the demand for tea. Similar is the case with other complements. In general, the demand for a good moves in the opposite direction of the price of its complementary goods.

In contrast to complements, goods like tea and coffee are not consumed together. In fact, they are substitutes for each other. Since tea is a substitute for coffee, if the price of coffee increases, the consumers can shift to tea, and hence, the consumption of tea is likely to go up. On the other hand, if the price of coffee decreases, the consumption of tea is likely to go down. The demand for a good usually moves in the direction of the price of its substitutes.

2.4.4 Shifts in the Demand Curve

The demand curve was drawn under the assumption that the consumer's income, the prices of other goods and the preferences of the consumer are given. What happens to the demand curve when any of these things changes?

Given the prices of other goods and the preferences of a consumer, if the income increases, the demand for the good at each price changes, and hence, there is a shift in the demand curve. For normal goods, the demand curve shifts rightward and for inferior goods, the demand curve shifts leftward.

Given the consumer's income and her preferences, if the price of a related good changes, the demand for a good at each level of its price changes, and hence, there is a shift in the demand curve. If there is an increase in the price of a substitute good, the demand curve shifts rightward. On the other hand, if there is an increase in the price of a complementary good, the demand curve shifts leftward.

The demand curve can also shift due to a change in the tastes and preferences of the consumer. If the consumer's preferences change in favour of a good, the demand curve for such a good shifts rightward. On the other hand, the demand curve shifts leftward due to an unfavourable change in the preferences of the consumer. The demand curve for ice-creams, for example, is likely to shift rightward in the summer because of preference for ice-creams goes up in summer. Revelation of the fact that cold-drinks might be injurious to health can lead to a change in preferences to cold-drinks. This is likely to result in a leftward shift in the demand curve for cold-drinks.

Shifts in the demand curve are depicted in Figure 2.14.

Fig. 2.14

Shifts in Demand. *The demand curve in panel (a) shifts leftward and that in panel (b) shifts rightward.*

2.4.5 Movements along the Demand Curve and Shifts in the Demand Curve

As it has been noted earlier, the amount of a good that the consumer chooses depends on the price of the good, the prices of other goods, income of the consumer and her tastes and preferences. The demand function is a relation between the amount of the good and its price when other things remain unchanged. The demand curve is a graphical representation of the demand function. At higher prices, the demand is less, and at lower prices, the demand is more. Thus, any change in the price leads to movements along the demand curve. On the other hand, changes in any of the other things lead to a shift in the demand curve. Figure 2.15 illustrates a movement along the demand curve and a shift in the demand curve.

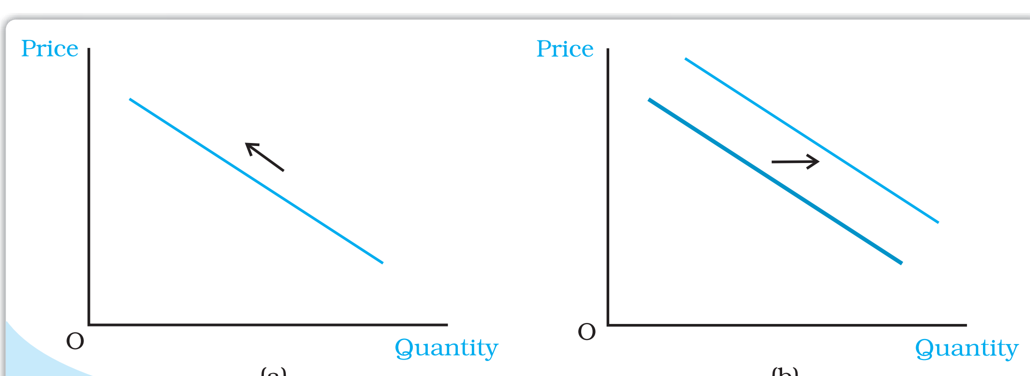


Fig. 2.15

Movement along a Demand Curve and Shift of a Demand Curve. *Panel (a) depicts a movement along the demand curve and panel (b) depicts a shift of the demand curve.*

2.5 Market Demand

In the last section, we studied the choice problem of the individual consumer and derived the demand curve of the consumer. However, in the market for a good, there are many consumers. It is important to find out the market demand for the good. The market demand for a good at a particular price is the total demand of all consumers taken together. The market demand for a good can be derived from the individual demand curves. Suppose there are only two consumers in the market for a good. Suppose at price p', the demand of consumer 1 is q'_1 and that of consumer 2 is q'_2. Then, the market demand of the good at p' is $q'_1 + q'_2$. Similarly, at price $\hat{p}$, if the demand of consumer 1 is $\hat{q}_1$ and that of consumer 2 is $\hat{q}_2$, the market demand of the good at $\hat{p}$ is $\hat{q}_1 + \hat{q}_2$. Thus, the market demand for the good at each price can be derived by adding up the demands of the two consumers at that price. If there are more than two consumers in the market for a good, the market demand can be derived similarly.

The market demand curve of a good can also be derived from the individual demand curves graphically by adding up the individual demand curves horizontally as shown in Figure 2.16. This method of adding two curves is called horizontal summation.

Derivation of the Market Demand Curve. *The market demand curve can be derived as a horizontal summation of the individual demand curves.*

Adding up Two Linear Demand Curves

Consider, for example, a market where there are two consumers and the demand curves of the two consumers are given as

$$d_1(p) = 10 - p \tag{2.14}$$

$$\text{and} \quad d_2(p) = 15 - p \tag{2.15}$$

Furthermore, at any price greater than 10, the consumer 1 demands 0 unit of the good, and similarly, at any price greater than 15, the consumer 2 demands 0 unit of the good. The market demand can be derived by adding equations (2.12) and (2.13). At any price less than or equal to 10, the market demand is given by 25 – 2p, for any price greater than 10, and less than or equal to 15, market demand is 15 – p, and at any price greater than 15, the market demand is 0.

2.6 Elasticity of Demand

The demand for a good moves in the opposite direction of its price. But the impact of the price change is always not the same. Sometimes, the demand for a good changes considerably even for small price changes. On the other hand, there are some goods for which the demand is not affected much by price changes. Demands for some goods are very responsive to price changes while demands for certain others are not so responsive to price changes. Price-elasticity of demand is a measure of the responsiveness of the demand for a good to changes in its price. Price-elasticity of demand for a good is defined as the percentage change in demand for the good divided by the percentage change in its price. Price-elasticity of demand for a good

$$e_D = \frac{\text{percentage change in demand for the good}}{\text{percentage change in the price of the good}}$$

Consider the demand curve of a good. Suppose at price p^0, the demand for the good is q^0 and at price p^1, the demand for the good is q^1. If price changes from p^0 to p^1, the change in the price of the good is, $\Delta p = p^1 - p^0$, and the change in the quantity of the good is, $\Delta q = q^1 - q^0$. The percentage change in price is, $\frac{p}{p^0} \times 100 = \frac{p^1 - p^0}{p^0} \times 100$, and the percentage change in quantity, $\frac{\Delta q}{q^0} \times 100 = \frac{q^1 - q^0}{q^0} \times 100$

Thus

$$e_D = \frac{(\Delta q / q^0) \times 100}{(\Delta p / p^0) \times 100} = \frac{\Delta q / q^0}{\Delta p / p^0} = \frac{(q^1 - q^0)/q^0}{(p^1 - p^0)/p^0} \qquad (2.16)$$

It is important to note that elasticity of demand is a number and it does not depend on the units in which the price of the good and the quantity of the good are measured.

Also note that the price elasticity of demand is a negative number since the demand for a good is negatively related to the price of a good. However, for simplicity, we will always refer to the absolute value of the elasticity.

The more responsive the demand for a good is to its price, the higher is the price- elasticity of demand for the good. If at some price, the percentage change in demand for a good is less than the percentage change in the price, then $|e_D| < 1$ and demand for the good is said to be inelastic at that price. If at some price, the percentage change in demand for a good is equal to the percentage change in the price, $|e_D| = 1$, and demand for the good is said to be unitary-elastic at that price. If at some price, the percentage change in demand for a good is greater than the percentage change in the price, then $|e_D| > 1$, and demand for the good is said to be elastic at that price.

Price elasticity of demand is a pure number and does not depend on the units in which price and quantity are measured

Suppose the unit of money is rupee and the quantity is measured in kilograms. At price p^0, let the demand be q^0, and at price p^1, let the demand be q^1. Consider a price change from p^0 to p^1.

The change in price = p^1 rupees per kilogram – p^0 rupees per kilogram = $(p^1 - p^0)$ rupees per kilogram.

$$\text{Percentage change in price of the good} = \frac{\textit{change in the price}}{\textit{initial price of the good}} \times 100$$

$$= \frac{(p^1 - p^0)\, rupees\ per\ kilogram}{p^0\ rupees\ per\ kilogram} \times 100 = \frac{(p^1 - p^0)}{p^0} \times 100.$$

Change in quantity of the good = q^1 kilograms – q^0 kilograms = $(q^1 - q^0)$ kilograms.

Percentage change in quantity of the good = $\frac{(q^1 - q^0)\ kilogram}{q^0\ kilogram} \times 100$

$$= \frac{q^1 - q^0}{q^0} \times 100.$$

$$e_D = \frac{(q^1 - q^0)}{q^0} \times 100 \Big/ \frac{(p^1 - p^0)}{p^0} \times 100 = \frac{(q^1 - q^0)}{q^0} \Big/ \frac{(p^1 - p^0)}{p^0}$$

If the unit of money used in the measurement of price is paisa and the quantity is measured in grams, the initial price of the good would be $100p^0$ paisa per 1,000 grams = $\frac{100p^0}{1,000}$ paisa per gram = $\frac{p^0}{10}$ paisa per gram. After the change, price would be $100p^1$ paisa per 1,000 grams = $\frac{100p^1}{1,000}$ paisa per gram = $\frac{p^1}{10}$ paisa per gram.

Change in price = $\frac{p^1}{10}$ paisa per gram – $\frac{p^0}{10}$ paisa per gram

= $\frac{(p^1 - p^0)}{10}$ paisa per gram.

Percentage change in price = $\frac{p^1 - p^0}{10}$ paisa per gram $\Big/ \frac{p^0}{10}$ paisa per gram

$= \frac{p^1 - p^0}{p^0}$.

Change in quantity of the good = $1,000q^1$ grams – $1,000q^0$ grams

= $1,000(q^1 - q^0)$ grams.

Percentage change in quantity of the good

$$= \frac{1,000(q^1 - q^0)\ grams}{1,000q^0\ grams} \times 100$$

$$= \frac{(q^1 - q^0)}{q^0} \times 100.$$

$$e_D = \frac{q^1 - q^0}{q^0} \Big/ \frac{(p^1 - p^0)}{p^0}$$

2.6.1 Elasticity along a Linear Demand Curve

Let us consider a linear demand curve $q = a - bp$. Note that at any point on the demand curve, the change in demand per unit change in the price $\frac{\Delta q}{\Delta p} = -b$.

Substituting the value of $\frac{\Delta q}{\Delta p}$ in (2.16), we obtain

$$e_D = -b\frac{p}{q} = -\frac{bp}{a - bp} \qquad (2.17)$$

From (2.17), it is clear that the elasticity of demand is different at different points on a linear demand curve. At $p = 0$, the elasticity is 0, at $q = 0$, elasticity is ∞. At $p = \frac{a}{2b}$, the elasticity is 1, at any price greater than 0 and less than $\frac{a}{2b}$, elasticity is less than 1, and at any price greater than $\frac{a}{2b}$, elasticity is greater than 1. The price elasticities of demand along the linear demand curve given by equation (2.17) are depicted in Figure 2.17.

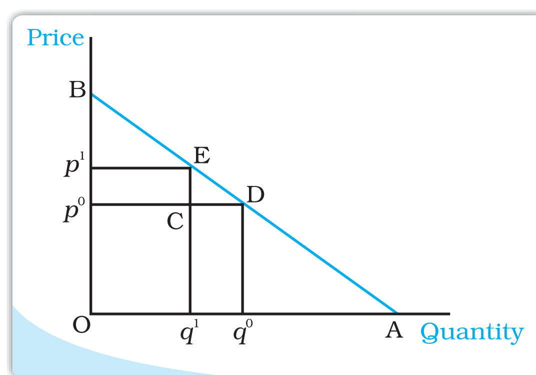
Elasticity along a Linear Demand Curve. *Price elasticity of demand is different at different points on the linear demand curve.*

Constant Elasticity Demand Curves

The elasticity of demand on different points on a linear demand curve is different varying from 0 to ∞. But sometimes, the demand curves can be such that the elasticity of demand remains constant throughout. Consider, for example, a vertical demand curve as the one depicted in Figure 2.18 (a). Whatever be the price, the demand is given at the level $\bar{q}$. A price change never leads to a change in the demand for such a demand curve and $|e_D|$ is always 0. Therefore, a vertical demand curve is perfectly inelastic.

Geometric Measure of Elasticity along a Linear Demand Curve

The elasticity of a linear demand curve can easily be measured geometrically. The elasticity of demand at any point on a straight line demand curve is given by the ratio of the lower segment and the upper segment of the demand curve at that point. To see why this is the case, consider the following figure which depicts a straight line demand curve, $q = a - bp$.



Suppose at price p^0, the demand for the good is q^0. Now consider a small change in the price. The new price is p^1, and at that price, demand for the good is q^1.

$\Delta q = q^1q^0 = CD$ and $\Delta p = p^1p^0 = CE$.

Therefore, $e_D = \dfrac{\Delta q / q^0}{\Delta p / p^0} = \dfrac{\Delta q}{\Delta p} \times \dfrac{p^0}{q^0} = \dfrac{q^1q^0}{p^1p^0} \times \dfrac{Op^0}{Oq^0} = \dfrac{CD}{CE} \times \dfrac{Op^0}{Oq^0}$

Since ECD and Bp^0D are similar triangles, $\dfrac{CD}{CE} = \dfrac{p^0D}{p^0B}$. *But* $\dfrac{p^0D}{p^0B} = \dfrac{Oq^o}{p^oB}$

$e_D = \dfrac{op^0}{P^0B} = \dfrac{q^0D}{P^0B}$.

Since Bp^0D and BOA are similar triangles, $\frac{q^0D}{p^0B} = \frac{DA}{DB}$

Thus, $e_D = \frac{DA}{DB}$.

The elasticity of demand at different points on a straight line demand curve can be derived by this method. Elasticity is 0 at the point where the demand curve meets the horizontal axis and it is $\propto$ at the point where the demand curve meets the vertical axis. At the midpoint of the demand curve, the elasticity is 1, at any point to the left of the midpoint, it is greater than 1 and at any point to the right, it is less than 1.

Note that along the horizontal axis $p = 0$, along the vertical axis $q = 0$ and at the midpoint of the demand curve $p = \frac{a}{2b}$.

Figure 2.18(b) depicts a demand curve which has the shape of a rectangular hyperbola. This demand curve has the nice property that a percentage change in price along the demand curve always leads to equal percentage change in quantity. Therefore, $|e_D| = 1$ at every point on this demand curve. This demand curve is called the unitary elastic demand curve.

Constant Elasticity Demand Curves*. Elasticity of demand at all points along the vertical demand curve, as shown in panel (a), is 0. Elasticity at all points on the demand curve in panel (b) is 1.*

2.6.2 Factors Determining Price Elasticity of Demand for a Good

The price elasticity of demand for a good depends on the nature of the good and the availability of close substitutes of the good. Consider, for example, necessities like food. Such goods are essential for life and the demands for such goods do not change much in response to changes in their prices. Demand for food does not change much even if food prices go up. On the other hand, demand for luxuries can be very responsive to price changes. In general, demand for a necessity is likely to be price inelastic while demand for a luxury good is likely to be price elastic.

Though demand for food is inelastic, the demands for specific food items are likely to be more elastic. For example, think of a particular variety of pulses. If the price of this variety of pulses goes up, people can shift to some other variety of pulses which is a close substitute. The demand for a good is likely to be elastic if close substitutes are easily available. On the other hand, if close substitutes are not available easily, the demand for a good is likely to be inelastic.

2.6.3 Elasticity and Expenditure

The expenditure on a good is equal to the demand for the good times its price. Often it is important to know how the expenditure on a good changes as a result of a price change. The price of a good and the demand for the good are inversely related to each other. Whether the expenditure on the good goes up or down as a result of an increase in its price depends on how responsive the demand for the good is to the price change.

Consider an increase in the price of a good. If the percentage decline in quantity is greater than the percentage increase in the price, the expenditure on the good will go down. On the other hand, if the percentage decline in quantity is less than the percentage increase in the price, the expenditure on the good will go up. And if the percentage decline in quantity is equal to the percentage increase in the price, the expenditure on the good will remain unchanged.

Relationship between Elasticity and change in Expenditure on a Good

Suppose at price p, the demand for a good is q, and at price $p + \Delta p$, the demand for the good is $q + \Delta q$.

At price p, the total expenditure on the good is pq, and at price $p + \Delta p$, the total expenditure on the good is $(p + \Delta p)(q + \Delta q)$.

If price changes from p to $(p + \Delta p)$, the change in the expenditure on the good is, $(p + \Delta p)(q + \Delta q) - pq = q\Delta p + p\Delta q + \Delta p\Delta q$.

For small values of Δp and Δq, the value of the term $\Delta p\Delta q$ is negligible, and in that case, the change in the expenditure on the good is approximately given by $q\Delta p + p\Delta q$.

Approximate change in expenditure $= \Delta E = q\Delta p + p\Delta q = \Delta p(q + p\dfrac{\Delta q}{\Delta p})$

$= \Delta p[q(1 + \dfrac{\Delta q}{\Delta p}\dfrac{p}{q})] = \Delta p[q(1 + e_D)]$.

Note that

if $e_D < -1$, then $q(1 + e_D) < 0$, and hence, ΔE has the opposite sign as Δp,

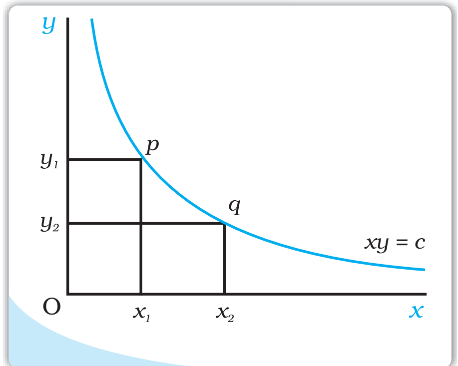
if $e_D > -1$, then $q(1 + e_D) > 0$, and hence, ΔE has the same sign as Δp,

if $e_D = -1$, then $q(1 + e_D) = 0$, and hence, $\Delta E = 0$.

Now consider a decline in the price of the good. If the percentage increase in quantity is greater than the percentage decline in the price, the expenditure on the good will go up. On the other hand, if the percentage increase in quantity is less than the percentage decline in the price, the expenditure on the good will go down. And if the percentage increase in quantity is equal to the percentage decline in the price, the expenditure on the good will remain unchanged.

The expenditure on the good would change in the opposite direction as the price change if and only if the percentage change in quantity is greater than the percentage change in price, ie if the good is price-elastic. The expenditure on the good would change in the same direction as the price change if and only if the percentage change in quantity is less than the percentage change in price, i.e., if the good is price inelastic. The expenditure on the good would remain unchanged if and only if the percentage change in quantity is equal to the percentage change in price, i.e., if the good is unit-elastic.

Rectangular Hyperbola



An equation of the form

$$xy = c$$

where x and y are two variables and c is a constant, giving us a curve called rectangular hyperbola. It is a downward sloping curve in the x-y plane as shown in the diagram. For any two points p and q on the curve, the areas of the two rectangles Oy_1px_1 and Oy_2qx_2 are same and equal to c.

If the equation of a demand curve takes the form $pq = e$, where e is a constant, it will be a rectangular hyperbola, where price (p) times quantity (q) is a constant. With such a demand curve, no matter at what point the consumer consumes, her expenditures are always the same and equal to e.

Summary

- The budget set is the collection of all bundles of goods that a consumer can buy with her income at the prevailing market prices.
- The budget line represents all bundles which cost the consumer her entire income. The budget line is negatively sloping.
- The budget set changes if either of the two prices or the income changes.
- The consumer has well-defined preferences over the collection of all possible bundles. She can rank the available bundles according to her preferences over them.
- The consumer's preferences are assumed to be monotonic.
- An indifference curve is a locus of all points representing bundles among which the consumer is indifferent.
- Monotonicity of preferences implies that the indifference curve is downward sloping.
- A consumer's preferences, in general, can be represented by an indifference map.
- A consumer's preferences, in general, can also be represented by a utility function.
- A rational consumer always chooses her most preferred bundle from the budget set.
- The consumer's optimum bundle is located at the point of tangency between the budget line and an indifference curve.
- The consumer's demand curve gives the amount of the good that a consumer chooses at different levels of its price when the price of other goods, the consumer's income and her tastes and preferences remain unchanged.
- The demand curve is generally downward sloping.
- The demand for a normal good increases (decreases) with increase (decrease) in the consumer's income.
- The demand for an inferior good decreases (increases) as the income of the consumer increases (decreases).

- The market demand curve represents the demand of all consumers in the market taken together at different levels of the price of the good.
- The price elasticity of demand for a good is defined as the percentage change in demand for the good divided by the percentage change in its price.
- The elasticity of demand is a pure number.
- Elasticity of demand for a good and total expenditure on the good are closely related.

