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Faculty of Economics, Commercial Sciences and Management

Department of Commercial Sciences

Microeconomics 01

Lectures and Exercises

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Microeconomics 01 Lectures and Exercises

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Introduction

Microeconomics is a fundamental branch of economic science that examines the decision-making processes of individual agents, such as consumers, firms, and resource owners, and how their interactions shape the allocation of resources within an economy. It seeks to understand how prices are determined in various markets, how these prices influence the behavior of economic agents, and how resources can be distributed efficiently under different market structures. By analyzing supply and demand, consumer behavior, production choices, and market equilibrium, microeconomics provides essential tools for understanding real-world economic issues on a smaller, more detailed scale.

This handout is designed to offer a concise yet comprehensive overview of key microeconomic concepts. It begins with the basic principles of microeconomic theory, including scarcity and economic problem. It then explores the functioning of markets through the study of supply, demand, and elasticity, consumer and producer behavior. Further sections cover production and cost analysis. The handout aims to support students in building a solid foundation in microeconomic theory and applying it to practical economic problems.

It aims to provide the conceptual foundation of Microeconomic theory in a manner to enable the students to understand the Microeconomics I so as to analyse real life situations. As well as it provides students with a comprehensive, simplified, and rigorous overview of microeconomic analysis, informed by multiple applications. It is designed as a summary of various issues related to the Microeconomics course as taught in the first year of the LMD degree program.

Chapter 01
Introduction to Microeconomics

Chapter 01: Introduction to Microeconomics

Outline of this Chapter :

- ✓ Introduction to economics
- ✓ Basic definitions of economics
- ✓ Basic problems in an economy
- ✓ Meaning of microeconomics and macroeconomics
- ✓ Questions for Review with answer.

After studying this chapter, you will be able to understand :

- ✓ The fundamental principles of economics
- ✓ Meaning of economy, economics, microeconomics, macroeconomics
- ✓ Differences between microeconomics and macroeconomics

1.The basic definition of economics:

The word ‘Economics’ was derived from the Greek words ‘Oikos’ (a house) and ‘Nemein’ (to manage), which meant managing a household, using the limited money or resources a household has.

- Economics as a subject came into being with the publication of very popular book in 1776, “An Enquiry into the Nature and Causes of Wealth of Nations”, written by Prof. Adam Smith. At that time it was called Political economy, which remained operational at least up to the middle part of the 19th century. It is since then that the economists developed tools and principles using inductive and deductive reasoning. In fact, the ‘Wealth of Nations’ is a landmark in the history of economic thought that separated economics from other social sciences.
- “Economics is a study of mankind in the ordinary business of life and examines that part of individual and social action which is connected with material requisites of wellbeing.” (Marshall)
- “Economics is a science which studies human behavior as a relationship between ends and scarce resources which have alternative uses.” (L. Robbins).

Economics is, fundamentally, the study of how people allocate their limited resources to their alternative uses to produce and consume goods and services to satisfy their endless wants or to maximize their gains.

Why do individuals have to make choices? The ultimate reason is that resources are scarce. A **resource** is anything that can be used to produce something else. Lists of the economy’s resources usually begin with land, labor (the time of workers), capital (machinery, buildings, and other man-made productive assets), and human capital (the educational achievements and skills of workers). A **resource** is scarce when there is **not enough** of the resource available to satisfy all the various ways a society wants to use it.

There are many scarce resources. These include natural resources—resources that come from the physical environment, such as minerals, lumber, and petroleum. There is also a limited quantity of human resources—labor, skill, and intelligence. And in a growing world economy with a rapidly increasing human population, even clean air and water have become scarce resources.

2. Resources

Factors of production are resources used to produce goods and services. Economists usually use the term **factor of production** to refer to a resource that is not used up in production.

Resources are valuable items that can be used to create the good and services that we need. Productive resources are factors that firms use to produce output. Economists divided productive resources into four major categories: land, labor, capital and entrepreneur. These resources are also referred to as factors of production or productive inputs. Such factors of production should be combined to be able to produce any produce.

- **Natural resources (land):** : Any natural resource provided by nature.(Oil, coal, natural gas, metals, stone)
- **Labor (Human resources):**human effort, including both **mental** (doctors lawyers) and **physical** (workers).
- **Capital:** can be **physical** that is the stock of factories machines and equipment that is used to produce goods and services.
- Or **human capital** that is the knowledge and skills acquired by a worker through education and experience used to produce goods and services.
- **Entrepreneurship:** the effort used to coordinate the factors of production to produce and sell products.

3.Branches of economics

Traditionally, the subject matter of economics has been studied under two broad branches: **Microeconomics** and **Macroeconomics**:

3.1.Microeconomics studies the economic phenomenon at micro level ,i.e, at the individual level .Microeconomics studies how consumers and producers make their choices , how their decisions and choices affect the demand and supply conditions, how consumers and producers interact to settle the prices of goods and services in the market, how prices are determined in different market setting, and how total output is distributed among those who contribute to production.

3.2.Macroeconomics studies the working and performance of the economy as a whole .It analyses behavior of the national aggregate including national income, aggregate consumption, saving , investment, total employment, the general price level and country's balance of payments. Macroeconomics analyses how these aggregate variables interact with one another, how they are determined and how they determine the aggregate national output.

Thus, it can be said that Microeconomics studies the behavior of individual economic units, while macroeconomics studies the whole economy.

3.3.Differences between Microeconomics and Macroeconomics:

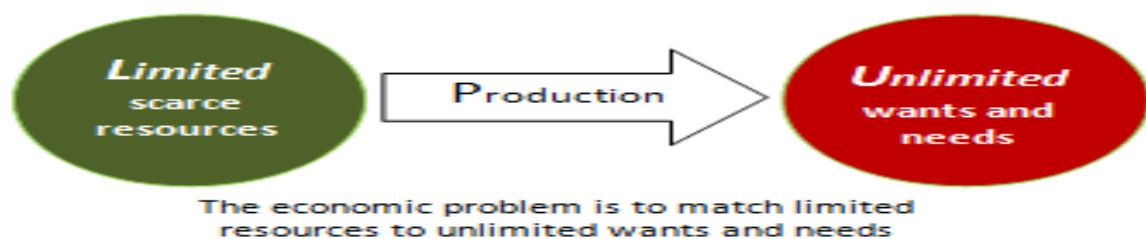
- **Microeconomics** deals with the analysis of small individual units of the economy such as individual consumers, individual firms and small aggregates or groups of individual units such as various industries and markets.
- **Macroeconomics** deals with the analysis of the economy as a whole and its large aggregates such as total national output and income, total employment, total consumption, aggregate investment, etc.

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DIFFERENCES BASED ON	MICROECONOMICS	MACROECONOMICS
1. SUBJECT-MATTER	Small segments such as individual household, individual firm, individual price, etc.	Large aggregates such as aggregate demand, aggregate supply, national income, general price level, etc.
2. USE OF TECHNIQUES:	Partial equilibrium analysis	General equilibrium analysis
3. ASSUMPTIONS:	Full employment in the economy	Underemployment of resources
4. CORE DIFFERENCES:	Price is the main determinant of microeconomics	Income is the main determinant of macroeconomics.

4. Economic problem

- The economic problem is the fundamental challenge facing all societies, which is how to satisfy **unlimited needs and wants** with **limited resources**



4.1. Scarcity and Choice

Economics is the social science concerned with scarcity. This means that economics is the subject that studies how society use or employ its scarce resources to produce goods and services in order to satisfy human wants. It has been stated that it is impossible to satisfy all of human wants, for all practical purpose in today's world, human wants are insatiable.

The fact that resources available to use are limited compared to our needs makes economizing inevitable. We have to make the most of what we have by constantly counting cost, weighing up alternative and going without some things so as to be able to operate within the limit of our resources.

- **Relative scarcity:** It means that resources are **not enough** to satisfy all human wants.
- All societies (poor and rich) face the problem of scarcity but at different degrees.
- **Choice:** As resources are scarce, all societies face the problem of deciding what to produce and the quantity to be produced.

4.2. Solving the economic problem

There are some basic economic problems, which are faced in all types of economies, whether they are capitalist, socialist or communist. But the dimension of these problems and the difficulty of solving them differ for various types of economies. These problems centers on three basic questions: what commodity are to be produced and in what quantities, how to produce these commodities, and for whom to produce. We shall briefly consider each of these questions.

➤ **What to produce?**

The problem what to produce is the problem of choices between commodities. This problem arises mainly for two reasons: scarcity of resources does not permit production of all the goods and services that people would like to consume, and all the goods and services are not equally valued in terms of their utility by the consumers. Some commodities yield higher utility than the others.

The answer to the question of what to produce depends on the allocation of the economy's scarce resources among alternative uses. For example, producing a large output of one good requires that substantial amount of resources be allocated to its production. Thus what a society produces is governed by the available of resources or factors of production.

➤ **How to produce?**

This question is purely technological. This question arises because there are more than one technically possible ways in which good are produced. It concerns the way or form in which the factors of production must be combined to yield maximum output or least cost of production.

➤ **For whom to produce?**

Goods and services are distributed in a variety of ways. 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.