Key Concepts

Budget set	Budget line
Preference	Indifference
Indifference curve	Rate of substitution
Monotonic preferences	Diminishing rate of substitution
Indifference map,Utility function	Consumer's optimum
Demand	Law of demand
Demand curve	Substitution effect
Income effect	Normal good
Inferior good	Substitute
Complement	Price elasticity of demand

Exercises

1. What do you mean by the budget set of a consumer?
2. What is budget line?
3. Explain why the budget line is downward sloping.
4. A consumer wants to consume two goods. The prices of the two goods are Rs 4 and Rs 5 respectively. The consumer's income is Rs 20.
   (i) Write down the equation of the budget line.
   (ii) How much of good 1 can the consumer consume if she spends her entire income on that good?
   (iii) How much of good 2 can she consume if she spends her entire income on that good?
   (iv) What is the slope of the budget line?

   Questions 5, 6 and 7 are related to question 4.
5. How does the budget line change if the consumer's income increases to Rs 40 but the prices remain unchanged?
6. How does the budget line change if the price of good 2 decreases by a rupee but the price of good 1 and the consumer's income remain unchanged?
7. What happens to the budget set if both the prices as well as the income double?
8. Suppose a consumer can afford to buy 6 units of good 1 and 8 units of good 2 if she spends her entire income. The prices of the two goods are Rs 6 and Rs 8 respectively. How much is the consumer's income?
9. Suppose a consumer wants to consume two goods which are available only in integer units. The two goods are equally priced at Rs 10 and the consumer's income is Rs 40.
   (i) Write down all the bundles that are available to the consumer.
   (ii) Among the bundles that are available to the consumer, identify those which cost her exactly Rs 40.
10. What do you mean by 'monotonic preferences'?
11. If a consumer has monotonic preferences, can she be indifferent between the bundles (10, 8) and (8, 6)?

12. Suppose a consumer's preferences are monotonic. What can you say about her preference ranking over the bundles (10, 10), (10, 9) and (9, 9)?

13. Suppose your friend is indifferent to the bundles (5, 6) and (6, 6). Are the preferences of your friend monotonic?

14. Suppose there are two consumers in the market for a good and their demand functions are as follows:

$d_1(p) = 20 - p$ for any price less than or equal to 20, and $d_1(p) = 0$ at any price greater than 20.

$d_2(p) = 30 - 2p$ for any price less than or equal to 15 and $d_1(p) = 0$ at any price greater than 15.

Find out the market demand function.

15. Suppose there are 20 consumers for a good and they have identical demand functions:

$d(p) = 10 - 3p$ for any price less than or equal to $\frac{10}{3}$ and $d_1(p) = 0$ at any price greater than $\frac{10}{3}$.

What is the market demand function?

16. Consider a market where there are just two consumers and suppose their demands for the good are given as follows:

Calculate the market demand for the good.

p	d_1	d_2
1	9	24
2	8	20
3	7	18
4	6	16
5	5	14
6	4	12

17. What do you mean by a normal good?

18. What do you mean by an 'inferior good'? Give some examples.

19. What do you mean by substitutes? Give examples of two goods which are substitutes of each other.

20. What do you mean by complements? Give examples of two goods which are complements of each other.

21. Explain price elasticity of demand.

22. Consider the demand for a good. At price Rs 4, the demand for the good is 25 units. Suppose price of the good increases to Rs 5, and as a result, the demand for the good falls to 20 units. Calculate the price elasticity .

23. Consider the demand curve $D(p) = 10 - 3p$. What is the elasticity at price $\frac{5}{3}$?

24. Suppose the price elasticity of demand for a good is – 0.2. If there is a 5 % increase in the price of the good, by what percentage will the demand for the good go down?

25. Suppose the price elasticity of demand for a good is – 0.2. How will the expenditure on the good be affected if there is a 10 % increase in the price of the good?

27. Suppose there was a 4 % decrease in the price of a good, and as a result, the expenditure on the good increased by 2 %. What can you say about the elasticity of demand?

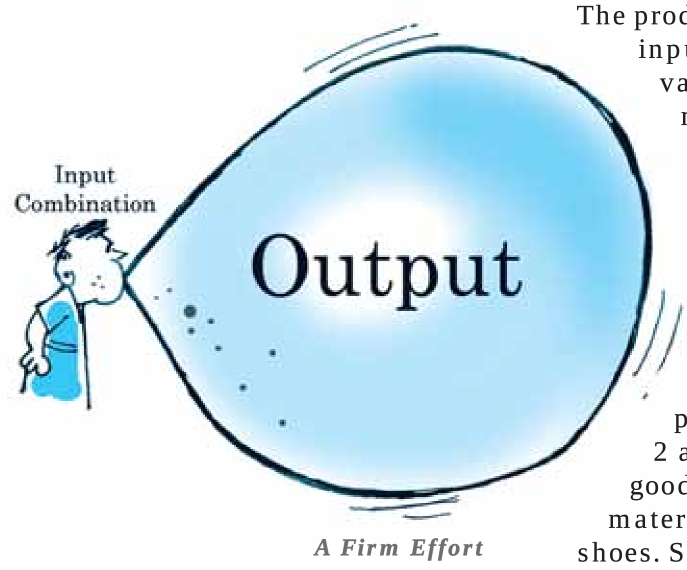
Chapter 3

Production and Costs

In the previous chapter, we have discussed the behaviour of the consumers. In this chapter as well as in the next, we shall examine the behaviour of a producer. A producer or a firm acquires different inputs like labour, machines, land, raw materials, etc. Combining these inputs, it produces output. This is called the process of production. In order to acquire inputs, it has to pay for them. That is the cost of production. Once the output has been produced, the firm sells it in the market and earns revenue. The revenue that it earns net of cost is the profit of the firm. We assume here that the objective of a firm is to maximise its profit. A firm looking at its cost structure and the market price of output decides to produce an amount of output such that its profit reaches the maximum.

In this chapter, we study different aspects of the production function of a firm. We discuss here – the relationship between inputs and output, the contribution of a variable input in the production process and different properties of production function. Then we look at the cost structure of the firm. We discuss the cost function and its various aspects. We learn about the properties of the short run and the long run cost curves.

3.1 Production Function



A Firm Effort

The production function of a firm is a relationship between inputs used and output produced by the firm. For various quantities of inputs used, it gives the maximum quantity of output that can be produced.

Consider a manufacturer who produces shoes. She employs two workers – worker 1 and worker 2, two machines – machine 1 and machine 2, and 10 kilograms of raw materials. Worker 1 is good in operating machine 1 and worker 2 is good in operating machine 2. If worker 1 uses machine 1 and worker 2 uses machine 2, then with 10 kilograms of raw materials, they can produce 10 pairs of shoes. However, if worker 1 uses machine 2 and worker 2 uses machine 1, which they are not good at operating, with the same 10 kilograms of raw materials, they will end up producing only 8 pairs of shoes. So with efficient use of inputs, 10 pairs of shoes can be produced whereas an inefficient use results in production of 8 pairs of shoes. Production function considers only the efficient use of inputs. It says that worker 1, worker 2, machine 1, machine 2 and 10 kilograms of raw materials together can produce 10 pairs of shoes which is the maximum possible output for this input combination.

A production function is defined for a given technology. It is the technological knowledge that determines the maximum levels of output that can be produced using different combinations of inputs. If the technology improves, the maximum levels of output obtainable for different input combinations increase. We then have a new production function.

The inputs that a firm uses in the production process are called factors of production. In order to produce output, a firm may require any number of different inputs. However, for the time being, here we consider a firm that produces output using only two factors of production – factor 1 and factor 2. Our production function, therefore, tells us what maximum quantity of output can be produced by using different combinations of these two factors.

We may write the production function as

$$q = f(x_1, x_2) \tag{3.1}$$

It says that by using x_1 amount of factor 1 and x_2 amount of factor 2, we can at most produce q amount of the commodity.

Table 3.1: Production Function

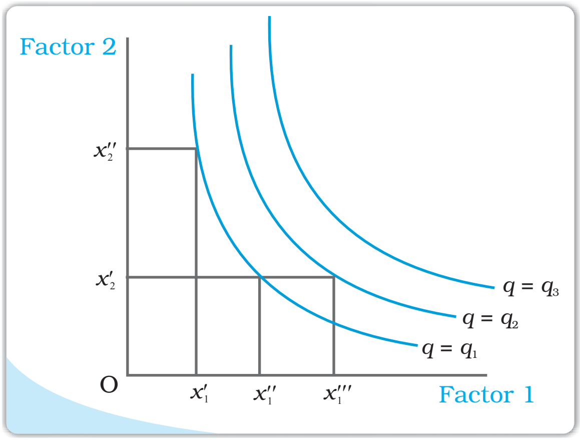
Factor		x_2						
		0	1	2	3	4	5	6
x_1	0	0	0	0	0	0	0	0
	1	0	1	3	7	10	12	13
	2	0	3	10	18	24	29	33
	3	0	7	18	30	40	46	50
	4	0	10	24	40	50	56	57
	5	0	12	29	46	56	58	59
	6	0	13	33	50	57	59	60

A numerical example of production function is given in Table 3.1. The left column shows the amount of factor 1 and the top row shows the amount of factor 2. As we move to the right along any row, factor 2 increases and as we move down along any column, factor 1 increases. For different values of the two factors, the table shows the corresponding output levels. For example, with 1 unit of factor 1 and 1 unit of factor 2, the firm can produce at most 1 unit of output; with 2 units of factor 1 and 2 units of factor 2, it can produce at most 10 units of output; with 3 units of factor 1 and 2 units of factor 2, it can produce at most 18 units of output and so on.

Isoquant

In Chapter 2, we have learnt about indifference curves. Here, we introduce a similar concept known as isoquant. It is just an alternative way of representing the production function. Consider a production function with two inputs factor 1 and factor 2. An isoquant is the set of all possible combinations of the two inputs that yield the same maximum possible level of output. Each isoquant represents a particular level of output and is labelled with that amount of output.

In the diagram, we have three isoquants for the three output levels, namely $q = q_1$, $q = q_2$ and $q = q_3$ in the inputs plane. Two input combinations (x'_1, x''_2) and (x''_1, x'_2) give us the same level of output q_1. If we fix factor 2 at x'_2 and increase factor 1 to x'''_1, output increases and we reach a higher isoquant, $q = q_2$. When marginal products are positive, with greater amount of one input, the same level of output can be produced by using lesser amount of the other. Therefore, isoquants are negatively sloped.



In our example, both the inputs are necessary for the production. If any of the inputs becomes zero, there will be no production. With both inputs positive, output will be positive. As we increase the amount of any input, output increases.

3.2 The Short Run and the Long Run

Before we begin with any further analysis, it is important to discuss two concepts– the **short run** and the **long run**.

In the **short run**, a firm cannot vary all the inputs. One of the factors – factor 1 or factor 2 – cannot be varied, and therefore, remain fixed in the short run. In order to vary the output level, the firm can vary only the other factor. The factor that remains fixed is called the **fixed input** whereas the other factor which the firm can vary is called the **variable input**.

Consider the example represented through Table 3.1. Suppose, in the short run, factor 2 remains fixed at 5 units. Then the corresponding column shows the different levels of output that the firm may produce using different quantities of factor 1 in the short run.

In the **long run**, all factors of production can be varied. A firm in order to produce different levels of output in the long run may vary both the inputs simultaneously. So, in the long run, there is no fixed input.

For any particular production process, long run generally refers to a longer time period than the short run. For different production processes, the long run periods may be different. It is not advisable to define short run and long run in terms of say, days, months or years. We define a period as long run or short run simply by looking at whether all the inputs can be varied or not.

3.3 Total Product, Average Product and Marginal Product

3.3.1 Total Product

Suppose we vary a single input and keep all other inputs constant. Then for different levels of employment of that input, we get different levels of output from the production function. This relationship between the variable input and output, keeping all other inputs constant, is often referred to as **Total Product** (TP) of the variable input.

In our production function, if we keep factor 2 constant, say, at the value $\overline{x}_2$ and vary factor 1, then for each value of x_1, we get a value of q for that particular $\overline{x}_2$. We write it in the following way

$$q = f(x_1; \overline{x}_2) \tag{3.2}$$

This is the total product function of factor 1.

Let us again look at Table 3.1. Suppose factor 2 is fixed at 4 units. Now in the Table 3.1, we look at the column where factor 2 takes the value 4. As we move down along the column, we get the output values for different values of factor 1. This is the total product of factor 1 schedule with $x_2 = 4$. At $x_1 = 0$, the TP is 0, at $x_1 = 1$, TP is 10 units of output, at $x_1 = 2$, TP is 24 units of output and so on. This is also sometimes called **total return** to or **total physical product** of the variable input.

Once we have defined total product, it will be useful to define the concepts of average product (AP) and marginal product (MP). They are useful in order to describe the contribution of the variable input to the production process.

3.3.2 Average Product

Average product is defined as the output per unit of variable input. We calculate it as

$$AP_1 = \frac{TP}{x_1} = \frac{f(x_1 : \overline{x}_2)}{x_1} \tag{3.3}$$

Table 3.2 gives us a numerical example of average product of factor 1. In Table 3.1, we have already seen the total product of factor 1 for $x_2 = 4$. In Table 3.2 we reproduce the total product schedule and extend the table to show the corresponding values of average product and marginal product. The first column shows the amount of factor 1 and in the fourth column we get the corresponding average product value. It shows that at 1 unit of factor 1, AP_1 is 10 units of output, at 2 units of factor 1, AP_1 is 12 units of output and so on.

3.3.3 Marginal Product

Marginal product of an input is defined as the change in output per unit of change in the input when all other inputs are held constant. When factor 2 is held constant, the marginal product of factor 1 is

$$\begin{aligned} MP_1 &= \frac{\textit{change in output}}{\textit{change in input}} \\ &= \frac{\Delta q}{\Delta x_1} \end{aligned} \tag{3.4}$$

where Δ represents the change of the variable.

If the input changes by discrete units, the marginal product can be defined in the following way. Suppose, factor 2 is fixed at $\overline{x}_2$. With $\overline{x}_2$ amount of factor 2, let, according to the total product curve, x_1 units of factor 1 produce 20 units of the output and $x_1 - 1$ units of factor 1 produce 15 units of the output. We say that the marginal product of the x_1th unit of factor 1 is

$$\begin{aligned} MP_1 &= f(x_1; \overline{x}_2) - f(x_1 - 1; \overline{x}_2) \\ &= (\text{TP at } x_1 \text{ units}) - (\text{TP at } x_1 - 1 \text{ unit}) \\ &= (20 - 15) \text{ units of output} \\ &= 5 \text{ units of output} \end{aligned} \tag{3.5}$$

Since inputs cannot take negative values, marginal product is undefined at zero level of input employment. Marginal products are additions to total product. For any level of employment of an input, the sum of marginal products of every unit of that input up to that level gives the total product of that input at that employment level. So total product is the sum of marginal products.

Average product of an input at any level of employment is the average of all marginal products up to that level. Average and marginal products are often referred to as average and marginal returns, respectively, to the variable input.

In the example represented through Table 3.1, if we keep factor 2 constant say, at 4 units, we get a total product schedule. From the total product, we then derive the marginal product and average product of factor 1. The third column of Table 3.2 shows that at zero unit of factor 1, MP_1 is undefined. At $x_1 = 1$, Mp_1 is 10 units of output, at $x_1 = 2$, MP_1 is 14 units of output and so on.

Table 3.2: Total Product, Marginal product and Average product

Factor 1	*TP*	MP_1	AP_1
0	0	-	-
1	10	10	10
2	24	14	12
3	40	16	13.33
4	50	10	12.5
5	56	6	11.2
6	57	1	9.5

3.4 The Law of Diminishing Marginal Product and the Law of Variable Proportions

The **law of diminishing marginal product** says that if we keep increasing the employment of an input, with other inputs fixed, eventually a point will be reached after which the resulting addition to output (i.e., marginal product of that input) will start falling.

A somewhat related concept with the law of diminishing marginal product is the **law of variable proportions**. It says that the marginal product of a factor input initially rises with its employment level. But after reaching a certain level of employment, it starts falling.

The reason behind the law of diminishing returns or the law of variable proportion is the following. As we hold one factor input fixed and keep increasing the other, the factor proportions change. Initially, as we increase the amount of the variable input, the factor proportions become more and more suitable for the production and marginal product increases. But after a certain level of employment, the production process becomes too crowded with the variable input and the factor proportions become less and less suitable for the production. It is from this point that the marginal product of the variable input starts falling.

Let us look at Table 3.2 again. With factor 2 fixed at 4 units, the table shows us the TP, MP_1 and AP_1 for different values of factor 1. We see that up to the employment level of 3 units of factor 1, its marginal product increases. Then it starts falling.

3.5 Shapes of Total Product, Marginal Product and Average Product Curves

An increase in the amount of one of the inputs keeping all other inputs constant generally results in an increase in output. Table 3.2 shows how the total product changes as the amount of factor 1 increases. The total product curve in the input-output plane is a positively sloped curve. Figure 3.1 shows the shape of the total product curve for a typical firm.

We measure units of factor 1 along the horizontal axis and output along the vertical axis. With x_1 units of factor 1, the firm can at most produce q_1 units of output.

According to the law of variable proportions, the marginal product of an input initially rises and then after a certain level of employment, it starts falling. The MP curve in the input-output plane, therefore, looks like an inverse 'U'-shaped curve.

Let us now see what the AP curve looks like. For the first unit of the variable input, one can easily check that the MP and the AP are same. Now as we increase the amount of input, the MP rises. AP being the average of marginal products, also rises, but rises less than MP. Then, after a point, the MP starts falling. However, as long as the value of MP remains higher than the value of the prevailing AP, the latter continues to rise. Once MP has fallen sufficiently, its value becomes less than the prevailing AP and the latter also starts falling. So AP curve is also inverse 'U'-shaped.

***Total Product**. This is a total product curve for factor 1. When all other inputs are held constant, it shows the different output levels obtainable from different amounts of factor 1.*

As long as the AP increases, it must be the case that MP is greater than AP. Otherwise, AP cannot rise. Similarly, when AP falls, MP has to be less than AP. It, therefore, follows that MP curve cuts AP curve from above at its maximum.

Figure 3.2 shows the shapes of AP and MP curves for a typical firm.

The AP of factor 1 is maximum at x_1. To the left of x_1, AP is rising and MP is greater than AP. To the right of x_1, AP is falling and MP is less than AP.

***Average and Marginal Product**. These are average and marginal product curves of factor 1.*

3.6 Returns to Scale

So far we looked at various aspects of production function when a single input varied and others remained fixed. Now we shall see what happens when all inputs vary simultaneously.

Constant returns to scale (CRS) is a property of production function that holds when a proportional increase in all inputs results in an increase in output by the same proportion.

Increasing returns to scale (IRS) holds when a proportional increase in all inputs results in an increase in output by more than the proportion.

Decreasing returns to scale (DRS) holds when a proportional increase in all inputs results in an increase in output by less than the proportion.

For example, suppose in a production process, all inputs get doubled. As a result, if the output gets doubled, the production function exhibits CRS. If output is less than doubled, the DRS holds, and if it is more than doubled, the IRS holds.

Returns to Scale

Consider a production function

$$q = f(x_1, x_2)$$

where the firm produces q amount of output using x_1 amount of factor 1 and x_2 amount of factor 2. Now suppose the firm decides to increase the employment level of both the factors t ($t > 1$) times. Mathematically, we can say that the production function exhibits constant returns to scale if we have,

$$f(tx_1, tx_2) = t.f(x_1, x_2)$$

ie the new output level $f(tx_1, tx_2)$ is exactly t times the previous output level $f(x_1, x_2)$.

Similarly, the production function exhibits increasing returns to scale if,

$$f(tx_1, tx_2) > t.f(x_1, x_2).$$

It exhibits decreasing returns to scale if,

$$f(tx_1, tx_2) < t.f(x_1, x_2).$$

3.7 Costs

In order to produce output, the firm needs to employ inputs. But a given level of output, typically, can be produced in many ways. There can be more than one input combinations with which a firm can produce a desired level of output. In Table 3.1, we can see that 50 units of output can be produced by three different input combinations – ($x_1 = 6$, $x_2 = 3$), ($x_1 = 4$, $x_2 = 4$) and ($x_1 = 3$, $x_2 = 6$). The question is which input combination will the firm choose? With the input prices given, it will choose that combination of inputs which is least expensive. So, for every level of output, the firm chooses the least cost input combination. This output-cost relationship is the cost function of the firm.

Cobb-Douglas Production Function

Consider a production function

$$q = x_1^{\alpha} x_2^{\beta}$$

where α and β are constants. The firm produces q amount of output using x_1 amount of factor 1 and x_2 amount of factor 2. This is called a **Cobb-Douglas production function**. Suppose with $x_1 = \bar{x}_1$ and $x_2 = \bar{x}_2$, we have q_0 units of output, i.e.

$$q_0 = \bar{x}_1^{\alpha} \bar{x}_2^{\beta}$$

If we increase both the inputs t ($t > 1$) times, we get the new output

$$q_1 = (t\bar{x}_1)^{\alpha}(t\bar{x}_2)^{\beta}$$
$$= t^{\alpha+\beta} \bar{x}_1^{\alpha} \bar{x}_2^{\beta}$$

When $\alpha + \beta = 1$, we have $q_1 = tq_0$. That is, the output increases t times. So the production function exhibits CRS. Similarly, when $\alpha + \beta > 1$, the production function exhibits IRS. When $\alpha + \beta < 1$ the production function exhibits DRS.

3.7.1 Short Run Costs

We have previously discussed the short run and the long run. In the short run, some of the factors of production cannot be varied, and therefore, remain fixed. The cost that a firm incurs to employ these fixed inputs is called the total fixed cost (TFC). Whatever amount of output the firm produces, this cost remains fixed for the firm. To produce any required level of output, the firm, in the short run, can adjust only variable inputs. Accordingly, the cost that a firm incurs to employ these variable inputs is called the total variable cost (TVC). Adding the fixed and the variable costs, we get the total cost (TC) of a firm

$$TC = TVC + TFC \tag{3.6}$$

In order to increase the production of output, the firm needs to employ more of the variable inputs. As a result, total variable cost and total cost will increase. Therefore, as output increases, total variable cost and total cost increase.

In Table 3.3, we have an example of cost function of a typical firm. The first column shows different levels of output. For all levels of output, the total fixed cost is Rs 20. Total variable cost increases as output increases. With output zero, TVC is zero. For 1 unit of output, TVC is Rs 10; for 2 units of output, TVC is Rs 18 and so on. In the fourth column, we obtain the total cost (TC) as the sum of the corresponding values in second column (TFC) and third column (TVC). At zero level of output, TC is just the fixed cost, and hence, equal to Rs 20. For 1 unit of output, total cost is Rs 30; for 2 units of output, the TC is Rs 38 and so on.

The **short run average cost** (**SAC**) incurred by the firm is defined as the total cost per unit of output. We calculate it as

$$SAC = \frac{TC}{q} \tag{3.7}$$

In Table 3.3, we get the SAC-column by dividing the values of the fourth column by the corresponding values of the first column. At zero output, SAC is undefined. For the first unit, SAC is Rs 30; for 2 units of output, SAC is Rs 19 and so on.

Similarly, the **average variable cost** (AVC) is defined as the total variable cost per unit of output. We calculate it as

$$AVC = \frac{TVC}{q} \tag{3.8}$$

Also, **average fixed cost (AFC)** is

$$AFC = \frac{TFC}{q} \tag{3.9}$$

Clearly,

$$SAC = AVC + AFC \tag{3.10}$$

In Table 3.3, we get the AFC-column by dividing the values of the second column by the corresponding values of the first column. Similarly, we get the AVC-column by dividing the values of the third column by the corresponding values of the first column. At zero level of output, both AFC and AVC are undefined. For the first unit of output, AFC is Rs 20 and AVC is Rs 10. Adding them, we get the SAC equal to Rs 30.

The **short run marginal cost (SMC)** is defined as the change in total cost per unit of change in output

$$SMC = \frac{\text{change in total cost}}{\text{change in output}} = \frac{\Delta TC}{\Delta q} \tag{3.11}$$

where Δ represents the change of the variable.

If output changes in discrete units, we may define the marginal cost in the following way. Let the cost of production for q_1 units and $q_1 - 1$ units of output be Rs 20 and Rs 15 respectively. Then the marginal cost that the firm incurs for producing q_1th unit of output is

$$\begin{aligned} MC &= (TC \text{ at } q_1) - (TC \text{ at } q_1 - 1) \\ &= \text{Rs } 20 - \text{Rs } 15 = \text{Rs } 5 \end{aligned} \tag{3.12}$$

Just like the case of marginal product, marginal cost also is undefined at zero level of output. It is important to note here that in the short run, fixed cost cannot be changed. When we change the level of output, whatever change occurs to total cost is entirely due to the change in total variable cost. So in the short

Table 3.3: Various Concepts of Costs

Output (units)	TFC (Rs)	TVC (Rs)	TC (Rs)	AFC (Rs)	AVC (Rs)	SAC (Rs)	SMC (Rs)
0	20	0	20	–	–	–	–
1	20	10	30	20	10	30	10
2	20	18	38	10	9	19	8
3	20	24	44	6.67	8	14.67	6
4	20	29	49	5	7.25	12.25	5
5	20	33	53	4	6.6	10.6	4
6	20	39	59	3.33	6.5	9.83	6
7	20	47	67	2.86	6.7	9.57	8
8	20	60	80	2.5	7.5	10	13
9	20	75	95	2.22	8.33	10.55	15
10	20	95	115	2	9.5	11.5	20

run, marginal cost is the increase in TVC due to increase in production of one extra unit of output. For any level of output, the sum of marginal costs up to that level gives us the total variable cost at that level. One may wish to check this from the example represented through Table 3.3. Average variable cost at some level of output is therefore, the average of all marginal costs up to that level. In Table 3.3, we see that when the output is zero, SMC is undefined. For the first unit of output, SMC is Rs 10; for the second unit, the SMC is Rs 8 and so on.

Shapes of the Short Run Cost Curves

Now let us see what these short run cost curves look like in the output-cost plane.

Previously, we have discussed that in order to increase the production of output the firm needs to employ more of the variable inputs. This results in an increase in total variable cost, and hence, an increase in total cost. Therefore, as output increases, total variable cost and total cost increase. Total fixed cost, however, is independent of the amount of output produced and remains constant for all levels of production.

Costs. *These are total fixed cost (TFC), total variable cost (TVC) and total cost (TC) curves for a firm. Total cost is the vertical sum of total fixed cost and total variable cost.*

Figure 3.3 illustrates the shapes of total fixed cost, total variable cost and total cost curves for a typical firm. TFC is a constant which takes the value c_1 and does not change with the change in output. It is, therefore, a horizontal straight line cutting the cost axis at the point c_1. At q_1, TVC is c_2 and TC is c_3.

AFC is the ratio of TFC to q. TFC is a constant. Therefore, as q increases, AFC decreases. When output is very close to zero, AFC is arbitrarily large, and as output moves towards infinity, AFC moves towards zero. AFC curve is, in fact, a rectangular hyperbola. If we multiply any value q of output with its corresponding AFC, we always get a constant, namely TFC.

Average Fixed Cost. *The average fixed cost curve is a rectangular hyperbola. The area of the rectangle* OFCq_1 *gives us the total fixed cost.*

Figure 3.4 shows the shape of average fixed cost curve for a typical firm. We measure output along the horizontal axis and AFC along the vertical axis. At q_1 level of output, we get the corresponding average fixed cost at F. The TFC can be calculated as

$$\begin{aligned} TFC &= AFC \times \text{quantity} \\ &= OF \times Oq_1 \\ &= \text{the area of the rectangle } OFCq_1 \end{aligned}$$

We can also calculate AFC from TFC curve. In Figure 3.5, the horizontal straight line cutting the vertical axis at F is the TFC curve. At q_0 level of output, total fixed cost is equal to OF. At q_0, the corresponding point on the TFC curve is A. Let the angle $\angle AOq_0$ be θ. The AFC at q_0 is

$$AFC = \frac{TFC}{quantity}$$

$$= \frac{Aq_0}{Oq_0} = \tan\theta$$

The Total Fixed Cost Curve. *The slope of the angle $\angle$AOq$_0$ gives us the average fixed cost at q$_0$.*

Let us now look at the SMC curve. Marginal cost is the additional cost that a firm incurs to produce one extra unit of output. According to the law of variable proportions, initially, the marginal product of a factor increases as employment increases, and then after a certain point, it decreases. This means initially to produce every next unit of output, the requirement of the factor becomes less and less, and then after a certain point, it becomes greater and greater. As a result, with the factor price given, initially the SMC falls, and then after a certain point, it rises. SMC curve is, therefore, 'U'-shaped.

At zero level of output, SMC is undefined. When output is discrete, the TVC at a particular level of output is the sum of all marginal costs up to that level. When output is perfectly divisible, the TVC at a particular level of output is given by the area under the SMC curve up to that level.

Now, what does the AVC curve look like? For the first unit of output, it is easy to check that SMC and AVC are the same. So both SMC and AVC curves start from the same point. Then, as output increases, SMC falls. AVC being the average of marginal costs, also falls, but falls less than SMC. Then, after a point, SMC starts rising. AVC, however, continues to fall as long as the value of SMC remains less than the prevailing value of AVC. Once the SMC has risen sufficiently, its value becomes greater than the value of AVC. The AVC then starts rising. The AVC curve is therefore 'U'-shaped.

As long as AVC is falling, SMC must be less than the AVC and as AVC, rises, SMC must be greater than the AVC. So the SMC curve cuts the AVC curve from below at the minimum point of AVC.

In Figure 3.6 we measure output along the horizontal axis and AVC along the vertical axis. At q_0 level of output, AVC is equal to OV . The total variable cost at q_0 is

$$\begin{aligned} TVC &= AVC \times \text{quantity} \\ &= OV \times Oq_0 \\ &= \text{the area of the rectangle } OV\,Bq_0. \end{aligned}$$

The Average Variable Cost Curve. *The area of the rectangle OVBq$_0$ gives us the total variable cost at q$_0$.*

In Figure 3.7, we measure output along the horizontal axis and TVC along the vertical axis. At q_0 level of output, OV is the total variable cost. Let the angle $\angle E0q_0$ be equal to θ. Then, at q_0, the AVC can be calculated as

$$AVC = \frac{TVC}{output}$$

$$= \frac{Eq_0}{Oq_0} = \tan\theta$$

The Total Variable Cost Curve. The slope of the angle ∠EOqo gives us the average variable cost at qo.

Let us now look at SAC. SAC is the sum of AVC and AFC. Initially, both AVC and AFC decrease as output increases. Therefore, SAC initially falls. After a certain level of output production, AVC starts rising. Now AVC and AFC are moving in opposite direction. Here, initially the fall in AFC is greater than the rise in AVC and SAC is still falling. But, after a certain level of production, rise in AVC overrides the fall in AFC. From this point onwards, SAC is rising. SAC curve is therefore 'U'-shaped.

It lies above the AVC curve with the vertical difference being equal to the value of AFC. The minimum point of SAC curve lies to the right of the minimum point of AVC curve.

Similar to the case of AVC and SMC, here too as long as SAC is falling, SMC is less than the SAC and when SAC is rising, SMC is greater than the SAC. SMC curve cuts the SAC curve from below at the minimum point of SAC.

Figure 3.8 shows the shapes of short run marginal cost, average variable cost and short run average cost curves for a typical firm. AVC reaches its minimum at q_1 units of output. To the left of q_1, AVC is falling and SMC is less than AVC. To the right of q_1, AVC is rising and SMC is greater than AVC. SMC curve cuts the AVC curve at 'P' which is the minimum point of AVC curve. The minimum point of SAC curve is 'S' which corresponds to the output q_2. It is the intersection point between SMC and SAC curves. To the left of q_2, SAC is falling and SMC is less than SAC. To the right of q_2, SAC is rising and SMC is greater than SAC.

Short Run Costs. Short run marginal cost, average variable cost and average cost curves.

3.7.2 Long Run Costs

In the long run, all inputs are variable. The total cost and the total variable cost therefore, coincide in the long run. **Long run average cost** (LRAC) is defined as cost per unit of output, i.e.

$$LRAC = \frac{TC}{q} \tag{3.13}$$

Long run marginal cost (LRMC) is the change in total cost per unit of change in output. When output changes in discrete units, then, if we increase production from q_1–1 to q_1 units of output, the marginal cost of producing q_1^{th} unit will be measured as

$$LRMC = (\text{TC at } q_1 \text{ units}) - (\text{TC at } q_1 - 1 \text{ units}) \quad (3.14)$$

Just like the short run, in the long run, the sum of all marginal costs up to some output level gives us the total cost at that level.

Shapes of the Long Run Cost Curves

We have previously discussed the returns to scales. Now let us see their implications for the shape of LRAC.

IRS implies that if we increase all the inputs by a certain proportion, output increases by more than that proportion. In other words, to increase output by a certain proportion, inputs need to be increased by less than that proportion. With the input prices given, cost also increases by a lesser proportion. For example, suppose we want to double the output. To do that, inputs need to be increased by less than double. The cost that the firm incurs to hire those inputs therefore also need to be increased by less than double. What is happening to the average cost here? It must be the case that as long as IRS operates, average cost falls as the firm increases output.

DRS implies that if we want to increase the output by a certain proportion, inputs need to be increased by more than that proportion. As a result, cost also increases by more than that proportion. So, as long as DRS operates, the average cost must be rising as the firm increases output.

CRS implies a proportional increase in inputs resulting in a proportional increase in output. So the average cost remains constant as long as CRS operates.

It is argued that in a typical firm IRS is observed at the initial level of production. This is then followed by the CRS and then by the DRS. Accordingly, the LRAC curve is a 'U'-shaped curve. Its downward sloping part corresponds to IRS and upward rising part corresponds to DRS. At the minimum point of the LRAC curve, CRS is observed.

Let us check how the LRMC curve looks like. For the first unit of output, both LRMC and LRAC are the same. Then, as output increases, LRAC initially falls, and then, after a certain point, it rises. As long as average cost is falling, marginal cost must be less than the average cost. When the average cost is rising, marginal cost must be greater than the average cost. LRMC curve is therefore a 'U'-shaped curve. It cuts the LRAC curve from below at the minimum point of the LRAC. Figure 3.9 shows the shapes of the long run marginal cost and the long run average cost curves for a typical firm.

LRAC reaches its minimum at q_1. To the left of q_1, LRAC is falling and LRMC is less than the LRAC curve. To the right of q_1, LRAC is rising and LRMC is higher than LRAC.

Long Run Costs. *Long run marginal cost and average cost curves.*

Summary

- For different combinations of inputs, the production function shows the maximum quantity of output that can be produced.
- In the short run, some inputs cannot be varied. In the long run, all inputs can be varied.
- Total product is the relationship between a variable input and output when all other inputs are held constant.
- For any level of employment of an input, the sum of marginal products of every unit of that input up to that level gives the total product of that input at that employment level.
- Both the marginal product and the average product curves are inverse 'U'-shaped. The marginal product curve cuts the average product curve from above at the maximum point of average product curve.
- In order to produce output, the firm chooses least cost input combinations.
- Total cost is the sum of total variable cost and the total fixed cost.
- Average cost is the sum of average variable cost and average fixed cost.
- Average fixed cost curve is downward sloping.
- Short run marginal cost, average variable cost and short run average cost curves are 'U'-shaped.
- SMC curve cuts the AVC curve from below at the minimum point of AVC.
- SMC curve cuts the SAC curve from below at the minimum point of SAC.
- In the short run, for any level of output, sum of marginal costs up to that level gives us the total variable cost. The area under the SMC curve up to any level of output gives us the total variable cost up to that level.
- Both LRAC and LRMC curves are 'U' shaped.
- LRMC curve cuts the LRAC curve from below at the minimum point of LRAC.

Key Concepts

Production function	Short run
Long run	Total product
Marginal product	Average product
Law of diminishing marginal product	Law of variable proportions
	Returns to scale
Cost function	Marginal cost, Average cost

Exercises

1. Explain the concept of a production function.
2. What is the total product of an input?
3. What is the average product of an input?
4. What is the marginal product of an input?
5. Explain the relationship between the marginal products and the total product of an input.
6. Explain the concepts of the short run and the long run.
7. What is the law of diminishing marginal product?
8. What is the law of variable proportions?
9. When does a production function satisfy constant returns to scale?
10. When does a production function satisfy increasing returns to scale?

11. When does a production function satisfy decreasing returns to scale?
12. Briefly explain the concept of the cost function.
13. What are the total fixed cost, total variable cost and total cost of a firm? How are they related?
14. What are the average fixed cost, average variable cost and average cost of a firm? How are they related?
15. Can there be some fixed cost in the long run? If not, why?
16. What does the average fixed cost curve look like? Why does it look so?
17. What do the short run marginal cost, average variable cost and short run average cost curves look like?
18. Why does the SMC curve cut the AVC curve at the minimum point of the AVC curve?
19. At which point does the SMC curve cut the SAC curve? Give reason in support of your answer.
20. Why is the short run marginal cost curve 'U'-shaped?
21. What do the long run marginal cost and the average cost curves look like?
22. The following table gives the total product schedule of labour. Find the corresponding average product and marginal product schedules of labour.

L	TP_L
0	0
1	15
2	35
3	50
4	40
5	48

23. The following table gives the average product schedule of labour. Find the total product and marginal product schedules. It is given that the total product is zero at zero level of labour employment.

L	AP_L
1	2
2	3
3	4
4	4.25
5	4
6	3.5

24. The following table gives the marginal product schedule of labour. It is also given that total product of labour is zero at zero level of employment. Calculate the total and average product schedules of labour.

L	MP_L
1	3
2	5
3	7
4	5
5	3
6	1

25. The following table shows the total cost schedule of a firm. What is the total fixed cost schedule of this firm? Calculate the TVC, AFC, AVC, SAC and SMC schedules of the firm.

Q	TC
0	10
1	30
2	45
3	55
4	70
5	90
6	120

26. The following table gives the total cost schedule of a firm. It is also given that the average fixed cost at 4 units of output is Rs 5. Find the TVC, TFC, AVC, AFC, SAC and SMC schedules of the firm for the corresponding values of output.

Q	TC
1	50
2	65
3	75
4	95
5	130
6	185

27. A firm's SMC schedule is shown in the following table. The total fixed cost of the firm is Rs 100. Find the TVC, TC, AVC and SAC schedules of the firm.

Q	TC
0	-
1	500
2	300
3	200
4	300
5	500
6	800

28. Let the production function of a firm be

$$Q = 5L^{\frac{1}{2}}K^{\frac{1}{2}}$$

Find out the maximum possible output that the firm can produce with 100 units of L and 100 units of K.

29. Let the production function of a firm be

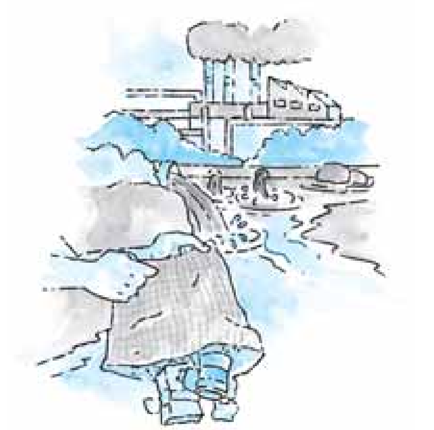
$$Q = 2L^2K^2$$

Find out the maximum possible output that the firm can produce with 5 units of L and 2 units of K. What is the maximum possible output that the firm can produce with zero unit of L and 10 units of K?

30. Find out the maximum possible output for a firm with zero unit of L and 10 units of K when its production function is

$$Q = 5L + 2K$$

Chapter 4



The Theory of the Firm under Perfect Competition

In the previous chapter, we studied concepts related to a firm's production function and cost curves. The focus of this chapter is different. Here we ask : how does a firm decide how much to produce? Our answer to this question is by no means simple or uncontroversial. We base our answer on a *critical*, if somewhat unreasonable, assumption about firm behaviour – a firm, we maintain, is a ruthless **profit maximiser**. So, the amount that a firm produces and sells in the market is that which maximises its profit.

The structure of this chapter is as follows. We first set up and examine in detail the profit maximisation problem of a firm. This done, we derive a firm's **supply curve**. The supply curve shows the levels of output that a firm chooses to produce for different values of the market price. Finally, we study how to aggregate the supply curves of individual firms and obtain the **market supply curve**.

4.1 Perfect Competition: Defining Features

In order to analyse a firm's profit maximisation problem, we must first specify the market environment in which the firm functions. In this chapter, we study a market environment called **perfect competition**. A perfectly competitive market has two defining features

1. The market consists of buyers and sellers (that is, firms). All firms in the market produce a certain homogeneous (that is, undifferentiated) good.
2. Each buyer and seller in the market is a price-taker.

Since the first feature of a perfectly competitive market is easy to understand, we focus on the second feature. From the viewpoint of a firm, what does price-taking entail? A price-taking firm believes that should it set a price above the market price, it will be unable to sell any quantity of the good that it produces. On the other hand, should the set price be less than or equal to the market price, the firm can sell as many units of the good as it wants to sell. From the viewpoint of a buyer, what does price-taking entail? A buyer would obviously like to buy the good at the lowest possible price. However, a price-taking buyer believes that should she ask for a price below the market price, no firm will be willing to sell to her. On the other hand, should the price asked be greater than or equal to the market price, the buyer can obtain as many units of the good as she desires to buy.

Since this chapter deals exclusively with firms, we probe no further into buyer behaviour. Instead, we identify conditions under which price-taking is a reasonable assumption for firms. Price-taking is often thought to be a reasonable assumption when the market has many firms *and* buyers have perfect information about the price prevailing in the market. Why? Let us start with a situation wherein each firm in the market charges the same (market) price and sells some amount of the good. Suppose, now, that a certain firm raises its price above the market price. Observe that since all firms produce the same good and all buyers are aware of the market price, the firm in question loses all its buyers. Furthermore, as these buyers switch their purchases to other firms, no "adjustment" problems arise; their demands are readily accommodated when there are many firms in the market. Recall, now, that an individual firm's inability to sell any amount of the good at a price exceeding the market price is precisely what the price-taking assumption stipulates.