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Review Questions

Activity 01 :choose the correct answer

- **Economics is best described as the study of:**
 - a. how markets find resources
 - b. how businesses maximize profits
 - c. how goods and services are produced
 - d. is the social science that studies how people use scarce resources to satisfy unlimited needs and wants.
 - e. how banking works
- **microeconomics deals with:**
 - a. The working of the entire economy or large sectors of it
 - b. Economic growth
 - c. Individual decision makers in the economy
 - d. Gross domestic product
- **Economics looks at:**
 - a. How governments satisfy business demand
 - b. How businesses use unlimited resources to satisfy unlimited consumer wants
 - c. How people use unlimited resources to satisfy limited wants
 - d. How people use scarce resources to satisfy unlimited wants
 - e. How people use unlimited resources to satisfy their unlimited wants
- **scarcity requires that people must:**
 - A cooperate b Compete c Trade d Make a choice.
- **scarcity is:**
 - a. Our inability to satisfy all our wants
 - b. A situation that exists during economic recession but not during economic booms
 - c. Eliminated by choices
 - d. An economic problem only for poor people
- **The perpetual problem in economics is:**
 - a. The inability of people to work together effectively.
 - b. The inability to satisfy everyone's wants with the resources available.
 - c. The gap between the income of the upper and lower socioeconomic classes
 - d. The inability to efficiently use resources.
 - e. How to supply enough to earn a consistent profit
- **In part, microeconomics is concerned with**
 - a. How a business firm decides upon the amount it produces and the price it sets
 - b. Changes in the economy's total output of goods and services over long periods of time
 - c. Factors that explain changes in the unemployment rate over time
 - d. D)The Federal Reserves' policy decisions

Activity 02 : answer the following questions

Question 01: Why does economy exist in the world?

Answer: An economy exists because of two basic facts:

1. Human wants for goods and services are Unlimited ; and

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2. Productive resources with which to produce goods and services are limited.

Question 02: What are the main definitions of economics?

Answer: The main definitions of economics are given by Adam Smith, Marshall and Robbins.

According to **Adam Smith**, “Economics enquire into the nature and causes of wealth of nations.”

Marshall defines “Economics is a study of mankind in the ordinary business of life and examines that part of individual and social action which is connected with material requisites of well being.”

Robbins defines, “Economics is a science which studies human behavior as a relationship between ends and scarce resources which have alternative uses.

Question 03: What are the basic problems/questions in economy?

Answer: The basic problems/questions in an economy are:

1. What to produce?
2. How to produce?
3. For whom to produce?

Chapter 02

Demand & Supply

Market Equilibrium

Chapter 02

Demand and Supply

Market Equilibrium

Our study of market economies requires us to examine both the demand-side and the supply-side of product and resources markets. Buyers and sellers interact with one another to engage in mutually beneficial exchanges in a market economy, and prices are set based on the demand and supply for a particular good, service or resource

In this chapter, we deal with demand analysis as a one part of price determination in free market. The other part of market mechanism is supply analysis which is another part of market mechanism, will be covered at a later time. In a free market mechanism, the demand and supply curves interact to determine the price and quantity of a good or services. The analysis of demand and supply is essential to understand price and output movement in a market.

Outline of this Chapter :

- ✓ Meaning of Demand and supply
- ✓ Factors Affecting Individual Demand and supply
- ✓ Demand Function
- ✓ Law of Demand and supply
- ✓ Individual Demand & Market Demand
- ✓ Individual supply & Market supply
- ✓ Change in Quantity Demanded Vs Change in Demand.
- ✓ Change in Quantity supplied Vs Change in supply.
- ✓ Equilibrium in the Market
- ✓ Changes in Market Equilibrium

After studying this chapter, you will be able to understand :

- ✓ Understand the meaning of demand and supply, and characteristics of demand and supply
- ✓ Factors affecting individual demand and supply
- ✓ Demand function and law of demand
- ✓ The basic differences between change in demand and change in quantity demanded
- ✓ Understand how equilibrium in the market can be reached
- ✓ Understand how market equilibrium will change as demand or supply of both changes

Demand

1. Definition of Demand

Demand is defined as the desire for a good for whose fulfilment a person has sufficient purchasing power and willingness to pay for the good. In simple words, demand is a desire for a good, backed by ability and willingness to pay. A desire without sufficient resources is merely a wish. A desire with resources but without willingness to spend is only a potential demand.

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Demand is the quantity of a good or service that buyers wish to purchase at each possible price, with all other influences on demand remaining unchanged.

Quantity demanded is the amount (number of units) of a product that a household would buy in a given period.

2. Factors Affecting/ Determining Demand

Demand depends on:

➤ The price of the product in question;

A rise in price of a good or service always decreases the quantity demanded of that good or service. Conversely, a fall in price will increase the quantity demanded.