4.2 Revenue

We have indicated that in a perfectly competitive market, a firm believes that it can sell as many units of the good as *it* wants by setting a price less than or equal to the market price. But, if this is the case, surely there is no reason to set a price lower than the market price. In other words, should the firm desire to sell some amount of the good, the price that it sets is exactly equal to the market price.

A firm earns revenue by selling the good that it produces in the market. Let the market price of a unit of the good be p. Let q be the quantity of the good produced, and therefore sold, by the firm at price p. Then, **total revenue** (TR) of the firm is defined as the market price of the good (p) multiplied by the firm's output (q). Hence,

$$TR = p \times q$$

To make matters concrete, consider the following numerical example. Let the market for candles be perfectly competitive and let the market price of a box of candles be Rs 10. For a candle manufacturer, Table 4.1 shows how total revenue is related to output. Notice that when no box is produced, TR is equal to zero; if one box of candles is produced, TR is equal to 1 × Rs 10 = Rs 10; if two boxes of candles are produced, TR is equal to 2 × Rs 10 = Rs 20; and so on.

With the example done, let us return to a more general setting. In a perfectly competitive market, a firm views the market price, p, as given. With the market price *fixed* at p, the **total revenue curve** of a firm shows the relationship between its total revenue (y-axis) and its output (x-axis). Figure 4.1 shows the total revenue curve of a firm. Three observations are relevant here. First, when the output is zero, the total revenue of the firm is also zero. Therefore, the TR curve passes through point O. Second, the total revenue increases as the output goes up. Moreover, the equation '$TR = p \times q$' is that of a

Table 4.1: Total Revenue

Boxes sold	*TR (in Rs)*
0	0
1	10
2	20
3	30
4	40
5	50

straight line. This means that the TR curve is an upward rising straight line. Third, consider the slope of this straight line. When the output is one unit (horizontal distance Oq_1 in Figure 4.1), the total revenue (vertical height Aq_1 in Figure 4.1) is $p \times 1 = p$. Therefore, the slope of the straight line is $Aq_1/Oq_1 = p$.

Now consider Figure 4.2. Here, we plot the market price (y-axis) for different values of a firm's output (x-axis). Since the market price is fixed at p, we obtain a horizontal straight line that cuts the y-axis at a height equal to p. This horizontal straight line is called the **price line**. The price line also depicts the demand curve facing a firm. Observe that Figure 4.2 shows that the market price, p, is independent of a firm's output. This means that a firm can sell as many units of the good as it wants to sell at price p.

Total Revenue curve. *The total revenue curve of a firm shows the relationship between the total revenue that the firm earns and the output level of the firm. The slope of the curve, Aq_1/Oq_1, is the market price.*

The **average revenue** (AR) of a firm is defined as total revenue per unit of output. Recall that if a firm's output is q and the market price is p, then TR equals $p \times q$. Hence

$$AR = \frac{TR}{q} = \frac{p \times q}{q} = p$$

In other words, for a price-taking firm, average revenue equals the market price.

Price Line. *The price line shows the relationship between the market price and a firm's output level. The vertical height of the price line is equal to the market price, p.*

The **marginal revenue** (MR) of a firm is defined as the increase in total revenue for a unit increase in the firm's output. Consider a situation where the firm's output is increased from q^0 to $(q^0 + 1)$. Given market price p, notice that

$$\begin{aligned} MR &= (TR \text{ from output } (q^0 + 1)) - (TR \text{ from output } q^0) \\ &= (p \times (q^0 + 1)) - (pq^0) = p \end{aligned}$$

In other words, for a price-taking firm, marginal revenue equals the market price.

Setting the algebra aside, the intuition for this result is quite simple. When a firm increases its output by one unit, this extra unit is sold at the market price. Hence, the firm's increase in total revenue from the one-unit output expansion – that is, MR – is precisely the market price.

4.3 Profit Maximisation

A firm produces and sells a certain amount of a good. The firm's profit, denoted by π, is defined to be the difference between its total revenue (TR) and its total cost of production (TC).[1] In other words

$$\pi = TR - TC$$

Clearly, the gap between TR and TC is the firm's earnings net of costs.

A firm wishes to maximise its profit. The critical question is: at what output level is the firm's profit maximised? Assuming that the firm's output is perfectly divisible, we now show that *if* there is a *positive* output level, q_0, at which profit is maximised, then three conditions *must* hold:

1. The market price, p, is equal to the marginal cost at q_0.
2. The marginal cost is non-decreasing at q_0.
3. In the short run, the market price, p, must be greater than or equal to the average variable cost at q_0. In the long run, the market price, p, must be greater than or equal to the average cost at q_0.

4.3.1 Condition 1

Consider condition 1. We show that condition 1 is true by arguing that a profit-maximising firm will *not* produce at an output level where market price exceeds marginal cost *or* marginal cost exceeds market price. We check both the cases.

Case 1: Price greater than MC is ruled out

Consider Figure 4.3 and note that at the output level q_2, the market price, p, exceeds the marginal cost. We claim that q_2 cannot be a profit-maximising output level. Why?

Observe that for all output levels slightly to the right of q_2, the market price continues to exceed the marginal cost. So, pick an output level q_3 slightly to the right of q_2 such that the market price exceeds the marginal cost for *all* output levels between q_2 and q_3.

Suppose, now, that the firm increases its output level from q_2 to q_3. The increase in the total revenue of the firm from this output expansion is just the market price multiplied by the change in quantity; that is, the area of the rectangle q_2q_3CB. On the other hand, the increase in total cost associated with this output expansion is just the area under the marginal cost curve between output levels q_2 and q_3; that is, the area of the region q_2q_3XW. But, a comparison of the two areas shows that the firm's profit is higher when its output level is q_3 rather than q_2. But, if this is the case, q_2 cannot be a profit-maximising output level.

Case 2: Price less than MC is ruled out

Consider Figure 4.3 and note that at the output level q_5, the market price, p, is less than the marginal cost. We claim that q_5 cannot be a profit-maximising output level. Why?

Observe that for all output levels slightly to the left of q_5, the market price remains lower than the marginal cost. So, pick an output level q_4 slightly to the left of q_5 such that the market price is less than the marginal cost for *all* output levels between q_4 and q_5.

Suppose, now, that the firm cuts its output level from q_5 to q_4. The decrease in the total revenue of the firm from this output contraction is just the market

[1]It is a convention in economics to denote profit with the Greek letter π.

price multiplied by the change in quantity; that is, the area of the rectangle q_4q_5EF. On the other hand, the decrease in total cost brought about by this output contraction is the area under the marginal cost curve between output levels q_4 and q_5; that is, the area of the region q_4q_5ZY. But, a comparison of the two areas shows that the firm's profit is higher when its output level is q_4 rather than q_5. But, if this is the case, q_5 cannot be a profit-maximising output level.

4.3.2 Condition 2

Consider the second condition that must hold when the profit-maximising output level is positive. Why is it the case that the marginal cost curve cannot slope downwards at the profit-maximising output level? To answer this question, refer once again to Figure 4.3. Note that at the output level q_1, the market price is equal to the marginal cost; however, the marginal cost curve is downward sloping. We claim that q_1 cannot be a profit-maximising output level. Why?

Observe that for *all* output levels slightly to the left of q_1, the market price is lower than the marginal cost. But, the argument outlined in case 2 of section 3.1 immediately implies that the firm's profit at an output level slightly smaller than q_1 exceeds that corresponding to the output level q_1. This being the case, q_1 cannot be a profit-maximising output level.

Conditions 1 and 2 for profit maximisation. *The figure is used to demonstrate that when the market price is p, the output level of a profit-maximising firm cannot be q_1 (marginal cost curve, MC, is downward sloping), q_2 (market price exceeds marginal cost), or q_5 (marginal cost exceeds market price).*

4.3.3 Condition 3

Consider the third condition that must hold when the profit-maximising output level is positive. Notice that the third condition has two parts: one part applies in the short run while the other applies in the long run.

Case 1: Price must be greater than or equal to AVC in the short run

We will show that the statement of Case 1 (see above) is true by arguing that a profit-maximising firm, in the short run, will *not* produce at an output level wherein the market price is lower than the AVC.

Price-AVC Relationship with Profit Maximisation (Short Run). *The figure is used to demonstrate that a profit-maximising firm produces zero output in the short run when the market price, p, is less than the minimum of its average variable cost (AVC). If the firm's output level is q_1, the firm's total variable cost exceeds its revenue by an amount equal to the area of rectangle p*EBA.

Let us turn to Figure 4.4. Observe that at the output level q_1, the market price p is lower than the AVC. We claim that q_1 cannot be a profit-maximising output level. Why?

Notice that the firm's total revenue at q_1 is as follows

$$\begin{aligned} \text{TR} &= \text{Price} \times \text{Quantity} \\ &= \text{Vertical height } Op \times \text{width } Oq_1 \\ &= \text{The area of rectangle } OpAq_1 \end{aligned}$$

Similarly, the firm's total variable cost at q_1 is as follows

$$\begin{aligned} \text{TVC} &= \text{Average variable cost} \times \text{Quantity} \\ &= \text{Vertical height } OE \times \text{Width } Oq_1 \\ &= \text{The area of rectangle } OEBq_1 \end{aligned}$$

Now recall that the firm's profit at q_1 is TR – (TVC + TFC); that is, [the area of rectangle $OpAq_1$] – [the area of rectangle $OEBq_1$] – TFC. What happens if the firm produces zero output? Since output is zero, TR and TVC are zero as well. Hence, the firm's profit at zero output is equal to – TFC. But, the area of rectangle $OpAq_1$ is strictly less than the area of rectangle $OEBq_1$. Hence, the firm's profit at q_1 is strictly less than what it obtains by not producing at all. This means, of course, that q_1 cannot be a profit-maximising output level.

Case 2: Price must be greater than or equal to AC in the long run

We will show that the statement of Case 2 (see above) is true by arguing that a profit-maximising firm, in the long run, will *not* produce at an output level wherein the market price is lower than the AC.

Let us turn to Figure 4.5. Observe that at the output level q_1, the market price p is lower than the (long run) AC. We claim that q_1 cannot be a profit-maximising output level. Why?

Notice that the firm's total revenue, TR, at q_1 is the area of the rectangle $OpAq_1$ (the product of price and quantity) while the firm's total cost, TC , is the area of the rectangle $OEBq_1$ (the product of average cost and quantity). Since the area of rectangle $OEBq_1$ is larger than the area of rectangle $OpAq_1$, the firm incurs a loss at the output level q_1. But, in the long run set-up, a firm that shuts down production has a profit of zero. This means, of course, that q_1 is not a profit-maximising output level.

Price-AC Relationship with Profit Maximisation (Long Run). *The figure is used to demonstrate that a profit-maximising firm produces zero output in the long run when the market price, p, is less than the minimum of its long run average cost (LRAC). If the firm's output level is q_1, the firm's total cost exceeds its revenue by an amount equal to the area of rectangle p*EBA.

4.3.4 The Profit Maximisation Problem: Graphical Representation

Using the material in sections 3.1, 3.2 and 3.3, let us graphically represent a firm's profit maximisation problem in the short run. Consider Figure 4.6. Notice that the market price is p. Equating the market price with the (short run) marginal cost, we obtain the output level q_0. At q_0, observe that SMC slopes upwards and p exceeds AVC. Since the three conditions discussed in sections 3.1-3.3 are satisfied at q_0, we maintain that the profit-maximising output level of the firm is q_0.

What happens at q_0? The total revenue of the firm at q_0 is the area of rectangle $OpAq_0$ (the product of price and quantity) while the total cost at q_0 is the area of rectangle $OEBq_0$ (the product of short run average cost and quantity). So, at q_0, the firm earns a profit equal to the area of the rectangle $EpAB$.

Geometric Representation of Profit Maximisation (Short Run). *Given market price* p*, the output level of a profit-maximising firm is* q_0. *At* q_0, *the firm's profit is equal to the area of rectangle* EpAB.

4.4 Supply Curve of a Firm

The **supply curve** of a firm shows the levels of output (plotted on the x-axis) that the firm chooses to produce corresponding to different values of the market price (plotted on the y-axis). Of course, for a given market price, the output level of a profit-maximising firm will depend on whether we are considering the short run or the long run. Accordingly, we distinguish between the **short run supply curve** and the **long run supply curve**.

4.4.1 Short Run Supply Curve of a Firm

Let us turn to Figure 4.7 and derive a firm's short run supply curve. We shall split this derivation into two parts. We first determine a firm's profit-maximising output level when the market price is greater than or equal to the minimum AVC. This done, we determine the firm's profit-maximising output level when the market price is less than the minimum AVC.

Case 1: Price is greater than or equal to the minimum AVC

Suppose the market price is p_1, which exceeds the minimum AVC. We start out by equating p_1 with SMC on the rising part of the SMC curve; this leads to the output level q_1. Note also that the AVC at q_1

Market Price Values. *The figure shows the output levels chosen by a profit-maximising firm in the short run for two values of the market price:* p_1 *and* p_2. *When the market price is* p_1, *the output level of the firm is* q_1; *when the market price is* p_2, *the firm produces zero output.*

does not exceed the market price, p_1. Thus, all three conditions highlighted in section 3 are satisfied at q_1. Hence, when the market price is p_1, the firm's output level in the short run is equal to q_1.

Case 2: Price is less than the minimum AVC

Suppose the market price is p_2, which is less than the minimum AVC. We have argued (see condition 3 in section 3) that if a profit-maximising firm produces a positive output in the short run, then the market price, p_2, *must* be greater than or equal to the AVC at that output level. But notice from Figure 4.7 that for *all* positive output levels, AVC strictly exceeds p_2. In other words, it cannot be the case that the firm supplies a positive output. So, if the market price is p_2, the firm produces zero output.

Combining cases 1 and 2, we reach an important conclusion. A firm's short run supply curve is the rising part of the SMC curve from and above the minimum AVC together with zero output for all prices strictly less than the minimum AVC. In figure 4.8, the bold line represents the short run supply curve of the firm.

The Short Run Supply Curve of a Firm*. The short run supply curve of a firm, which is based on its short run marginal cost curve (SMC) and average variable cost curve (AVC), is represented by the bold line.*

4.4.2 Long Run Supply Curve of a Firm

Let us turn to Figure 4.9 and derive the firm's long run supply curve. As in the short run case, we split the derivation into two parts. We first determine the firm's profit-maximising output level when the market price is greater than or equal to the minimum (long run) AC. This done, we determine the firm's profit-maximising output level when the market price is less than the minimum (long run) AC.

Case 1: Price greater than or equal to the minimum LRAC

Suppose the market price is p_1, which exceeds the minimum LRAC. Upon equating p_1 with LRMC on the rising part of the LRMC curve, we obtain output level q_1. Note also that the LRAC at q_1 does not exceed the market price, p_1. Thus, all three conditions highlighted in section 3 are satisfied at q_1.

Profit maximisation in the Long Run for Different Market Price Values*. The figure shows the output levels chosen by a profit-maximising firm in the long run for two values of the market price: p_1 and p_2. When the market price is p_1, the output level of the firm is q_1; when the market price is p_2, the firm produces zero output.*

Hence, when the market price is p_1, the firm's supplies in the long run become an output equal to q_1.

Case 2: Price less than the minimum LRAC

Suppose the market price is p_2, which is less than the minimum LRAC. We have argued (see condition 3 in section 3) that if a profit-maximising firm produces a positive output in the long run, the market price, p_2, *must* be greater than or equal to the LRAC at that output level. But notice from Figure 4.9 that for *all* positive output levels, LRAC strictly exceeds p_2. In other words, it cannot be the case that the firm supplies a positive output. So, when the market price is p_2, the firm produces zero output.

Combining cases 1 and 2, we reach an important conclusion. A firm's long run supply curve is the rising part of the LRMC curve from and above the minimum LRAC together with zero output for all prices less than the minimum LRAC. In Figure 4.10, the bold line represents the long run supply curve of the firm.

The Long Run Supply Curve of a Firm. *The long run supply curve of a firm, which is based on its long run marginal cost curve (LRMC) and long run average cost curve (LRAC), is represented by the bold line.*

4.4.3 The Shut Down Point

Previously, while deriving the supply curve, we have discussed that in the short run the firm continues to produce as long as the price remains greater than or equal to the minimum of AVC. Therefore, along the supply curve as we move down, the last price-output combination at which the firm produces positive output is the point of minimum AVC where the SMC curve cuts the AVC curve. Below this, there will be no production. This point is called the short run **shut down point** of the firm. In the long run, however, the shut down point is the minimum of LRAC curve.

4.4.4 The Normal Profit and Break-even Point

A firm uses different kinds of inputs in the production process. To acquire some of them, the firm has to pay directly. For example, if a firm employs labour it has to pay wages to them; if it uses some raw materials, it has to buy them. There may be some other kinds of inputs which the firm owns, and therefore, does not need to pay to anybody for them. These inputs though do not involve any explicit cost, they involve some opportunity cost to the firm. The firm instead of using these inputs in the current production process could have used them for some other purpose and get some return. This forgone return is the opportunity cost to the firm. The firm normally expects to earn a profit that along with the explicit costs can also cover the opportunity costs. The profit level that is just enough to cover the explicit costs and opportunity costs of the firm is called the **normal profit**. If a firm includes both its explicit costs and opportunity costs in the calculation of total cost, the normal profit becomes that level of profit when total revenue equals total cost, i.e., the zero level of profit. Profit that a firm earns over and above the normal profit is called the **super-normal profit**. In the long run, a firm does not produce if it earns anything less than the normal profit. In the short run, however, it may produce even if the profit is less than this level. The point on the supply curve at which a firm earns normal profit is called the **break-even point** of the firm. The point of minimum average cost at which the supply curve cuts the LRAC curve (in short run, SAC curve) is therefore the break-even point of a firm.

Opportunity cost

In economics, one often encounters the concept of opportunity cost. Opportunity cost of some activity is the gain foregone from the second best activity. Suppose you have Rs 1,000 which you decide to invest in your family business. What is the opportunity cost of your action? If you do not invest this money, you can either keep it in the house-safe which will give you zero return or you can deposit it in either bank-1 or bank-2 in which case you get an interest at the rate of 10 per cent or 5 per cent respectively. So the maximum benefit that you may get from other alternative activities is the interest from the bank-1. But this opportunity will no longer be there once you invest the money in your family business. The opportunity cost of investing the money in your family business is therefore the amount of forgone interest from the bank-1.

4.5 Determinants of a Firm's Supply Curve

In the previous section, we have seen that a firm's supply curve is a part of its marginal cost curve. Thus, *any* factor that affects a firm's marginal cost curve is of course a **determinant of its supply curve**. In this section, we discuss three such factors.

4.5.1 Technological Progress

Suppose a firm uses two factors of production – say, capital and labour – to produce a certain good. Subsequent to an organisational innovation by the firm, the same levels of capital and labour now produce more units of output. Put differently, to produce a given level of output, the organisational innovation allows the firm to use fewer units of inputs. It is expected that this will lower the firm's marginal cost at any level of output; that is, there is a rightward (or downward) shift of the MC curve. As the firm's supply curve is essentially a segment of the MC curve, technological progress shifts the supply curve of the firm to the right. At any given market price, the firm now supplies more units of output.

4.5.2 Input Prices

A change in input prices also affects a firm's supply curve. If the price of an input (say, the wage rate of labour) increases, the cost of production rises. The consequent increase in the firm's average cost at any level of output is usually accompanied by an increase in the firm's marginal cost at any level of output; that is, there is a leftward (or upward) shift of the MC curve. This means that the firm's supply curve shifts to the left: at any given market price, the firm now supplies fewer units of output.

4.5.3 Unit Tax

A unit tax is a tax that the government imposes per unit sale of output. For example, suppose that the unit tax imposed by the government is Rs 2. Then, if the firm produces and sells 10 units of the good, the total tax that the firm must pay to the government is 10 × Rs 2 = Rs 20.

How does the long run supply curve of a firm change when a unit tax is imposed? Let us turn to figure 4.11. Before the unit tax is imposed, $LRMC^0$ and $LRAC^0$ are, respectively, the long run marginal cost curve and the long run average cost curve of the firm. Now, suppose the government puts in place a unit tax of Rs *t*. Since the firm must pay an extra Rs *t* for each unit of the good produced, the firm's long run average cost and long run marginal cost at any level of output increases by Rs *t*. In Figure 4.11, $LRMC^1$ and $LRAC^1$ are, respectively, the long run marginal cost curve and the long run average cost curve of the firm upon imposition of the unit tax.

Cost Curves and the Unit Tax. *$LRAC^0$ and $LRMC^0$ are, respectively, the long run average cost curve and the long run marginal cost curve of a firm before a unit tax is imposed. $LRAC^1$ and $LRMC^1$ are, respectively, the long run average cost curve and the long run marginal cost curve of a firm after a unit tax of Rs t is imposed.*

Recall that the long run supply curve of a firm is the rising part of the LRMC curve from and above the minimum LRAC together with zero output for all prices less than the minimum LRAC. Using this observation in Figure 4.12, it is immediate that S^0 and S^1 are, respectively, the long run supply curve of the firm before and after the imposition of the unit tax. Notice that the unit tax shifts the firm's long run supply curve to the left: at any given market price, the firm now supplies fewer units of output.

Supply Curves and Unit Tax. *S^0 is the supply curve of a firm before a unit tax is imposed. After a unit tax of Rs t is imposed, S^1 represents the supply curve of the firm.*

4.6 Market Supply Curve

The market supply curve shows the output levels (plotted on the *x*-axis) that firms in the market produce in aggregate corresponding to different values of the market price (plotted on the *y*-axis).

How is the market supply curve derived? Consider a market with *n* firms: firm 1, firm 2, firm 3, and so on. Suppose the market price is fixed at *p*. Then, the output produced by the n firms in aggregate is [supply of firm 1 at price p] + [supply of firm 2 at price p] + ... + [supply of firm n at price p]. In other words, the market supply at price p is the summation of the supplies of individual firms at that price.

Let us now construct the market supply curve geometrically with just two firms in the market: firm 1 and firm 2. The two firms have different cost structures. Firm 1 will not produce anything if the market price is less than $\overline{p}_1$ while firm 2 will not produce anything if the market price is less than $\overline{p}_2$. Assume also that $\overline{p}_2$ is greater than $\overline{p}_1$.

In panel (a) of Figure 4.13 we have the supply curve of firm 1, denoted by S_1; in panel (b), we have the supply curve of firm 2, denoted by S_2. Panel (c) of Figure 4.13 shows the market supply curve, denoted by Sm. When the market price is strictly below $\overline{p}_1$, both firms choose not to produce any amount of the good; hence, market supply will also be zero for all such prices. For a market price greater than or equal to $\overline{p}_1$ but strictly less than $\overline{p}_2$, only firm 1 will produce a positive amount of the good. Therefore, in this range, the market supply curve coincides with the supply curve of firm 1. For a market price greater than or equal to $\overline{p}_2$, both firms will have positive output levels. For example, consider a situation wherein the market price assumes the value p_3 (observe that p_3 exceeds $\overline{p}_2$). Given p_3, firm 1 supplies q_3 units of output while firm 2 supplies q_4 units of output. So, the market supply at price p_3 is q_5, where $q_5 = q_3 + q_4$. Notice how the market supply curve, S_m, in panel (c) is being constructed: we obtain S_m by taking a horizontal summation of the supply curves of the two firms in the market, S_1 and S_2.

It should be noted that the market supply curve has been derived for a fixed number of firms in the market. As the number of firms changes, the market supply curve shifts as well. Specifically, if the number of firms in the market increases (decreases), the market supply curve shifts to the right (left).

We now supplement the graphical analysis given above with a related numerical example. Consider a market with two firms: firm 1 and firm 2. Let the supply curve of firm 1 be as follows

$$S_1(p) = \begin{cases} 0 & : p < 10 \\ p - 10 & : p \geq 10 \end{cases}$$

The Market Supply Curve Panel. *(a) shows the supply curve of firm 1. Panel (b) shows the supply curve of firm 2. Panel (c) shows the market supply curve, which is obtained by taking a horizontal summation of the supply curves of the two firms.*

Notice that $S_1(p)$ indicates that (1) firm 1 produces an output of 0 if the market price, p, is strictly less than 10, and (2) firm 1 produces an output of $(p - 10)$ if the market price, p, is greater than or equal to 10. Let the supply curve of firm 2 be as follows

$$S_2(p) = \begin{cases} 0 & : p < 15 \\ p - 15 & : p \geq 15 \end{cases}$$

The interpretation of $S_2(p)$ is identical to that of $S_1(p)$, and is, hence, omitted. Now, the market supply curve, $S_m(p)$, simply sums up the supply curves of the two firms; in other words

$$S_m(p) = S_1(p) + S_2(p)$$

But, this means that $S_m(p)$ is as follows

$$S_m(p) = \begin{cases} 0 & : p < 10 \\ p - 10 & : p \geq 10 \text{ and } p < 15 \\ (p - 10) + (p - 15) = 2p - 25 & : p \geq 15 \end{cases}$$

4.7 Price Elasticity of Supply

The price elasticity of supply of a good measures the responsiveness of quantity supplied to changes in the price of the good. More specifically, the price elasticity of supply, denoted by e_S, is defined as follows

$$\text{Price elasticity of supply } (e_S) = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$$

Given the market supply curve of a good (that is, $S_m(p)$), let q^0 be the quantity of the good supplied to the market when its market price is p^0. For some reason, the market price of the good changes from p^0 to p^1. Let q^1 be the quantity of the good supplied to the market when the market price is p^1. Notice that when the market price moves from p^0 to p^1, the percentage change in price is $100 \times \frac{(p^1 - p^0)}{p^0}$; similarly, when the quantity supplied moves from q^0 to q^1, the percentage change in quantity supplied is $100 \times \frac{(q^1 - q^0)}{q^0}$. So

$$e_S = \frac{100 \times (q^1 - q^0)/q^0}{100 \times (p^1 - p^0)/p^0} = \frac{q^1/q^0 - 1}{p^1/p^0 - 1}$$

To make matters concrete, consider the following numerical example. Suppose the market for cricket balls is perfectly competitive. When the price of a cricket ball is Rs10, let us assume that 200 cricket balls are produced in aggregate by the firms in the market. When the price of a cricket ball rises to Rs 30, let us assume that 1,000 cricket balls are produced in aggregate by the firms in the market. Then

1. $\frac{q'}{q^0}$ 1 $\frac{1000}{200}$ 1 4

2. $\frac{p'}{p^0}$ 1 $\frac{30}{10}$ 1 2

3. $e_S = \frac{4}{2} = 2.$

When the supply curve is vertical, supply is completely insensitive to price and the elasticity of supply is zero. In other cases, when supply curve is positively sloped, with a rise in price, supply rises and hence, the elasticity of supply is positive. Like the price elasticity of demand, the price elasticity of supply is also independent of units.

4.7.1 The Geometric Method

Consider the Figure 4.11. Panel (a) shows a straight line supply curve. *S* is a point on the supply curve. It cuts the price-axis at its positive range and as we extend the straight line, it cuts the quantity-axis at *M* which is at its negative range. The price elasticity of this supply curve at the point *S* is given by the ratio, Mq_0 / Oq_0. For any point *S* on such a supply curve, we see that $Mq_0 > Oq_0$. The elasticity at any point on such a supply curve, therefore, will be greater than 1.

In panel (c) we consider a straight line supply curve and *S* is a point on it. It cuts the quantity-axis at *M* which is at its positive range. Again the price elasticity of this supply curve at the point *S* is given by the ratio, Mq_0 / Oq_0. Now, $Mq_0 < Oq_0$ and hence, $e_S < 1$. *S* can be any point on the supply curve, and therefore at all points on such a supply curve $e_S < 1$.

Now we come to panel (b). Here the supply curve goes through the origin. One can imagine that the point *M* has coincided with the origin here, i.e., Mq_0 has become equal to Oq_0. The price elasticity of this supply curve at the point *S* is given by the ratio, Oq_0 / Oq_0 which is equal to 1. At any point on a straight line, supply curve going through the origin price elasticity will be one.

Price Elasticity Associated with Straight Line Supply Curves. In panel (a), price elasticity (e_S) at S is greater than 1. In panel (b), price elasticity (e_S) at S is equal to 1. In panel (c), price elasticity (e_S) at S is less than 1.

Summary

- In a perfectly competitive market, firms are price-takers.
- The total revenue of a firm is the market price of the good multiplied by the firm's output of the good.
- For a price-taking firm, average revenue is equal to market price.
- For a price-taking firm, marginal revenue is equal to market price.
- The demand curve that a firm faces in a perfectly competitive market is perfectly elastic; it is a horizontal straight line at the market price.
- The profit of a firm is the difference between total revenue earned and total cost incurred.

- If there is a positive level of output at which a firm's profit is maximised in the short run, three conditions must hold at that output level
  (i) $p = SMC$
  (ii) SMC is non-decreasing
  (iii) $p \geq AV\,C$.
- If there is a positive level of output at which a firm's profit is maximised in the long run, three conditions must hold at that output level
  (i) $p = LRMC$
  (ii) $LRMC$ is non-decreasing
  (iii) $p \geq LRAC$.
- The short run supply curve of a firm is the rising part of the *SMC* curve from and above minimum *AVC* together with 0 output for all prices less than the minimum *AVC*.
- The long run supply curve of a firm is the rising part of the *LRMC* curve from and above minimum *LRAC* together with 0 output for all prices less than the minimum *LRAC*.
- Technological progress is expected to shift the supply curve of a firm to the right.
- An increase (decrease) in input prices is expected to shift the supply curve of a firm to the left (right).
- The imposition of a unit tax shifts the supply curve of a firm to the left.
- The market supply curve is obtained by the horizontal summation of the supply curves of individual firms.
- The price elasticity of supply of a good is the percentage change in quantity supplied due to one per cent change in the market price of the good.

Key Concepts

Perfect competition	Revenue, Profit
Profit maximisation	Firms supply curve
Market supply curve	Price elasticity of supply

Exercises

1. What are the characteristics of a perfectly competitive market?
2. How are the total revenue of a firm, market price, and the quantity sold by the firm related to each other?
3. What is the 'price line'?
4. Why is the total revenue curve of a price-taking firm an upward-sloping straight line? Why does the curve pass through the origin?
5. What is the relation between market price and average revenue of a price-taking firm?
6. What is the relation between market price and marginal revenue of a price-taking firm?
7. What conditions must hold if a profit-maximising firm produces positive output in a competitive market?
8. Can there be a positive level of output that a profit-maximising firm produces in a competitive market at which market price is not equal to marginal cost? Give an explanation.

9. Will a profit-maximising firm in a competitive market ever produce a positive level of output in the range where the marginal cost is falling? Give an explanation.
10. Will a profit-maximising firm in a competitive market produce a positive level of output in the short run if the market price is less than the minimum of *AVC*? Give an explanation.
11. Will a profit-maximising firm in a competitive market produce a positive level of output in the long run if the market price is less than the minimum of *AC*? Give an explanation.
12. What is the supply curve of a firm in the short run?
13. What is the supply curve of a firm in the long run?
14. How does technological progress affect the supply curve of a firm?
15. How does the imposition of a unit tax affect the supply curve of a firm?
16. How does an increase in the price of an input affect the supply curve of a firm?
17. How does an increase in the number of firms in a market affect the market supply curve?
18. What does the price elasticity of supply mean? How do we measure it?
19. Compute the total revenue, marginal revenue and average revenue schedules in the following table. Market price of each unit of the good is Rs 10.

Quantity Sold	*TR*	*MR*	*AR*
0			
1			
2			
3			
4			
5			
6			

20. The following table shows the total revenue and total cost schedules of a competitive firm. Calculate the profit at each output level. Determine also the market price of the good.

Quantity Sold	*TR (Rs)*	*TC (Rs)*	*Profit*
0	0	5	
1	5	7	
2	10	10	
3	15	12	
4	20	15	
5	25	23	
6	30	33	
7	35	40	

21. The following table shows the total cost schedule of a competitive firm. It is given that the price of the good is Rs 10. Calculate the profit at each output level. Find the profit maximising level of output.

Price (Rs)	*TC (Rs)*
0	5
1	15
2	22
3	27
4	31
5	38
6	49
7	63
8	81
9	101
10	123

22. Consider a market with two firms. The following table shows the supply schedules of the two firms: the SS_1 column gives the supply schedule of firm 1 and the SS_2 column gives the supply schedule of firm 2. Compute the market supply schedule.

Price (Rs)	SS_1 *(units)*	SS_2 *(units)*
0	0	0
1	0	0
2	0	0
3	1	1
4	2	2
5	3	3
6	4	4

23. Consider a market with two firms. In the following table, columns labelled as SS_1 and SS_2 give the supply schedules of firm 1 and firm 2 respectively. Compute the market supply schedule.

Price (Rs)	SS_1 *(kg)*	SS_2 *(kg)*
0	0	0
1	0	0
2	0	0
3	1	0
4	2	0.5
5	3	1
6	4	1.5
7	5	2
8	6	2.5

24. There are three identical firms in a market. The following table shows the supply schedule of firm 1. Compute the market supply schedule.

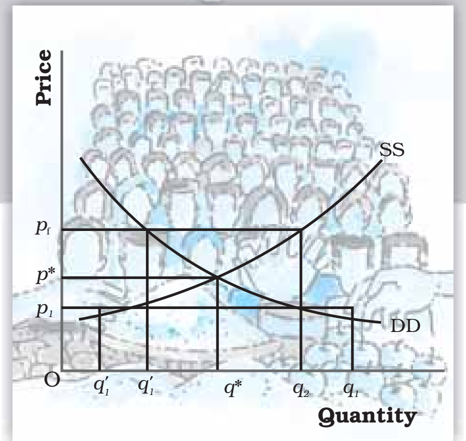
Price (Rs)	SS_1 *(units)*
0	0
1	0
2	2
3	4
4	6
5	8
6	10
7	12
8	14

25. A firm earns a revenue of Rs 50 when the market price of a good is Rs 10. The market price increases to Rs 15 and the firm now earns a revenue of Rs 150. What is the price elasticity of the firm's supply curve?

26. The market price of a good changes from Rs 5 to Rs 20. As a result, the quantity supplied by a firm increases by 15 units. The price elasticity of the firm's supply curve is 0.5. Find the initial and final output levels of the firm.

27. At the market price of Rs 10, a firm supplies 4 units of output. The market price increases to Rs 30. The price elasticity of the firm's supply is 1.25. What quantity will the firm supply at the new price?

Chapter 5



Market Equilibrium

This chapter will be built on the foundation laid down in Chapters 2 and 4 where we studied the consumer and firm behaviour when they are price takers. In Chapter 2, we have seen that an individual's demand curve for a commodity tells us what quantity a consumer is willing to buy at different prices when he takes price as *given*. The market demand curve in turn tells us how much of the commodity all the consumers taken together are willing to purchase at different prices when everyone takes price as *given*. In Chapter 4, we have seen that an individual firm's supply curve tells us the quantity of the commodity that a profit-maximising firm would wish to sell at different prices when it takes price as *given* and the market supply curve tells us how much of the commodity all the firms taken together would wish to supply at different prices when each firm takes price as *given*.

In this chapter, we combine both consumers' and firms' behaviour to study market equilibrium through demand-supply analysis and determine at what price equilibrium will be attained. We also examine the effects of demand and supply shifts on equilibrium. At the end of the chapter, we will look at some of the applications of demand-supply analysis.

5.1 Equilibrium, Excess Demand, Excess Supply

A perfectly competitive market consists of buyers and sellers who are driven by their self-interested objectives. Recall from Chapters 2 and 4 that objectives of the consumers are to maximise their respective preference and that of the firms are to maximise their respective profits. Both the consumers' and firms' objectives are compatible in the equilibrium.

An equilibrium is defined as a situation where the plans of all consumers and firms in the market match and the market clears. In equilibrium, the aggregate quantity that all firms wish to sell equals the quantity that all the consumers in the market wish to buy; in other words, market supply equals market demand. The price at which equilibrium is reached is called **equilibrium price** and the quantity bought and sold at this price is called **equilibrium quantity**. Therefore, (p^*, q^*) is an equilibrium if

$$q^D(p^*) = q^S(p^*)$$

where p^* denotes the equilibrium price and $q^D(p^*)$ and $q^S(p^*)$ denote the market demand and market supply of the commodity respectively at price p^*.

If at a price, market supply is greater than market demand, we say that there is an **excess supply** in the market at that price and if market demand exceeds market supply at a price, it is said that **excess demand** exists in the market at that price. Therefore, equilibrium in a perfectly competitive market can be defined alternatively as zero excess demand-zero excess supply situation. Whenever market supply is not equal to market demand, and hence the market is not in equilibrium, there will be a tendency for the price to change. In the next two sections, we will try to understand what drives this change.

Out-of-equilibrium Behaviour

From the time of Adam Smith (1723-1790), it has been maintained that in a perfectly competitive market an 'Invisible Hand' is at play which changes price whenever there is imbalance in the market. Our intuition also tells us that this 'Invisible Hand' should raise the prices in case of 'excess demand' and lower the prices in case of 'excess supply'. Throughout our analysis we shall maintain that the 'Invisible Hand' plays this very important role. Moreover, we shall take it that the 'Invisible Hand' by following this process is able to reach the equilibrium. This assumption will be taken to hold in all that we discuss in the text.

5.1.1 Market Equilibrium: Fixed Number of Firms

Recall that in Chapter 2 we have derived the market demand curve for price-taking consumers, and for price-taking firms the market supply curve was derived in Chapter 4 under the assumption of a fixed number of firms. In this section with the help of these two curves we will look at how supply and demand forces work together to determine where the market will be in equilibrium when the number of firms is fixed. We will also study how the equilibrium price and quantity change due to shifts in demand and supply curves.

Figure 5.1 illustrates equilibrium for a perfectly competitive market with a fixed number of firms. Here SS denotes the market supply curve and DD denotes the market demand curve for a commodity. The market supply curve SS shows how much of the commodity firms would wish to supply at different prices, and the demand curve DD tells us how much of the commodity, the consumers would be willing to purchase at different prices. Graphically, an equilibrium is a point where the market supply curve intersects the market demand curve because this is where the market demand equals market supply. At any other point, either there is excess supply or

Market Equilibrium with Fixed Number of Firms. *Equilibrium occurs at the intersection of the market demand curve DD and market supply curve SS. The equilibrium quantity is q* and the equilibrium price is p*. At a price greater than p*, there will be excess supply, and at a price below p*, there will be excess demand.*

there is excess demand. To see what happens when market demand does not equal market supply, let us look, in Figure 5.1, at any price at which the equality does not hold.

In Figure 5.1, if the prevailing price is p_1, the market demand is q_1 whereas the market supply is q_1'. Therefore, there is excess demand in the market equal to $q_1' q_1$. Some consumers who are either unable to obtain the commodity at all or obtain it in insufficient quantity will be willing to pay more than p_1. The market price would tend to increase. All other things remaining constant as price rises, quantity demanded falls, quantity supplied increases and the market moves towards the point where the quantity that the firms want to sell is equal to the quantity that the consumers want to buy. At p^*, the supply decisions of the firms match with the demand decisions of the consumers.

Similarly, if the prevailing price is p_2, the market supply (q_2) will exceed the market demand (q_2') at that price giving rise to excess supply equal to $q_2' q_2$. Under such a circumstance, some firms will not be able to sell their desired quantity; so, they will lower their price. All other things remaining constant as price falls, quantity demanded rises, quantity supplied falls, and at p^*, the firms are able to sell their desired output since market demand equals market supply at that price. Therefore, p^* is the equilibrium price and the corresponding quantity q^* is the equilibrium quantity.

To understand the equilibrium price and quantity determination more clearly, let us explain it through an example.

EXAMPLE 5.1

Let us consider the example of a market consisting of identical[1] farms producing same quality of wheat. Suppose the market demand curve and the market supply curve for wheat are given by:

$$
\begin{aligned}
q^D &= 200 - p \quad \text{for} \quad 0 \le p \le 200 \\
&= 0 \quad \text{for} \quad p > 200 \\
q^S &= 120 + p \quad \text{for} \quad p \ge 10 \\
&= 0 \quad \text{for} \quad 0 \le p < 10
\end{aligned}
$$

where q^D and q^S denote the demand for and supply of wheat (in kg) respectively and p denotes the price of wheat per kg in rupees.

Since at equilibrium price market clears, we find the equilibrium price (denoted by p^*) by equating market demand and supply and solve for p^*.

$$q^D(p^*) = q^S(p^*)$$
$$200 - p^* = 120 + p^*$$

Rearranging terms,

$$2p^* = 80$$
$$p^* = 40$$

Therefore, the equilibrium price of wheat is Rs 40 per kg. The equilibrium quantity (denoted by q^*) is obtained by substituting the equilibrium price into either the demand or the supply curve's equation since in equilibrium quantity demanded and supplied are equal.

[1]Here, by identical we mean that all farms have same cost structure.

$$q^D = q^* = 200 - 40 = 160$$

Alternatively,

$$q^S = q^* = 120 + 40 = 160$$

Thus, the equilibrium quantity is 160 kg.

At a price less than p^*, say $p^1 = 25$

$$q^D = 200 - 25 = 175$$

$$q^S = 120 + 25 = 145$$

Therefore, at $p_1 = 25$, $q^D > q^S$ which implies that there is excess demand at this price.

Algebraically, excess demand (ED) can be expressed as

$$\begin{aligned} ED(p) &= q^D - q^S \\ &= 200 - p - (120 + p) \\ &= 80 - 2p \end{aligned}$$

Notice from the above expression that for any price less than $p^*(= 40)$, excess demand will be positive.

Similarly, at a price greater than p^*, say $p_2 = 45$

$$q^D = 200 - 45 = 155$$

$$q^S = 120 + 45 = 165$$

Therefore, there is excess supply at this price since $q^S > q^D$. Algebraically, excess supply (ES) can be expressed as

$$\begin{aligned} ES(p) &= q^S - q^D \\ &= 120 + p - (200 - p) \\ &= 2p - 80 \end{aligned}$$

Notice from the above expression that for any price greater than $p^*(= 40)$, excess supply will be positive.

Therefore, at any price greater than p^*, there will be excess supply, and at any price lower than p^*,there will be excess demand.