➤ Changes in Income

A household's **income** is the sum of all the wages, salaries, profits, interest payments, rents, and other forms of earnings received by the household in a given period of time. We must specify a time period for it—income per month or per year. You can spend or consume more or less than your income in any given period.

When individuals have more income, they are normally more likely to purchase a good at any given price.

The effect of income on the demand of a product differs depending on the nature of the product.

- **Normal Goods** are goods for which demand goes up when income is higher and for which demand goes down when income is lower. This is because people have more purchasing power and can afford to buy more of the goods they prefer (**Cars, Mobiles, Meat**).
- **Inferior Goods** are goods for which demand falls when income rises, people stop buying an inferior good and switch their consumption to the preferred, more expensive alternative. (**public Transportation, used clothes**)

➤ Prices of Related Goods:

In reality, there are many goods in the marketplace that interact with each other in unique ways. Some goods seem to pair nicely, whereas others compete.

✓ Substitutes Goods

A **substitute** is a good that can serve as replacements for one another.

Substitutes are usually goods that in some way serve a similar function: coffee and tea. By definition, the relation between demand for a product and price of its substitute is of **positive nature**. When price of a product (tea) falls (or increases), then demand for its substitute (coffee) falls (or increases). The relationship of this nature is given in fig below.

✓ Complements Goods

Complimentary goods are those used alongside another good.

Complement goods are usually goods that in some sense are consumed together: **coffee and sugar, ink and printer** a change in the price of one of the goods will affect the demand for its complement. **In particular**, when the price of one good rises, the demand for its complement decreases. If coffee increases in price, we will purchase less sugar.

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➤ Changes in the Number of Consumers

With an increase (or decrease) in the size of population, demand for the product increases (or decreases).

➤ Changes in Expectations

Expected changes in future income can also lead to changes in demand: if you expect your income to rise in the future, you will typically borrow today and increase your demand for certain goods; and if you expect your income to fall in the future, you are likely to save today and reduce your demand for some goods.

➤ Changes in Tastes

Taste and preferences depend generally on the social customs, religious value, habits of people, and the age and sex of the consumers, **For example**, preference for junk food in the younger generation has increased as compared to normal home-made nutritious food. People have certain preferences, or tastes, that determine what they choose to consume and that these tastes can change. Economists usually lump together changes in demand due to fads, beliefs, cultural shifts, and so on under the heading of changes in tastes or preferences.

3. Demand function

Function: a relationship or expression involving one or more variables.

In economics, functions frequently describe cause and effect.

- The variable on the left-hand side is what is being explained (“the effect”).
- On the right-hand side is what’s doing the explaining (“the causes”).

Demand function states the relationship between demand for a product (the dependent variables) and its determinants (the independent variables).

$$QD_x = f(P_x, P_y, I, T)$$

Where;

D_x = Demand for commodity x;

P_x = Price of commodity x;

P_y = Price of other commodity y;

I = Consumers’ incomes

T = Consumers’ tastes and preferences.

Assume that the quantity demanded of a commodity Q_d depends only on its price, other factors remaining constant, the demand function will then read as demand for a commodity Q_d depends on its price P_x :

$$QD_x = f(P_x)$$

Where :

QD_x is demand for commodity x.

P_x is price of X.

In its standard form a linear demand equation is $QDX = a - bpx$ That is, quantity demanded is a function of price:

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- **a:** It expresses the quantity demanded of a commodity when its price is zero, i.e. it is the quantity demanded that is not affected by the price. **.(the point of satiety)**
- **b:** slope of the demand curve, is the derivative of the demand function Q_s with respect to P I.e,

$$b = \frac{\Delta Q}{\Delta P} = \frac{\delta Q}{\delta P} < 0$$

4. Law of demand

The relationship between quantity of a good that consumers are willing to buy and the price of the good that shows **opposite relationship** between price and quantity demanded is known as **law of demand**. In other words, higher the price, lower the demand and lower the price, higher the demand, if other things remains same. That is, the quantity demanded is **negatively related** to the price of the good.

Economists call this **inverse** relationship between price and quantity demanded the **law of demand**. The law of demand assumes that all other variables that affect demand (which we explained) are held constant.

5. Demand schedule

A demand schedule is a table showing how much of a good or service consumers will want to buy at different prices. Or is a tabular presentation of different prices of a commodity and its corresponding quantity demanded per unit of time.

Example:

The table below presents demand schedule of shirts(P_s) and the corresponding number of shirts demanded(Q_s) per month.

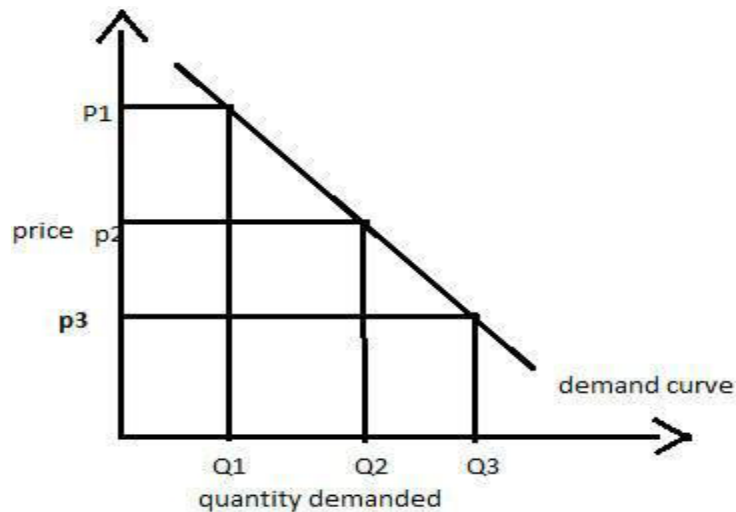
P_s	$Q_s(10^3)$
800	8
600	15
400	30
300	40
200	55
100	80

The table illustrates the law of demand, the quantity demanded for shirts increases as its price decreases, for instance, at price 800 per shirt n only 8 thousand shirts are demanded per month. When price decreases to 400, the quantity demanded for shirts increases to 30 thousand. This negative, or inverse, relationship between quantity demanded and price gives the law of demand.

6. Demand curve

A **demand curve** shows the relationship between price and quantity demanded on a graph, with **quantity on the horizontal axis** and the **price on the vertical axis**.

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Demand curve has a negative slope, i.e, it slopes downwards from left to right depicting that with increase in price, quantity demanded falls and vice versa. The reasons for a downward sloping demand curve can be explained as follows:

- **Income effect:** With the fall in price of a commodity, the purchasing power of consumer increases. Thus, he can buy same quantity of commodity with less money or he can purchase greater quantities of same commodity with same money. Similarly, if the price of a commodity rises, it is equivalent to decrease in income of the consumer as now he has to spend more for buying the same quantity as before. This change in purchasing power (real income) due to price change is known as income effect.
- **Substitution effect:** When price of a commodity falls, it becomes relatively cheaper compared to other commodities whose price have not changed. Thus, the consumer tend to consume more of the commodity whose price has fallen, i.e, they tend to substitute that commodity for other commodities which have not become relatively dear.

Example : Suppose the demand function for a consumer is as follows:

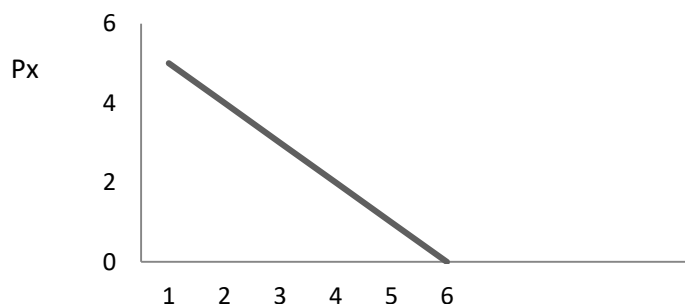
$$Qd = 6 - Px$$

- 1- Determine demand schedule
- 2- Drawing the demand curve.

1-Demand schedule

Px(Price of Coffee)	1	2	3	4	5	6
Qdx(Quantity of Coffee)	5	4	3	2	1	0

2-Demand curve



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The demand schedule for coffee yields the corresponding demand curve, which shows how much of a good or service consumers want to buy at any given price. The demand curve and the demand schedule reflect the law of demand: As price rises, the quantity demanded falls. Similarly, a decrease in price raises the quantity demanded. As a result, the demand curve is **downward sloping**

7.The market demand curve

- **The individual demand curve**, which shows the relationship between quantity demanded and price for an individual consume
- The market demand is the **total quantity demanded** by all the individuals in a market at a particular point of time at various alternative prices. The market demand for a product depends on all the factors that determine the individual's demand and on the number of consumers in the market. **Graphically**, it is represented by the horizontal summation of all the individuals' demand curves for the commodity in the market.

Example: Suppose, there are only 3 consumers (A,B and C) of Pepsi and their weekly individual demand for Pepsi at its different prices is given as in table below. The last column of the table shows the market demand, I.e, the aggregate of individual demand for Pepsi.

Individual and Market Demand for the Pepsi Cans				
Price	N0. Of Pepsi Cans demanded by			Market demand =A+B+C
	A	B	C	
12	0	0	0	0
10	0	0	4	4
8	0	4	8	12
6	3	8	12	23
4	5	12	16	33
2	8	16	20	44
0	11	20	24	55

The last column of the table shows the market demand for Pepsi. **The market demand curve** can be obtained by plotting the data in the last column of the table.