Wage Determination in Labour Market

Here we will briefly discuss the theory of wage determination under a perfectly competitive market structure using the demand-supply analysis. The basic difference between a labour market and a market for goods is with respect to the source of supply and demand. In the labour market, households are the suppliers of labour and the demand for labour comes from firms whereas in the market for goods, it is the opposite. Here, it is important to point out that by labour, we mean the hours of work provided by labourers and not the number of labourers. The wage rate is determined at the intersection of the demand and supply curves of labour where the demand for and supply of labour balance. We shall now see what the demand and supply curves of labour look like.

To examine the demand for labour by a single firm, we assume that the labour is the only variable factor of production and the labour market is perfectly competitive, which in turn, implies that each firm takes wage rate as *given*. Also, the firm we are concerned with, is perfectly competitive in nature and carries out production with the goal of profit maximisation. We also assume that given the technology of the firm, the law of diminishing marginal product holds.

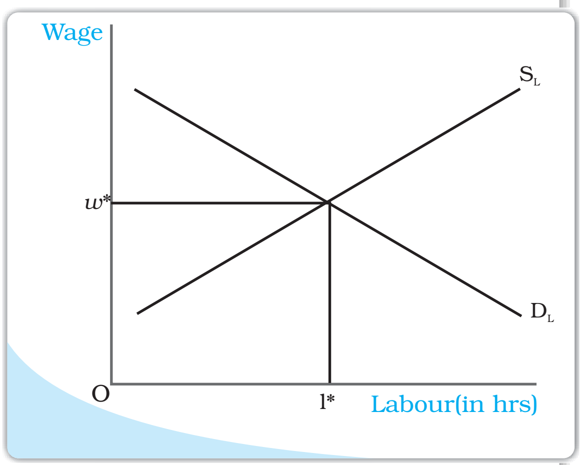
The firm being a profit maximiser will always employ labour upto the point where the extra cost she incurs for employing the last unit of labour is equal to the additional benefit she earns from that unit. The extra cost of hiring one more unit of labour is the wage rate (w). The extra output produced by one more unit of labour is its marginal product (MP_L) and by selling each extra unit of output, the additional earning of the firm is the marginal revenue (MR) she gets from that unit. Therefore, for each extra unit of labour, she gets an additional benefit equal to marginal revenue times marginal product which is called **Marginal Revenue Product of Labour (MRP_L)**. Thus, while hiring labour, the firm employs labour up to the point where

$$w = MRP_L$$
$$\text{and } MRP_L = MR \times MP_L$$

Since we are dealing with a perfectly competitive firm, marginal revenue is equal to the price of the commodity[a] and hence marginal revenue product of labour in this case is equal to the value of marginal product of labour (VMP_L).

As long as the VMP_L is greater than the wage rate, the firm will earn more profit by hiring one more unit of labour, and if at any level of labour employment VMP_L is less than the wage rate, the firm can increase her profit by reducing a unit of labour employed.

Given the assumption of the law of diminishing marginal product, the fact that the firm always produces at w = VMP_L implies that the demand curve for labour is downward sloping. To explain why it is so, let us assume at some wage rate w_1, demand for labour is l_1. Now, suppose the wage rate increases to w_2. To maintain the wage-VMP_L equality, VMP_L should also increase. The price of the commodity remaining constant[b], this is possible only if MP_L increases which in turn implies that less labour should be employed owing to the diminishing marginal productivity of labour. Hence, at higher wage, less labour is demanded thereby leading to a downward sloping demand, curve. To arrive at the market demand curve from individual firms' demand curve, we simply add up the demand for labour by individual firms at different wages and since each firm demands less labour as wage increases, the market demand curve is also downward sloping.



Wage is determined at the point where the labour demand and supply curves intersect.

[a]Recall from Chapter 4 that for a perfectly competitive firm, marginal revenue equals price.
[b]Since the firm under consideration is perfectly competitive, it believes it cannot influence the price of the commodity.

Having explored the demand side, we now turn to the supply side. As already mentioned, it is the households which determine how much labour to supply at a given wage rate. Their supply decision is essentially a choice between income and leisure. On the one hand, individuals enjoy leisure and find work irksome and on the other, they value income for which they must work.

So there is a trade-off between enjoying leisure and spending more hours for work. To derive the labour supply curve for a single individual, let us assume at some wage rate w_1, the individual supplies l_1 units of labour. Now suppose the wage rises to w_2. This increase in wage rate will have two effects: First, due to the increase in wage rate, the opportunity cost of leisure increases which makes leisure costlier. Therefore, the individual will want to enjoy less leisure. As a result, they will work for longer hours. Second, because of the increase in wage rate to w_2, the purchasing power of the individual increases. So, she would want to spend more on leisure activities. The final effect of the increase in wage rate will depend on which of the two effects predominates. At low wage rates, the first effect dominates the second and so the individual will be willing to supply more labour with an increase in wage rate. But at high wage rates, the second effect dominates the first and the individual will be willing to supply less labour for every increase in wage rate. Thus, we get a backward bending individual labour supply curve which shows that up to a certain wage rate for every increase in wage rate, there is an increased supply of labour. Beyond this wage rate for every increase in wage rate, labour supply will decrease. Nevertheless, the market supply curve of labour, which we obtain by aggregating individuals' supply at different wages, will be upward sloping because though at higher wages some individuals may be willing to work less, many more individuals will be attracted to supply more labour.

With an upward sloping supply curve and downward sloping demand curve, the equilibrium wage rate is determined at the point where these two curves intersect; in other words, where the labour that the households wish to supply is equal to the labour that the firms wish to hire. This is shown in the diagram.

Shifts in Demand and Supply

In the above section, we studied market equilibrium under the assumption that tastes and preferences of the consumers, prices of the related commodities, incomes of the consumers, technology, size of the market, prices of the inputs used in production, etc remain constant. However, with changes in one or more of these factors either the supply or the demand curve or both may shift, thereby affecting the equilibrium price and quantity. Here, we first develop the general theory which outlines the impact of these shifts on equilibrium and then discuss the impact of changes in some of the above mentioned factors on equilibrium.

Demand Shift

Consider Figure 5.2 in which we depict the impact of demand shift when the number of firms is fixed. Here, the initial equilibrium point is E where the market demand curve DD_0 and the market supply curve SS_0 intersect so that q_0 and p_0 are the equilibrium quantity and price respectively.

Shifts in Demand*. Initially, the market equilibrium is at E. Due to the shift in demand to the right, the new equilibrium is at G as shown in panel (a) and due to the leftward shift, the new equilibrium is at F, as shown in panel (b). With rightward shift the equilibrium quantity and price increase whereas with leftward shift, equilibrium quantity and price decrease.*

Now suppose the market demand curve shifts rightward to DD_2 with supply curve remaining unchanged at SS_0, as shown in panel (a). This shift indicates that at any price the quantity demanded is more than before. Therefore, at price p_0 now there is excess demand in the market equal to q_0q_0''. In response to this excess demand some individuals will be willing to pay higher price and the price would tend to rise. The new equilibrium is attained at G where the equilibrium quantity q_2 is greater than q_0 and the equilibrium price p_2 is greater than p_0.

Similarly if the demand curve shifts leftward to DD_1, as shown in panel (b), at any price the quantity demanded will be less than what it was before the shift. Therefore, at the initial equilibrium price p_0 now there will be excess supply in the market equal to $q_0'q_0$ in response to which some firms will reduce the price of their commodity so that they can sell their desired quantity. The new equilibrium is attained at the point F at which the demand curve DD_1 and the supply curve SS_0 intersect and the resulting equilibrium price p_1 is less than p_0 and quantity q_1 is less than q_0. Notice that *the direction of change in equilibrium price and quantity is same whenever there is a shift in demand curve.*

Having developed the general theory, we now consider some examples to understand how demand curve and the equilibrium quantity and price are affected in response to a change in some of the aforementioned factors which are also enlisted in Chapter 2. More specifically, we would analyse the impact of increase in consumers' income and an increase in the number of consumers on equilibrium.

Suppose due to a hike in the salaries of the consumers, their incomes increase. How would it affect equilibrium? With an increase in income, consumers are able to spend more money on some goods. But recall from Chapter 2 that the consumers will spend less on an inferior good with increase in income whereas for a normal good, with prices of all commodities and tastes and preferences of the consumers held constant, we would expect the demand for the good to increase at each price as a result of which the market demand curve will shift rightward. Here we consider the example of a normal good like clothes, the demand for which increases with increase in income of consumers, thereby causing a rightward shift in the demand curve. However, this income increase does not have any impact on the supply curve, which shifts only due to some changes in the factors relating to technology or cost of production of the firms. Thus, the supply curve remains unchanged. In the Figure 5.2 (a), this is shown by a shift in the demand curve from DD_0 to DD_2 but the supply curve remains unchanged at SS_0. From the figure, it is clear that at the new equilibrium, the price of clothes is higher and the quantity demanded and sold is also higher.

Now let us turn to another example. Suppose due to some reason, there is increase in the number of consumers in the market for clothes. As the number of consumers increases, other factors remaining unchanged, at each price, more clothes will be demanded. Thus, the demand curve will shift rightwards. But this increase in the number of consumers does not have any impact on the supply curve since the supply curve may shift only due to changes in the parameters relating to firms' behaviour or with an increase in the number of firms, as stated in Chapter 4. This case again can be illustrated through Figure 5.2(a) in which the demand curve DD_0 shifts rightward to DD_2, the supply curve remaining unchanged at SS_0. The figure clearly shows that compared to the old equilibrium point E, at point G which is the new equilibrium point, there is an increase in both price and quantity demanded and supplied.

Supply Shift

In Figure 5.3, we show the impact of a shift in supply curve on the equilibrium price and quantity. Suppose, initially, the market is in equilibrium at point E where the market demand curve DD_0 intersects the market supply curve SS_0 such that the equilibrium price is p_0 and the equilibrium quantity is q_0.

Shifts in Supply. *Initially, the market equilibrium is at E. Due to the shift in supply curve to the left, the new equilibrium point is G as shown in panel (a) and due to the rightward shift the new equilibrium point is F, as shown in panel (b). With rightward shift, the equilibrium quantity increases and price decreases whereas with leftward shift,equilibrium quantity decreases and price increases.*

Now, suppose due to some reason, the market supply curve shifts leftward to SS_2 with the demand curve remaining unchanged, as shown in panel (a). Because of the shift, at the prevailing price, p_0, there will be excess demand equal to $q_0''q_o$ in the market. Some consumers who are unable to obtain the good will be willing to pay higher prices and the market price tends to increase. The new equilibrium is attained at point G where the supply curve SS_2 intersects the demand curve DD_0 such that q_2 quantity will be bought and sold at price p_2. Similarly, when supply curve shifts rightward, as shown in panel (b), at p_0 there will be supply excess of goods equal to $q_0 q_0'$. In response to this excess supply, some firms will reduce their price and the new equilibrium will be attained at F where the supply curve SS_1 intersects the demand curve DD_0 such that the new market price is p_1 at which q_1 quantity is bought and sold. Notice *the directions of change in price and quantity are opposite whenever there is a shift in supply curve.*

Now with this understanding, we can analyse the behaviour of equilibrium price and quantity when various aspects of the market change. Here, we will consider the effect of an increase in input price and an increase in number of firms on equilibrium.

Let us consider a situation where all other things remaining constant, there is an increase in the price of an input used in the production of a commodity. This will increase the marginal cost of production of the firms using this input. Therefore, at each price, the market supply will be less than before. Hence, the supply curve shifts leftward. In the Figure 5.3(a), this is shown by a shift in the supply curve from SS_0 to SS_2. But this increase in input price has no impact on the demand of the consumers since it does not depend on the input prices directly. Therefore, the demand curve remains unchanged. In Figure 5.3(a), this is shown by the demand curve remaining unchanged at DD_0. As a result, compared to the old equilibrium, now the market price rises and quantity produced decreases.

Let us discuss the impact of an increase in the number of firms. Since at each price now more firms will supply the commodity, the supply curve shifts to the right but it does not have any effect on the demand curve. This example can be illustrated by Figure 5.3(b) where the supply curve shifts from SS_0 to SS_1 whereas the demand curve remains unchanged at DD_0. From the figure, we can say that there will be a decrease in price of the commodity and increase in the quantity produced compared to the initial situation.

Simultaneous Shifts of Demand and Supply

What happens when both demand and supply curves shift simultaneously? The simultaneous shifts can happen in four possible ways:

(i) Both supply and demand curves shift rightwards.

(ii) Both supply and demand curves shift leftwards.

(iii) Supply curve shifts leftward and demand curve shifts rightward.

(iv) Supply curve shifts rightward and demand curve shifts leftward.

The impact on equilibrium price and quantity in all the four cases are given in Table 5.1. Each row of the table describes the direction in which the equilibrium price and quantity will change for each possible combination of the simultaneous shifts in demand and supply curves. For instance, from the second row of the table, we see that due to a rightward shift in both demand and supply curves, the equilibrium quantity increases invariably but the equilibrium price may either increase, decrease or remain unchanged. The actual direction in which the price will change will depend on the magnitude of the shifts. Check this yourself by varying the magnitude of shifts for this particular case.

In the first two cases which are shown in the first two rows of the table, the impact on equilibrium quantity is unambiguous but the equilibrium price may change, if at all, in either direction depending on the magnitudes of shifts. In the next two cases, shown in the last two rows of the table, the effect on price is unambiguous whereas effect on quantity depends on the magnitude of shifts in the two curves.

Table 5.1: Impact of Simultaneous Shifts on Equilibrium

Shift in Demand	*Shift in Supply*	*Quantity*	*Price*
Leftward	Leftward	Decreases	May increase, decrease or remain unchanged
Rightward	Rightward	Increases	May increase, decrease or remain unchanged
Leftward	Rightward	May increase, decrease or remain unchanged	Decreases
Rightward	Leftward	May increase, decrease or remain unchanged	Increases

Here we give diagrammatic representations for case (ii) and case (iii) in Figure 5.4 and leave the rest as exercises for the readers.

***Simultaneous Shifts in Demand and Supply**. Initially, the equilibrium is at E where the demand curve DD_0 and supply curve SS_0 intersect. In panel (a), both the supply and the demand curves shift rightwards leaving price unchanged but quantity getting increased. In panel (b), the supply curve shifts rightward and demand curve shifts leftward leaving quantity unchanged but price decreased.*

In the Figure 5.4(a), it can be seen that due to rightward shifts in both demand and supply curves, the equilibrium quantity increases whereas the equilibrium price remains unchanged, and in Figure 5.4(b), equilibrium quantity remains the same whereas price decreases due to a leftward shift in demand curve and a rightward shift in supply curve.

5.1.2 Market Equilibrium: Free Entry and Exit

In the last section, the market equilibrium was studied under the assumption that there is a fixed number of firms. In this section, we will study market equilibrium when firms can enter and exit the market freely. Here, for simplicity, we assume that all the firms in the market are identical.

What is the implication of the entry and exit assumption? This assumption implies that in equilibrium no firm earns supernormal profit or incurs loss by remaining in production; in other words, the equilibrium price will be equal to the minimum average cost of the firms.

To see why it is so, suppose, at the prevailing market price, each firm is earning supernormal profit. The possibility of earning supernormal profit will attract some new firms which will lead to a reduction in the supernormal profit and eventually supernormal profit will be wiped out when there is a sufficient number of firms. At this point, with all firms in the market earning normal profit, no more firms will have incentive to enter. Similarly, if the firms are earning less than normal profit at the prevailing price, some firms will exit which will lead to an increase in profit, and with sufficient number of firms, the profits of each firm will increase to the level of normal profit. At this point, no more firm will want to leave since they will be earning normal profit here. Thus, with free entry and exit, each firm will always earn normal profit at the prevailing market price.

Free for all

Recall from the previous chapter that the firms will earn supernormal profit so long as the price is greater than the minimum average cost and at prices less than minimum average cost, they will earn less than normal profit. Therefore, at prices greater than the minimum average cost, new firms will enter, and at prices below minimum average cost, existing firms will start exiting. At the price level equal to the minimum average cost of the firms, each firm will earn normal profit so that no new firm will be attracted to enter the market. Also the existing firms will not leave the market since they are not incurring any loss by producing at this point. So, this price will prevail in the market.

Therefore, free entry and exit of the firms imply that the market price will always be equal to the minimum average cost, that is

$$p = \min AC$$

From the above, it follows that the equilibrium price will be equal to the minimum average cost of the firms. In equilibrium, the quantity supplied will be determined by the market demand at that price so that they are equal. Graphically, this is shown in Figure 5.5 where the market will be in equilibrium at point E at which the demand curve DD intersects the $p_0 = \min AC$ line such that the market price is p_0 and the total quantity demanded and supplied is equal to q_0.

At $p_0 = \min AC$ each firm supplies same amount of output, say q_{0f}. Therefore, the equilibrium

Price Determination with Free Entry and Exit. *With free entry and exit in a perfectly competitive market, the equilibrium price is always equal to min AC and the equilibrium quantity is determined at the intersection of the market demand curve DD with the price line* p = *min* AC.

number of firms in the market is equal to the number of firms required to supply q_0 output at p_0, each in turn supplying q_{0f} amount at that price. If we denote the equilibrium number of firms by n_0, then

$$n_0 = \frac{q_0}{q_{0_f}}$$

To understand the equilibrium price and quantity determination more clearly, let us look at the following example.

EXAMPLE 5.2

Consider the example of a market for wheat such that the demand curve for wheat is given as follows

$$\begin{aligned} q^D &= 200 - p \quad \text{for } 0 \le p \le 200 \\ &= 0 \quad \text{for } p > 200 \end{aligned}$$

Assume that the market consists of identical farms. The supply curve of a single farm is given by

$$\begin{aligned} q_f^s &= 10 + p \quad \text{for } p \ge 20 \\ &= 0 \quad \text{for } 0 \le p < 20 \end{aligned}$$

The free entry and exit of farms would mean that the farms will never produce below minimum average cost because otherwise they will incur loss from production in which case they will exit the market.

As we know, with free entry and exit, the market will be in equilibrium at a price which equals the minimum average cost of the farms. Therefore, the equilibrium price is

$$p_0 = 20$$

At this price, market will supply that quantity which is equal to the market demand. Therefore, from the demand curve, we get the equilibrium quantity:

$$q_0 = 200 - 20 = 180$$

Also at $p_0 = 20$, each farm supplies

$$q_{0f} = 10 + 20 = 30$$

Therefore, the equilibrium number of farms is

$$n_0 = \frac{q_0}{q_{0_f}} = \frac{180}{30} = 6$$

Thus, with free entry and exit, the equilibrium price, quantity and number of farms are Rs 20, 180 kg and 6 respectively.

Shifts in Demand

Let us examine the impact of shift in demand on equilibrium price and quantity when the firms can freely enter and exit the market. From the previous section, we know that free entry and exit of the firms would imply that under all circumstances equilibrium price will be equal to the minimum average cost of the existing firms. Under this condition, even if the market demand curve shifts in either direction, at the new equilibrium, the market will supply the desired quantity at the same price.

In Figure 5.6, DD_0 is the market demand curve which tells us how much quantity will be demanded by the consumers at different prices and p_0 denotes the price which is equal to the minimum average cost of the firms. The initial equilibrium is at point E where the demand curve DD_0 cuts the $p_0 = \min AC$ line and the total quantity demanded and supplied is q_0. The equilibrium number of firms is n_0 in this situation.

Now suppose the demand curve shifts to the right for some reason. At p_0 there will be excess demand for the commodity. Some dissatisfied consumers will be willing to pay higher price for the commodity, so the price tends to rise. This gives rise to a possibility of earning supernormal profit which will attract new firms to the market. The entry of these new firms will eventually wipe out the supernormal profit and the price will again reach p_0. Now higher quantity will be supplied at the same price. From the panel (a), we can see that the new demand curve DD_1 intersects the $p_0 = \min AC$ line at point F such that the new equilibrium will be (p_0, q_1) where q_1 is greater than q_0. The new equilibrium number of firms n_1 is greater than n_0 because of the entry of new firms. Similarly, for a leftward shift of the demand curve to DD_2, there will be

Shifts in Demand. *Initially, the demand curve was DD_0, the equilibrium quantity and price were q_0 and p_0 respectively. With rightward shift of the demand curve to DD_1, as shown in panel (a), the equilibrium quantity increases and with leftward shift of the demand curve to DD_2, as shown in panel (b), the equilibrium quantity decreases. In both the cases, the equilibrium price remains unchanged at p_0.*

excess supply at the price p_0. In response to this excess supply, some firms, which will be unable to sell their desired quantity at p_0, will wish to lower their price. The price tends to decrease which will lead to the exit of some of the existing firms and the price will again reach p_0. Therefore, in the new equilibrium, less quantity will be supplied which will be equal to the reduced demand at that price. This is shown in panel (b) where due to the shift of demand curve from DD_0 to DD_2, quantity demanded and supplied will decrease to q_2 whereas the price will remain unchanged at p_0. Here, the equilibrium number of firms, n_2 is less than n_0 due to the exit of some existing firms. Thus, *due to a shift in demand rightwards (leftwards), the equilibrium quantity and number of firms will increase (decrease) whereas the equilibrium price will remain unchanged.*

Here, we should note that with free entry and exit, shift in demand has a larger effect on quantity than it does with the fixed number of firms. But unlike with fixed number of firms, here, we do not have any effect on equilibrium price at all.