The market demand function

The determination of the market demand function differs whether the individual demand functions are **identical or no identical**

- A.** Suppose each individual has an **identical** demand function. In that case, we multiply the total consumers in the market by the individual demand function to obtain it. :

$$QDX=n. Qdx$$

For example, there are **50** buyers in the gasoline market with the following individual demand functions: $Q_d = 8 - P_x$

The market demand function for the above case is :

$$QD= 50 (8 - P_x) = 400 - 50P_x$$

- B.** However, if the demand function varies between individuals, we cannot apply the above calculation. Instead, we have to add each demand function.

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$$QDX = \sum Q_{dx}$$

$$= Q_{dx1} + Q_{dx2} + Q_{dx3} + \dots + Q_{dxn}$$

For example, there are three consumers in the market: A, B, and C. The three demand functions for a product are as follows:

$$Q_{da} = 10 - 2P \quad Q_{db} = 5 - P \quad Q_{dc} = 15 - 3P$$

From those individual demand function, we can derive the market demand function by adding up all the individual functions. Thus, the market demand function is :

$$QD_m = (10 - 2P) + (5 - P) + (15 - 3P) = 30 - 6P$$

8.Changes in Quantity Demanded Versus Changes in Demand

Demand for any product depends on the price of that product and also on several factors like prices of substitutes, income, taste, preference etc. In changes in demand we remove the assumption other things remaining the same and bring a change in all demand determinants.

Thus the price may or may not change but the change in factors other than price gives us either increase or decrease in demand.

- Changes in price affect the **quantity demanded** per period.
- Changes in income, other goods prices, tastes, or expectations affect **demand**.

The Difference between the Change in Demand and the Change in Quantity Demanded

	Quantity demanded	Demand
Representation	It is a single point on the demand curve.	Demand is represented by the demand curve, which shows the various quantities that would be demanded at different prices.
Demand curve	Changes in the quantity demanded are caused by changes in the price of the good itself, leading to movement along the demand curve (not shifting the entire curve).	Changes in demand are caused by factors like income, preferences, or the prices of related goods, and these changes result in the demand curve shifting either to the left (decrease) or to the right (increase).
Example	If the price of electric cars drops from \$50,000 to \$40,000, the quantity demanded increases, meaning more people will buy electric cars at the lower price. This is a movement along the demand curve	If electric cars become more popular, the demand for electric cars increases, shifting the demand curve to the right.

9.Movement Along a Demand Curve Versus Shift of Demand

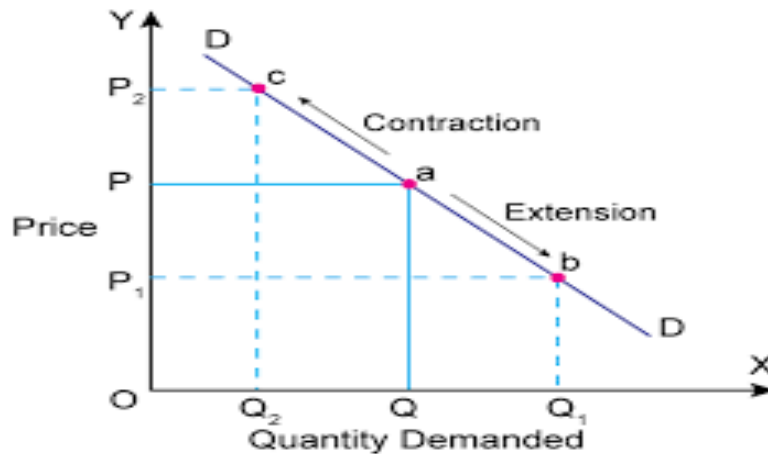
It's crucial to make the distinction between such **shifts** of the demand curve and **movements along** the demand curve

9.1.Movement Along a Demand Curve

- A movement along the demand curve is caused by a change in the price of the good only, other things remaining the same.

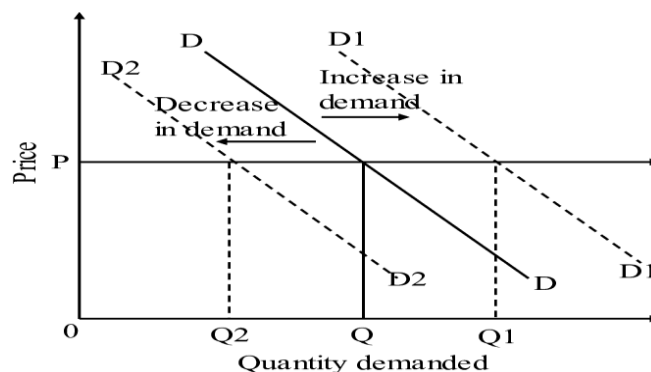
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- It is also called change in quantity demanded of the commodity.
- Movement is always along the same demand curve, i.e., no new demand curve is drawn.
- Movement along a demand curve can be of two types:
- Expansion or extension of demand curve; and Contraction of demand curve
- Expansion or extension of demand refers to rise in demand due to fall in the price of the good (Move from point A to point B)
- Contraction of demand refers to fall in demand due to rise in the price of the good. (Move from point A to point c)



9.2.Shift of Demand

- A shift of the demand curve is a change in the quantity demanded at any given price, represented by the change of the original demand curve to a new position, denoted by a new demand curve., from D to D1 or D2.
- Change in income, preferences, or prices of other goods or services leads to Change in demand (Shift of curve).
- When economists talk about an “**increase in demand**,” they mean a **rightward** shift of the demand curve: at any given price, consumers demand a larger quantity of the good or service than before. This is shown by the **rightward shift** of the original demand curve D to D1. And when economists talk about a “**decrease in demand**,” they mean a **leftward** shift of the demand curve: at any given price, consumers demand a smaller quantity of the good or service than before. This is shown by the **leftward shift** of the original demand curve D to D2



Supply

1. Definition of supply

Supply of a commodity means quantity of the commodity which is actually offered for sale at a given price during some particular time. It is the quantity of a commodity that a seller is willing to sell in the market at a given price and at a given period of time. Supply refers to a schedule showing various quantities of a commodity that the producers are willing to sell at different possible prices of that commodity at a given time.

2. Factors that affect supply (Determinants of Supply)

➤ The price of the good or service:

Price is the prime determinant of supply, higher the price, higher the quantity supplied and lower the price, lower the quantity supplied.

➤ Input Prices

Perhaps the most obvious shock to the supply curve is the cost of inputs. Also known as 'Factors of Production', these are the combination of labor, materials, and machinery used to produce goods and services. A rise in input prices increases the cost of production, discourage producers to produce

➤ Technology

Technological improvement reduces cost of production. It induces the producers to produce more and increase the supply of a commodity. More is offered for sale at a given price.

- Improvements in technology will lower costs of production and increase supply.
- Decay in technology will increase costs of production.

➤ Taxes and subsidies

A **tax** will increase costs of production, causing a decrease in supply, while a **subsidy** will decrease costs of production, causing an increase in supply.

➤ Number of Producers

Larger the number of firms, greater the quantity supplied and vice versa. Thus, under conditions of perfect competition, supply of a commodity is generally higher than under monopoly.

- When more firms enter the market, supply will increase.
- When firms leave the market, supply will decrease.

➤ Producers' Expectations:

Generally, supply is restricted if the producers expect that price of a commodity to rise in the near future, and vice versa.

3. The Law of Supply:

- A rise in price almost always leads to an increase in the **quantity supplied** of that good or service, while a fall in price will decrease the quantity supplied.
- Economists call this **positive relationship (direct)** between price and quantity supplied—that a higher price leads to a higher quantity supplied and a lower price leads to a lower quantity supplied—the **law of supply**.

4. Supply function

It is the mathematical relationship that explains the relationship between the quantity supplied and the determinants of supply, and it can be written as follows:

$$Q_s = f(P_x, P_y, T_s, T, N, \dots)$$

Where :

Q_s : represents the quantity supplied.

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Px: the price of the good itself.

Py: the prices of other goods.

Ts: taxes and subsidy

T :technology

N: Number of Producers

Usually, economists use several variables to explain how they affect supply. They assume other factors do not change or *ceteris paribus*. The supply function equation is;

$$QS = C + dP$$

Where :

C: the level of supply independent of price

Qs: Quantity supplied of the good x

Px: Price of the good x

d: Represents the slope of the supply curve and is always **positive**. It is calculated by the relationship:

$$d = \frac{\Delta Q_s}{\Delta P}$$

5. Supply schedule

A supply schedule is a table, that shows the quantity supplied at a range of different prices.

6. Supply curve

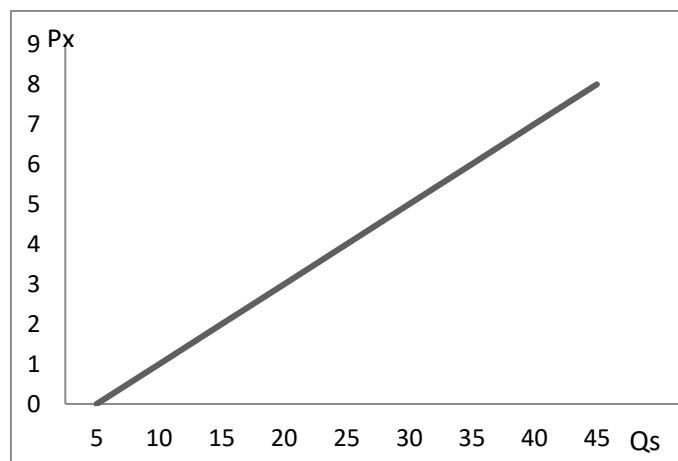
A **supply curve** is a graphic illustration of the relationship between **price**, shown on the **vertical axis**, and **quantity**, shown on the **horizontal axis**.