5.2 Applications

In this section, we try to understand how the supply-demand analysis can be applied. In particular, we look at two examples of government intervention in the form of price control. Often, it becomes necessary for the government to regulate the prices of certain goods and services when their prices are either too high or too low in comparison to the desired levels. We will analyse these issues within the framework of perfect competition to look at what impact these regulations have on the market for these goods.

Price Catcher

5.2.1 Price Ceiling

It is not very uncommon to come across instances where government fixes a maximum allowable price for certain goods. The government-imposed upper limit on the price of a good or service is called **price ceiling**. Price ceiling is generally imposed on necessary items like wheat, rice, kerosene, sugar and it is fixed below the market-determined price since at the market-determined price some section of the population will not be able to afford these goods. Let us examine the effects of price ceiling on market equilibrium through the example of market for wheat.

Figure 5.7 shows the market supply curve SS and the market demand curve DD for wheat.

The equilibrium price and quantity of wheat are p^* and q^* respectively. When the government imposes price ceiling at *pc* which is lower than the equilibrium price level, the consumers demand q_c kilograms of wheat whereas the firms supply q_c' kilograms. Therefore, there will be an excess demand for wheat in the market at that price.

Effect of Price Ceiling in Wheat Market. The equilibrium price and quantity are p* *and* q* *respectively. Imposition of price ceiling at* pc *gives rise to excess demand in the wheat market.*

Hence, though the intention of the government was to help the consumers, it would end up creating shortage of wheat. Therefore, to ensure availability of wheat to everyone, ration coupons are issued to the consumers so that no individual can buy more than a certain amount of wheat and this stipulated amount of wheat is sold through ration shops which are also called fair price shops.

In general, price ceiling accompanied by rationing of the goods may have the following adverse consequences on the consumers: (a) Each consumer has to stand in long queues to buy the good from ration shops. (b) Since all consumers will not be satisfied by the quantity of the goods that they get from the fair price shop, some of them will be willing to pay higher price for it. This may result in the creation of black market.

5.2.2 Price Floor

For certain goods and services, fall in price below a particular level is not desirable and hence the government sets floors or minimum prices for these goods and services. The government-imposed lower limit on the price that may be charged for a particular good or service is called **price floor**. Most well-known examples of imposition of price floor are agricultural price support programmes and the minimum wage legislation.

Effect of Price Floor on the Market for Goods. *The market equilibrium is at (p*, q*). Imposition of price floor at* p_f *gives rise to an excess supply.*

Through an agricultural price support programme, the government imposes a lower limit on the purchase price for some of the agricultural goods and the floor is normally set at a level higher than the market-determined price for these goods. Similarly, through the minimum wage legislation, the government ensures that the wage rate of the labourers does not fall below a particular level and here again the minimum wage rate is set above the equilibrium wage rate.

Figure 5.8 shows the market supply and the market demand curve for a commodity on which price floor is imposed. The market equilibrium here would occur at price p^* and quantity q^*. But when the government imposes a floor higher than the equilibrium price at p_f, the market demand is q_f whereas the firms want to supply q'_f, thereby leading to an excess supply in the market equal to $q_f q'_f$.

In the case of agricultural support, to prevent price from falling because of excess supply, government needs to buy the surplus at the predetermined price.

Summary

- In a perfectly competitive market, equilibrium occurs where market demand equals market supply.
- The equilibrium price and quantity are determined at the intersection of the market demand and market supply curves when there is fixed number of firms.
- Each firm employs labour upto the point where the marginal revenue product of labour equals the wage rate.
- With supply curve remaining unchanged when demand curve shifts rightward (leftward), the equilibrium quantity increases (decreases) and equilibrium price increases (decreases) with fixed number of firms.

- With demand curve remaining unchanged when supply curve shifts rightward (leftward), the equilibrium quantity increases (decreases) and equilibrium price decreases (increases) with fixed number of firms.
- When both demand and supply curves shift in the same direction, the effect on equilibrium quantity can be unambiguously determined whereas the effect on equilibrium price depends on the magnitude of the shifts.
- When demand and supply curves shift in opposite directions, the effect on equilibrium price can be unambiguously determined whereas the effect on equilibrium quantity depends on the magnitude of the shifts.
- In a perfectly competitive market with identical firms if the firms can enter and exit the market freely, the equilibrium price is always equal to minimum average cost of the firms.
- With free entry and exit, the shift in demand has no impact on equilibrium price but changes the equilibrium quantity and number of firms in the same direction as the change in demand.
- In comparison to a market with fixed number of firms, the impact of a shift in demand curve on equilibrium quantity is more pronounced in a market with free entry and exit.
- Imposition of price ceiling below the equilibrium price leads to an excess demand.
- Imposition of price floor above the equilibrium price leads to an excess supply.

Key Concepts

Equilibrium
Excess demand
Excess supply
Marginal revenue product of labour
Value of marginal product of labour
Price ceiling, Price floor

Exercises

1. Explain market equilibrium.
2. When do we say there is excess demand for a commodity in the market?
3. When do we say there is excess supply for a commodity in the market?
4. What will happen if the price prevailing in the market is
   (i) above the equilibrium price?
   (ii) below the equilibrium price?
5. Explain how price is determined in a perfectly competitive market with fixed number of firms.
6. Suppose the price at which equilibrium is attained in exercise 5 is above the minimum average cost of the firms constituting the market. Now if we allow for free entry and exit of firms, how will the market price adjust to it?
7. At what level of price do the firms in a perfectly competitive market supply when free entry and exit is allowed in the market? How is equilibrium quantity determined in such a market?
8. How is the equilibrium number of firms determined in a market where entry and exit is permitted?
9. How are equilibrium price and quantity affected when income of the consumers
   (a) increase? (b) decrease?
10. Using supply and demand curves, show how an increase in the price of shoes affects the price of a pair of socks and the number of pairs of socks bought and sold.

11. How will a change in price of coffee affect the equilibrium price of tea? Explain the effect on equilibrium quantity also through a diagram.

12. How do the equilibrium price and quantity of a commodity change when price of input used in its production changes?

13. If the price of a substitute(Y) of good X increases, what impact does it have on the equilibrium price and quantity of good X?

14. Compare the effect of shift in demand curve on the equilibrium when the number of firms in the market is fixed with the situation when entry-exit is permitted.

15. Explain through a diagram the effect of a rightward shift of both the demand and supply curves on equilibrium price and quantity.

16. How are the equilibrium price and quantity affected when
    (a) both demand and supply curves shift in the same direction?
    (b) demand and supply curves shift in opposite directions?

17. In what respect do the supply and demand curves in the labour market differ from those in the goods market?

18. How is the optimal amount of labour determined in a perfectly competitive market?

19. How is the wage rate determined in a perfectly competitive labour market?

20. Can you think of any commodity on which price ceiling is imposed in India? What may be the consequence of price-ceiling?

21. A shift in demand curve has a larger effect on price and smaller effect on quantity when the number of firms is fixed compared to the situation when free entry and exit is permitted. Explain.

22. Suppose the demand and supply curve of commodity X in a perfectly competitive market are given by:

    $q^D = 700 - p$

    $q^S = 500 + 3p$ for $p \geq 15$

    $= 0$ for $0 \leq p < 15$

    Assume that the market consists of identical firms. Identify the reason behind the market supply of commodity X being zero at any price less than Rs 15. What will be the equilibrium price for this commodity? At equilibrium, what quantity of X will be produced?

23. Considering the same demand curve as in exercise 22, now let us allow for free entry and exit of the firms producing commodity X. Also assume the market consists of identical firms producing commodity X. Let the supply curve of a single firm be explained as

    $q^S_f = 8 + 3p$ for $p \geq 20$

    $= 0$ for $0 \leq p < 20$

    (a) What is the significance of $p = 20$?
    (b) At what price will the market for X be in equilibrium? State the reason for your answer.
    (c) Calculate the equilibrium quantity and number of firms.

24. Suppose the demand and supply curves of salt are given by:

    $q^D = 1,000 - p$ $\qquad$ $q^S = 700 + 2p$

    (a) Find the equilibrium price and quantity.
    (b) Now suppose that the price of an input used to produce salt has increased so that the new supply curve is

    $q^S = 400 + 2p$

    How does the equilibrium price and quantity change? Does the change conform to your expectation?
    (c) Suppose the government has imposed a tax of Rs 3 per unit of sale of salt. How does it affect the equilibrium price and quantity?

25. Suppose the market determined rent for apartments is too high for common people to afford. If the government comes forward to help those seeking apartments on rent by imposing control on rent, what impact will it have on the market for apartments?

Chapter 6

Non-competitive Markets

We recall that perfect competition was theorised as a market structure where both consumers and firms were price takers. The behaviour of the firm in such circumstances was described in the Chapter 4. We discussed that the perfect competition market structure is approximated by a market satisfying the following conditions:

(i) there exist a very large number of firms and consumers of the commodity, such that the output sold by each firm is negligibly small compared to the total output of all the firms combined, and similarly, the amount purchased by each consumer is extremely small in comparison to the quantity purchased by all consumers together;

(ii) firms are free to start producing the commodity or to stop production;

(iii) the output produced by each firm in the industry is indistinguishable from the others and the output of any other industry cannot substitute this output; and

(iv) consumers and firms have perfect knowledge of the output, inputs and their prices.

In this chapter, we shall discuss situations where one or more of these conditions are not satisfied. If assumptions (i) and (ii) are dropped, we get market structures called monopoly and oligopoly. If assumption (iii) is dropped, we obtain a market structure called monopolistic competition. Dropping of assumption (iv) is dealt with as 'economics of risk'. This chapter will examine the market structures of monopoly, monopolistic competition and oligopoly.

6.1 Simple Monopoly in the Commodity Market

'I' 'M' Perfect Competition

A market structure in which there is a single seller is called monopoly. The conditions hidden in this single line definition, however, need to be explicitly stated. A monopoly market structure requires that there is a single producer of a particular commodity; no other commodity works as a substitute for this commodity; and for this situation to persist over time, sufficient restrictions are required to be in place to prevent any other firm from entering the market and to start selling the commodity.

Competitive Behaviour versus Competitive Structure

A perfectly competitive market has been defined as one where an individual firm is unable to influence the price at which the product is sold in the market. Since price remains the same for any level of output of the individual firm, such a firm is able to sell any quantity that it wishes to sell at the given market price. It, therefore, does not need to compete with other firms to obtain a market for its produce.

This is clearly the opposite of the meaning of what is commonly understood by competition or competitive behaviour. We see that Coke and Pepsi compete with each other in a variety of ways to achieve a higher level of sales or a greater share of the market. Conversely, we do not find individual farmers competing among themselves to sell a larger amount of crop. This is because both Coke and Pepsi possess the power to influence the market price of soft drinks, while the individual farmer does not.

Thus, competitive behaviour and competitive market structure are, in general, inversely related; the more competitive the market structure, less competitive is the behaviour of the firms. On the other hand, the less competitive the market structure, the more competitive is the behaviour of firms towards each other. Pure monopoly is the most visible exception.

In order to examine the difference in the equilibrium resulting from a monopoly in the commodity market as compared to other market structures, we also need to assume that all other markets remain perfectly competitive. In particular, we need (i) that the market of the particular commodity is perfectly competitive from the demand side ie all the consumers are price takers; and (ii) that the markets of the inputs used in the production of this commodity are perfectly competitive both from the supply and demand side.

If all the above conditions are satisfied, then we define the situation as one of monopoly in a single commodity market.

6.1.1 Market Demand Curve is the Average Revenue Curve

The market demand curve in Figure 6.1 shows the quantities that consumers as a whole are willing to purchase at different prices. If the market price is at the higher level p_0, consumers are willing to purchase the lesser quantity q_0. On the other hand, if the market price is at the lower level p_1, consumers are willing to buy a higher quantity q_1. That is, price in the market affects the quantity demanded by the consumers. This is also expressed by saying that the quantity purchased by the consumers is a decreasing function of the price.

Market Demand Curve. *Shows the quantities that consumers as a whole are willing to purchase at different prices.*

For the monopoly firm, the above argument expresses itself from the reverse direction. The monopoly firm's decision to sell a larger quantity is possible only at a lower price. Conversely, if the monopoly firm brings a smaller quantity of the commodity into the market for sale it will be able to sell at a higher price. Thus, for the monopoly firm, the price depends on the quantity of the commodity sold. The same is also expressed by stating that price is a decreasing function of the quantity sold. Thus, for the monopoly firm, the market demand curve expresses the price that is available for different quantities supplied. This idea is reflected in the statement that the monopoly firm faces the market demand curve.

The above idea can be viewed from another angle. Since the firm is assumed to have perfect knowledge of the market demand curve, the monopoly firm can decide the price at which it wishes to sell its commodity, and therefore, determines the quantity to be sold. For instance, examining Figure 6.1 again, since the monopoly firm is aware of the shape of the curve DD, if it wishes to sell the commodity at the price p_0, it can do so by producing and selling quantity q_0, since at the price p_0, consumers are willing to purchase the quantity q_0. This idea is concretised in the slogan: 'Monopoly firm is a price maker'.

The contrast with the firm in a perfectly competitive market structure should be clear. In that case, the firm could bring into the market as much quantity of the commodity as it wished and could sell it at the same price. Since this does not happen for a monopoly firm, the amount of money received by the firm through the sale of the commodity has to be examined again.

We do this exercise through a schedule, a graph, and using a simple equation of a straight line demand curve. As an example, let the demand function be given by the equation

$$q = 20 - 2p,$$

where q is the quantity sold and p is the price in rupees.

The equation can be written in terms of p as

$$p = 10 - 0.5q$$

Substituting different values of q from 0 to 13 gives us the prices from 10 to 3.5. These are shown in the q and p columns of Table 6.1.

These numbers are depicted in a graph in Figure 6.2 with prices on the vertical axis and quantities on the horizontal axis. The prices that are available for different quantities of the commodity are shown by the solid straight line D.

The total revenue (TR) received by the firm from the sale of the commodity equals the product of the price and the quantity sold. In the case of the monopoly firm, the total revenue is not a straight line. Its shape depends on the shape of the demand curve. Mathematically, TR is represented as a function of the quantity sold. Hence, in our example

$$\begin{aligned} TR &= p \times q \\ &= (10 - 0.5q) \times q \\ &= 10q - 0.5q^2 \end{aligned}$$

Table 6.1: Prices and Revenue

q	p	TR	AR	MR
0	10	0	–	–
1	9.5	9.5	9.5	9.5
2	9	18	9	8.5
3	8.5	25.5	8.5	7.5
4	8	32	8	6.5
5	7.5	37.5	7.5	5.5
6	7	42	7	4.5
7	6.5	45.5	6.5	3.5
8	6	48	6	2.5
9	5.5	49.5	5.5	1.5
10	5	50	5	0.5
11	4.5	49.5	4.5	-0.5
12	4	48	4	-1.5
13	3.5	45.5	3.5	-2.5

This is not the equation of a straight line. It is a quadratic equation in which the squared term has a negative cofficient. Such an equation represents an inverted vertical parabola.

In Table 6.1, the TR column represents the product of the p and q columns. It can be noticed that as the quantity increases, TR increases to Rs 50 when output becomes 10 units, and after this level of output, total revenue starts declining. The same is visible in Figure 6.2.

Total, Average and Marginal Revenue Curves: *The total revenue, average revenue and the marginal revenue curves are depicted here.*

The revenue received by the firm per unit of commodity sold is called the Average Revenue (AR). Mathematically, $AR = TR/q$. In Table 6.1, the AR column provides values obtained by dividing TR values by q values. It can be seen that the AR values turn out to be the same as the values in the p column. This is only to be expected

$$AR = \frac{TR}{q}$$

Since $TR = p \times q$, substituting this into the AR equation

$$AR = \frac{(p \times q)}{q} = p$$

As seen earlier, the p values represent the market demand curve as shown in Figure 6.2. The AR curve will therefore lie exactly on the market demand curve. This is expressed by the statement that the market demand curve is the average revenue curve for the monopoly firm.

Graphically, the value of AR can be found from the TR curve for any level of quantity sold through a simple construction given in Figure 6.3. When quantity is of 6 units, draw a vertical line passing through the value 6 on the horizontal axis. This line will cut the TR curve at the point marked 'a' at a height equal to 42. Draw a straight line joining the origin O and point 'a'. The slope of this ray from the origin to a point on the TR provides the value of AR. The slope of this ray is equal to 7. Therefore, AR has the value 7. The same can be verified from Table 6.1.

Relation between Average Revenue and Total Revenue Curves. *The average revenue at any level of output is given by the slope of the line joining the origin and the point on the total revenue curve corresponding to the output level under consideration.*

6.1.2 Total, Average and Marginal Revenues

A more careful glance at Table 6.1 reveals that TR does not increase by the same amount for every unit increase in quantity. Sale of the first unit leads to a change in TR from Rs 0 when quantity is of 0 unit to Rs 9.50 when quantity is 1 unit, i.e., a rise of Rs 9.50. As the quantity increases further, the rise in TR is smaller. For example, for the 5^{th} unit of the commodity, the rise in TR is Rs 5.50 (Rs 37.50 for 5 units minus Rs 32 for 4 units). As mentioned earlier, after 10 units of output, TR starts declining. This implies that bringing more than 10 units for sale leads to a level of TR less than Rs 50. Thus, the rise in TR due to the 12th unit is: 48 – 49.50 = –1.5, ie a fall of Rs 1.50.

This change in TR due to the sale of an additional unit is termed Marginal Revenue (MR). In Table 6.1, this is depicted in the last column. The values in every row of the MR column after the first equal the TR value in that row minus the TR value in the previous row. In the last paragraph, it was shown that TR increases more slowly as quantity sold increases and falls after quantity reaches 10 units. The same can be viewed through the MR values which fall as *q* increases. After the quantity reaches 10 units, MR has negative values. In Figure 6.2, MR is depicted by the dotted line.

Graphically, the values of the MR curve are given by the slope of the TR curve. The slope of any smooth curve is defined as the slope of the tangent to the curve at that point. This is depicted in Figure 6.4. At point 'a' on the TR curve, the value of MR is given by the slope of the line L_1, and at point 'b' by the line L_2. It can be seen that both lines have positive slope, but the line L_2 is flatter than line L_1, ie its slope is lesser. The value of MR for the same level of quantity is also lesser. When 10 units of the commodity are sold, the tangent to the TR is horizontal, ie its slope is zero. The value of the MR for the same quantity is zero. At point '*d*' on the TR curve, where the tangent is negatively sloped, the MR takes a negative value.

Relation between Marginal Revenue and Total Revenue Curves*. The marginal revenue at any level of output is given by the slope of the total revenue curve at that level of output.*

We can now conclude that when total revenue is rising, marginal revenue is positive, and when total revenue shows a fall, marginal revenue is negative.

Another relation can be seen between the AR and the MR curves. Figure 6.2 shows that the MR curve lies below the AR curve. The same can be seen in Table 6.1 where the values of MR at any level of output are lower than the corresponding values of AR. We can conclude that if the AR curve (ie the demand curve) is falling steeply, the MR curve is far below the AR curve. On the other hand, if the AR curve is less steep, the vertical distance between the AR and MR curves is smaller. Figure 6.5(a) shows a flatter AR curve while Figure 6.5(b) shows a steeper AR curve. For the same units of the commodity, the difference between AR and MR in panel (a) is smaller than the difference in panel (b).

Relation between Average Revenue and Marginal Revenue curves. *If the AR curve is steeper, then the MR curve is far below the AR curve.*

6.1.3 Marginal Revenue and Price Elasticity of Demand

The MR values also have a relation with the price elasticity of demand. The detailed relation is not derived here. It is sufficient to notice only one aspect– price elasticity of demand is more than 1 when the MR has a positive value, and becomes less than the unity when MR has a negative value. This can be seen in Table 6.2, which uses the same data presented in Table 6.1. As the quantity of the commodity increases, MR value becomes smaller and the value of the price elasticity of demand also becomes smaller. Recall that the demand curve is called elastic at a point where price elasticity is greater than unity, inelastic at a point where the price elasticity is less than unity and unitary elastic when price elasticity is equal to 1. Table 6.2 shows that when quantity is less than 10 units, MR is positive and the demand curve is elastic and when quantity is of more than 10 units, the demand curve is inelastic. At the quantity level of 10 units, the demand curve is unitary elastic.

6.1.4 Short Run Equilibrium of the Monopoly Firm

As in the case of perfect competition, we continue to regard the monopoly firm as one which maximises profit. In this section, we analyse this profit maximising behaviour to determine the quantity produced by a monopoly firm and price at which it is sold. We shall assume that a firm does not maintain stocks of the quantity produced and that the entire quantity produced is put up for sale.

The Simple Case of Zero Cost

Suppose there exists a village situated sufficiently far away from other villages. In this village, there is exactly one well from which water is available. All residents are completely dependent for their water

Table 6.2: MR and Price Elasticity

q	p	MR	Elasticity
0	10	-	-
1	9.5	9.5	19
2	9	8.5	9
3	8.5	7.5	5.67
4	8	6.5	4
5	7.5	5.5	3
6	7	4.5	2.33
7	6.5	3.5	1.86
8	6	2.5	1.5
9	5.5	1.5	1.22
10	5	0.5	1
11	4.5	-0.5	0.82
12	4	-1.5	0.67
13	3.5	-2.5	0.54

requirements on this well. The well is owned by one person who is able to prevent others from drawing water from it except through purchase of water. The person who purchases the water has to draw the water out of the well. The well owner is thus a monopolist firm which bears zero cost in producing the good. We shall analyse this simple case of a monopolist bearing zero costs to determine the amount of water sold and the price at which it is sold.

Figure 6.6 depicts the same TR, AR and MR curves, as in Figure 6.2. The profit received by the firm equals the revenue received by the firm minus the cost incurred, that is, Profit = TR – TC. Since in this case TC is zero, profit is maximum when TR is maximum. This, as we have seen earlier, occurs when output is of 10 units. This is also the level when MR equals zero. The amount of profit is given by the length of the vertical line segment from ‘a’ to the horizontal axis.

Short Run Equilibrium of the Monopolist with Zero Costs*. The monopolist’s profit is maximised at that level of output for which the total revenue is the maximum.*

The price at which this output will be sold is the price that the consumers as a whole are willing to pay. This is given by the market demand curve D. At output level of 10 units, the price is Rs 5. Since the market demand curve is the AR curve for the monopolist firm, Rs 5 is the average revenue received by the firm. The total revenue is given by the product of AR and the quantity sold, ie Rs 5 × 10 units = Rs 50. This is depicted by the area of the shaded rectangle.

Comparison with Perfect Competition

We compare the above outcome with what it would be under perfectly competitive market structure. Let us assume that there is an infinite number of such wells. If one well owner charges Rs 5 per unit of water to get a profit of Rs 50, another well owner realising there are still consumers willing to buy water at a lower rate, will fix the price lower than Rs 5, say at Rs 4. Consumers will decide to purchase from the second water seller and demand a larger quantity of 12 units creating a total revenue of Rs 48. In similar fashion, another water seller, in order to obtain the revenue, would offer a still lower price, say Rs 3, and selling 14 units earning a revenue of Rs 42. Since there is an infinite number of firms, price would continue to move down infinitely till it reaches zero. At this output, 20 units of water would be sold and profit would become zero.

Through this comparison, we can see that a perfectly competitive equilibrium results in a larger quantity being sold at a lower price. We can now proceed to the general case involving positive costs of production.

Introducing Positive Costs

Analysing using Total curves

In Chapter 3, we have discussed the concept of cost and the shape of the total cost curve having been depicted as shown by TC in Figure 6.7. The TR curve is also drawn in the same diagram. The profit received by the firm equals the total revenue minus the total cost. In the figure, we can see that if quantity q_1 is produced, the total revenue is TR_1 and total cost is TC_1. The difference, $TR_1 - TC_1$, is the profit received. The same is depicted by the length of the line segment AB, i.e., the vertical distance between the TR and TC curves at q_1 level of output. It should be clear that this vertical distance changes for diferent levels of output. When output level is less than q_2, the TC curve lies above the TR curve, i.e., TC is greater than TR, and therefore profit is negative and the firm makes losses.

The same situation exists for output levels greater than q_3. Hence, the firm can make positive profits only at output levels between q_2 and q_3, where TR curve lies above the TC curve. The monopoly firm will choose that level of output which maximises its profit. This would be the level of output for which the vertical distance between the TR and TC is maximum and TR is above the TC, i.e., TR – TC is maximum. This occurs at the level of output q_0. If the difference TR – TC is calculated and drawn as a graph, it will look as in the curve marked 'Profit' in Figure 6.7. It should be noticed that the Profit curve has its maximum value at the level of output q_0.

Equilibrium of the Monopolist in terms of the Total Curves*. The monopolist's profit is maximised at the level of output for which the vertical distance between the* TR *and TC is a maximum and TR is above the TC.*

The price at which this output is sold is the price consumers are willing to pay for this q_0 quantity of the commodity. So the monopoly firm will charge the price corresponding to the quantity level q_0 on the demand curve.

Using Average and Marginal curves

The analysis shown above can also be conducted using Average and Marginal Revenue and Average and Marginal Cost. Though a bit more complex, this method is able to exhibit the process in greater light.

In Figure 6.8, the Average Cost (AC), Average Variable Cost (AVC) and Marginal Cost (MC) curves are drawn along with the Demand (Average Revenue) Curve and Marginal Revenue crve.

It may be seen that at quantity level below q_0, the level of MR is higher than the level of MC. This means that the increase in total revenue from selling an extra unit of the commodity is greater than the increase in total cost for producing the additional unit. This implies that an additional unit of output would create additional profits since Change in profit = Change in TR – Change in TC.

Equilibrium of the Monopolist in terms of the Average and the Marginal Curve*. The monopolist's profit is maximised at that level of output for which the MR = MC and the MC is rising.*

Therefore, if the firm is producing a level of output less than q_0, it would desire to increase its output since that would add to its profits. As long as the MR curve lies above the MC curve, the reasoning provided above would apply and thus the firm would increase its output. This process comes to a halt when the firm reaches an output level of q_0 since at this level MR equals MC and increasing output provides no increase in profits.

On the other hand, if the firm was producing a level of output which is greater than q_0, MC is greater than MR. This means that the lowering of total cost by reducing one unit of output is greater than the loss in total revenue due to this reduction. It is therefore advisable for the firm to reduce output. This argument would hold good as long as the MC curve lies above the MR curve, and the firm would keep reducing its output. Once output level reaches q_0, the values of MC and MR become equal and the firm stops reducing its output.

Since the firm inevitably reaches the output level q_0, this level is called the equilibrium level of output. Since this equilibrium level of output corresponds to the point where the MR equals MC, this equality is called the equilibrium condition for the output produced by a monopoly firm.

At this equilibrium level of output q_0, the average cost is given by the point '*d*' where the vertical line from q_0 cuts the AC curve. The average cost is thus given by the height dq_0. Since total cost equals the product of AC and the quantity produced being q_0, the same is given by the area of the rectangle Oq_0dc.

As shown earlier, once the quantity of output produced is determined, the price at which it is sold is given by the amount that the consumers are willing to pay, as expressed through the market demand curve. Thus, the price is given by the point '*a*' where the vertical line through q_0 meets the market demand curve D. This provides price given by the height aq_0. Since the price received by the firm is the revenue per unit of output, it is the Average Revenue for the firm. The total revenue being the product of AR and the level of output q_0, can be shown as the area of the rectangle Oq_0ab.

It can be seen from the diagram that the area of the rectangle Oq_0ab is larger than the area of the rectangle Oq_0dc, i.e., TR is greater than TC. The difference is the area of the rectangle *cdab*. Thus, Profit = TR – TC which can be represented by this area *cdab*.

Comparison with Perfect Competition again

We compare the monopoly firm's equilibrium quantity and price with that of the perfectly competitive firm. Recall that the perfectly competitive firm was a price taker. Given the market price, the firm in a perfectly competitive market structure believed that it could not alter the price by producing more of the output or less of it.

Suppose that the firm, whose equilibrium we were considering above, believed that it was a perfectly competitive firm. Then, given its level of output at q_0, price of the commodity at $aq_0 = Ob$, it would expect the price to remain fixed at *Ob*, and therefore, every additional unit of output could be sold at that price. Since the cost of producing an additional unit, given by the MC, stands at eq_0 which is less than aq_0, the firm would expect a gain in profit by increasing the output. This would continue as long as the price remained higher than the MC. At the point '*f*' in Figure 6.8, where the MC curve cuts the demand curve, price received by the firm becomes equal to the MC. Hence, it would no longer be considered beneficial by this perfectly competitive firm to increase output. It is for this reason that Price = Marginal Cost that is considered the equilibrium condition for the perfectly competitive firm.

The diagram shows that at this level of output, the quantity produced q_c is greater than q_0. Also, the price paid by the consumers is lower at p_c. From this we conclude that the perfectly competitive market provides a production and sale of a larger quantity of the commodity compared to a monopoly firm. Further the price of the commodity under perfect competition is lower compared to monopoly. The profit earned by the perfectly competitive firm is also smaller.

In the Long Run

We saw in Chapter 5 that with free entry and exit, perfectly competitive firms obtain zero profits. That was due to the fact that if profits earned by firms were positive, more firms would enter the market and the increase in output would bring the price down, thereby decreasing the earnings of the existing firms. Similarly, if firms were facing losses, some firms would close down and the reduction in output would raise prices and increase the earnings of the remaining firms. The same is not the case with monopoly firms. Since other firms are prevented from entering the market, the profits earned by monopoly firms do not go away in the long run.

Some Critical Views

The results presented above portray an extremely negative picture of the impact of monopoly in a commodity market: the monopoly firms solely benefit themselves, at the cost of consumers. The monopoly firm receives a higher profit and a positive profit even in the long run. On the other hand, consumers get a lesser quantity of the output and have to pay more for each unit consumed.

However, varying views have been expressed by economists concerning the question of monopoly. First, it can be argued that monopoly of the kind described above cannot exist in the real world. This is because all commodities are, in a sense, substitutes for each other. This in turn is because of the fact that all the firms producing commodities, in the final analysis, compete to obtain the income in the hands of consumers.

Another argument is that even a firm in a pure monopoly situation is never without competition. This is because the economy is never stationary. New commodities using new technologies are always coming up, which are close substitutes for the commodity produced by the monopoly firm. Hence, the monopoly firm always has competition in the long run. Even in the short run, the threat of competition is always present and the monopoly firm is unable to behave in the manner we have described above.

Still another view argues that the existence of monopolies may be beneficial to society. Since monopoly firms earn large profits, they possess sufficient funds to take up research and development work, something which the small perfectly competitive firm is unable to do. By doing such research, monopoly firms are able to produce better quality goods. Also, because of the more modern technologies which such firms are able to use, their marginal cost may be so much lower that the equilibrium level of output, where MC = MR, may be even larger than that in the case of perfect competition.

6.2 Other Non-perfectly Competitive Markets

6.2.1 Monopolistic Competition

We now consider a market structure where the number of firms is large, there is free entry and exit of firms, but the goods produced by them are not homogeneous. Such a market structure is called monopolistic competition.

This kind of a structure is more commonly visible. There is a very large number of biscuit producing firms, for example. But many of the biscuits being produced are associated with some brand name and are distinguishable from one another by these brand names and packaging and are slightly different in taste. The consumer develops a taste for a particular brand of biscuit over time, or becomes loyal to a particular brand for some reason, and is, therefore, not immediately willing to substitute it for another biscuit. However, if the price difference becomes large, the consumer would be willing to choose a biscuit of another brand. The price difference required for the consumer to change the brand consumed may vary. Therefore, if price of a particular brand is lowered, some consumers will shift to consuming that brand. Further, lowering of the price will lead to more consumers shifting to the brand with the lower price.

Hence, the demand curve faced by the firm is not horizontal (perfectly elastic) as is the case with perfect competition. The demand curve faced by the firm is not the market demand curve, as in the case with monopoly. In the case of monopolistic competition, the firm expects small increases in demand if it lowers the price. Hence, the marginal revenue is slightly less than the average revenue. The firm increases its output whenever the marginal revenue is greater than the marginal cost. But since the marginal revenue is lower than the price, the marginal revenue becomes equal to the marginal cost at a lower level of output compared to perfect competition.

For this reason, the monopolistic competitive firm produces lower output as compared to the perfectly competitive firm. Given lower output, since consumers as a whole are willing to pay more per unit, the price of the commodity becomes higher than the price under perfect competition.

The situation described above is one that exists in the short run. But the market structure of monopolistic competition allows for new firms to enter the market. If the firms in the industry are receiving positive amounts of profit in the short run, this will attract new firms to start producing the commodity (entry into the market). As output of the commodity expands, prices in the market will tend to fall till profits become zero and there is now no attraction for new firms to enter. Conversely, if firms in the industry are facing losses in the short run, some firms would stop producing (exit from the market) the commodity and the fall in total quantity produced would lead to a higher price. Entry or exit would halt once profits become zero and this would serve as the long run equilibrium.

Since the demand of the output of each firm continues to increase with a fall in the price of its brand, the long run equilibrium continues to be associated with a lower level of total output and a higher price as compared to perfect competition.

6.2.2 How do Firms behave in Oligopoly?

If the market of a particular commodity consists of more than one seller but the number of sellers is few, the market structure is termed oligopoly. The special case of oligopoly where there are exactly two sellers is termed duopoly. In analysing this market structure, we assume that the product sold by the two firms is homogeneous and there is no substitute for the product, produced by any other firm.

Given that there are a few firms, the output decisions of any one firm would necessarily affect the market price and therefore the amount sold by the other firms as also their total revenues. It is, therefore, only to be expected that other firms would react to protect their profits. This reaction would be through taking fresh decisions about the quantity and price of their own output. There are various ways in which this can be theorised. We briefly explain two of them.

Firstly duopoly firms may collude together and decide not to compete with each other and maximise total profits of the two firms together. In such a case the two firms would behave like a single monopoly firm that has two different factories producing the commodity.

Secondly, take the case of a duopoly where each of the two firms decides how much quantity to produce by maximising its own profit assuming that the other firm would not change the quantity that it is supplying.

We can examine the impact using a simple example where both the duopolist firms have zero cost. A similar situation in the case of monopoly was earlier considered in The Simple Case of Zero Cost in section 6.1.4. Recall that in that case we were able to show that given a straight line demand curve, the maximum quantity demanded by the consumers was 20 units at zero price, and this would have been the equilibrium in case of a perfectly competitive market structure. Given a monopoly structure, the quantity supplied was 10 units at a price of Rs 5. It can be shown that whenever the demand curve is a straight line and total cost is zero, the monopolist finds it most profitable to supply half of the maximum demand of the good. Let us use the same example to examine the outcome in case there were two duopoly firms, A and B behaving in the manner described above.

Assume that Firm B supplies zero units of the good, then Firm A realizing that maximum demand is 20 units, would decide to supply half of it, i.e. 10 units. Given that Firm A is supplying 10 units, Firm B would realize that out of the maximum demand of 20 units, a demand of 10 units (i.e. 20 minus 10) still exists and hence would supply half of it, i.e. 5 units. Since firm B has changed its supply from zero to 5 units, Firm A would realize that the total demand is 15 units (i.e., 20 minus 5) and supply half to it, i.e., 7.5 units. In the fashion, the two firms would keep making moves. It can be shown that these lead to an equilibrium. Let us examine these steps:

Step	Firm	Quantity Supplied
1	B	0
2	A	$\frac{1}{2} \times 20 = \frac{20}{2}$
3	B	$\frac{1}{2}(20 - \frac{1}{2} \times 20) = \frac{20}{2} - \frac{20}{4}$
4	A	$\frac{1}{2}(20 - \frac{1}{2}(20 - \frac{1}{2} \times 20)) = \frac{20}{2} - \frac{20}{4} + \frac{20}{8}$
5	B	$\frac{1}{2}(20 - \frac{1}{2}(20 - \frac{1}{2}(20 - \frac{1}{2} \times 20))) = \frac{20}{2} - \frac{20}{4} + \frac{20}{8} - \frac{20}{16}$

And so on.

Therefore both the firms would finally supply an output equal to

$$\frac{20}{2} - \frac{20}{4} + \frac{20}{8} - \frac{20}{16} + \frac{20}{32} - \frac{20}{64} + \frac{20}{128} \dots = \frac{20}{3}$$

The total quantity supplied in the market equals the sum of the quantity supplied by the two firms is

$$\frac{20}{3} + \frac{20}{3} = 2 \times \frac{20}{3}$$

which is greater than the quantity supplied under a monopoly market structure and less than the quantity supplied under a perfectly competitive structure. Since price depends on the quantity supplied by the formula $p = 10 - 0.5q$, for $q = \frac{40}{3}$, price is $10 - \frac{20}{3}$ = Rs 3.33. This is lower than the price under monopoly and higher than under perfect competition.

Even in the case where there are positive costs, the mathematics only becomes more complex, but the results are similar. That through a very large number of moves and countermoves, the two firm reach an equilibrium quantity of total output. The quantity produced by both firms together is more than what a pure monopoly would have produced and lesser than that produced if the market structure was perfectly competitive. The equilibrium market price is naturally lower than in the case of pure monopoly and higher than under perfect competition.

Thirdly, some economists argue that oligopoly market structure makes the market price of the commodity rigid, i.e. the market price does not move freely in response to changes in demand. The reason for this lies in the way in which oligopoly firms react to a change in price initiated by any firm. If one firm feels that a price increase would generate higher profits, and therefore increases the price at which it sells its output, other firms do not follow. The price increase would therefore lead to a huge fall in the quantity sold by the firm leading to a fall in its revenue and profit. It is therefore not rational for any firm to increase the price. On the other hand, a firm may estimate that it could earn a larger revenue and profit by selling a larger quantity of output and therefore lowers the price at which it sells the commodity. Other firms would perceive this action as a threat and therefore follow the first firm and lower their price as well. The increase in the total quantity sold due to the lowering of price is therefore shared by all the firms, and the firm that had initially lowered the price is able to achieve only a small increase in the quantity it sells. A relatively large lowering of price by the first firm leads to a relatively small increase in the quantity sold. Thus, this firm experiences an inelastic demand curve and its decision to lower price leads to a lowering of its revenue and profit. Any firm therefore finds it irrational to change the prevailing price, leading to prices that are more rigid compared to perfect competition.

Summary

- The market structure called monopoly exists where there is exactly one seller in any market.
- A commodity market has a monopoly structure, if there is one seller of the commodity, the commodity has no substitute, and entry into the industry by another firm is prevented.
- The market price of the commodity depends on the amount supplied by the monopoly firm. The market demand curve is the average revenue curve for the monopoly firm.
- The shape of the total revenue curve depends on the shape of the average revenue curve. In the case of a negatively sloping straight line demand curve, the total revenue curve is an inverted vertical parabola.
- Average revenue for any quantity level can be measured by the slope of the line from the origin to the relevant point on the total revenue curve.
- Marginal revenue for any quantity level can be measured by the slope of the tangent at the relevant point on the total revenue curve.

- The average revenue is a declining curve if and only if the value of the marginal revenue is lesser than the average revenue.
- The steeper is the negatively sloped demand curve, the further below is the marginal revenue curve.
- The demand curve is elastic when marginal revenue has a positive value, and inelastic when the marginal revenue has a negative value.
- If the monopoly firm has zero costs or only has fixed cost, the quantity supplied in equilibrium is given by the point where marginal revenue is zero. In contrast, perfect competition would supply an equilibrium quantity given by the point where average revenue is zero.
- Equilibrium of a monopoly firm is defined as the point where MR = MC and MC is rising. This point provides the equilibrium quantity produced. The equilibrium price is provided by the demand curve given the equilibrium quantity.
- Positive short run profit to a monopoly firm continue in the long run.
- Monopolistic competition in a commodity market arises due to the commodity being non-homogenous.
- In monopolistic competition, the short run equilibrium results in quantity produced being lesser and prices being higher compared to perfect competition. This situation persists in the long run, but long run profits are zero.
- Oligopoly in a commodity market occurs when there are a small number of firms producing a homogenous commodity.

Key Concepts

Monopoly
Monopolistic Competition
Oligopoly.

Exercises

1. What would be the shape of the demand curve so that the total revenue curve is
(a) a positively sloped straight line passing through the origin?
(b) a horizontal line?

2. From the schedule provided below calculate the total revenue, demand curve and the price elasticity of demand:

Quantity	1	2	3	4	5	6	7	8	9
Marginal Revenue	10	6	2	2	2	0	0	0	-5

3. What is the value of the MR when the demand curve is elastic?

4. A monopoly firm has a total fixed cost of Rs 100 and has the following demand schedule:

Quantity	1	2	3	4	5	6	7	8	9	10
Price	100	90	80	70	60	50	40	30	20	10

Find the short run equilibrium quantity, price and total profit. What would be the equilibrium in the long run? In case the total cost was Rs 1000, describe the equilibrium in the short run and in the long run.

5. If the monopolist firm of Exercise 3, was a public sector firm. The government set a rule for its manager to accept the goverment fixed price as given (i.e. to be a price taker and therefore behave as a firm in a perfectly competitive market), and the government decide to set the price so that demand and supply in the market are equal. What would be the equilibrium price, quantity and profit in this case?
6. Comment on the shape of the MR curve in case the TR curve is a (i) positively sloped straight line, (ii) horizontal straight line.
7. The market demand curve for a commodity and the total cost for a monopoly firm producing the commodity is given by the schedules below. Use the information to calculate the following:

Quantity	0	1	2	3	4	5	6	7	8
Price	52	44	37	31	26	22	19	16	13

Quantity	0	1	2	3	4	5	6	7	8
Total Cost	10	60	90	100	102	105	109	115	125

   (a) The MR and MC schedules
   (b) The quantites for which the MR and MC are equal
   (c) The equilibrium quantity of output and the equilibrium price of the commodity
   (d) The total revenue, total cost and total profit in equilibrium.
8. Will the monopolist firm continue to produce in the short run if a loss is incurred at the best short run level of output?
9. Explain why the demand curve facing a firm under monopolistic competition is negatively sloped.
10. What is the reason for the long run equilibrium of a firm in monopolistic competition to be associated with zero profit?
11. List the three different ways in which oligopoly firms may behave.
12. If duopoly behaviour is one that is described by Cournot, the market demand curve is given by the equation $q = 200 - 4p$, and both the firms have zero costs, find the quantity supplied by each firm in equilibrium and the equilibrium market price.
13. What is meant by prices being rigid? How can oligopoly behaviour lead to such an outcome?