The supply schedule and the supply curve are just two different ways of showing the same information. Notice that the horizontal and vertical axes on the graph for the supply curve are the same as for the demand curve.

Example

Px	0	1	2	3	4	5	6	7	8
QSx	5	10	15	20	25	30	35	40	45

Supply curve



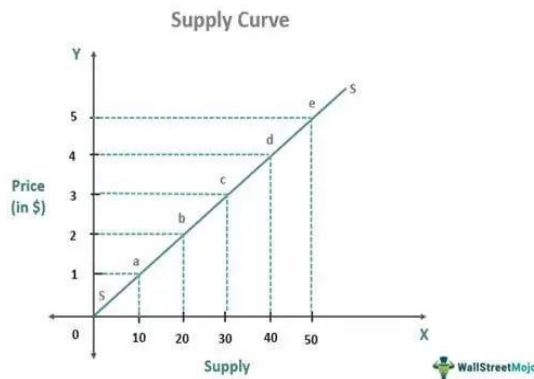
From the curve we notice if the price increases, the quantity supplied increases, and if the price falls, the quantity supplied falls. For example, when the price increases from 3 to 4, the quantity supplied increases from 20 to 25, and vice versa. This indicates **the direct** relationship between price and quantity supplied.

7. Individual and market supply curve

7.1. Individual supply curve

Individual supply schedule is a tabular statement of the various quantities of product that is supplied by a particular single seller or producer at various price levels over a period of time, with all other factors being constant. The schedule of supply is a table that represents it. For instance :

Schedule of Individual Supply	
Price (\$)	Quantity (Kgs)
1	10
2	20
3	30
4	40
5	50



7.2. The market supply curve

The market or aggregate supply is the total quantity of a good supplied by all the suppliers in a market at various prices over a particular time period. The market supply depends on all the factors that determine the individual supply and on the number of suppliers of the good in the market. Mathematically, it is obtained by adding individual supply schedule and plotting it on a graph.

Price per unit of product X (Px)	Quantity supplied by Company A (Qa)	Quantity supplied by Company B (Qb)	Market Supply (Qa + Qb)
1	0	5	5
2	5	10	15
3	10	15	25
3	15	20	35
5	20	25	45

7.3. Market Supply Equation

we calculate the market supply function of a product by aggregating the quantities supplied by each company. Say, the quantity function supplied by individual producers is $Q_s = -100 + 200P$, and there are ten companies in the market. Then the market demand function in this case is :

$$Q_s = 10 (-100 + 200P) = -1000 + 2000P$$

Likewise, to determine its function, we add up the own supply function of each producer.

$$Q_{da} = -70 + 10P \quad Q_{db} = -80 + 4P \quad Q_{dc} = -30 + P$$

From this information, we can derive the market Supply function by adding up all the individual functions. Thus, the market demand function is :

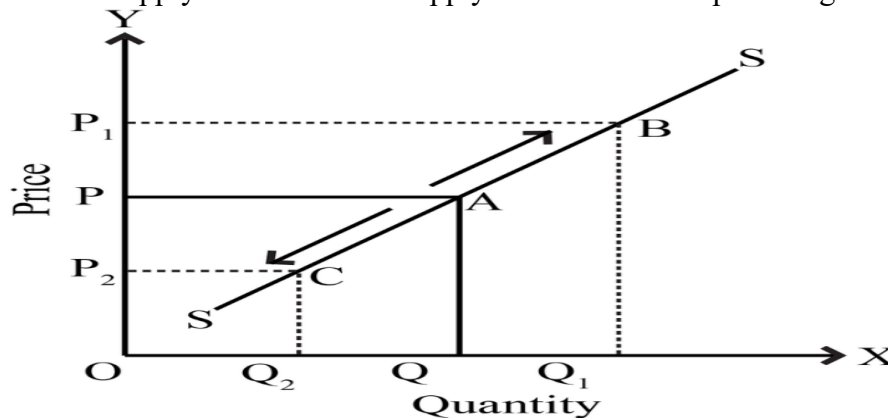
$$Q_{dm} = (-70 + 10P) + (-80 + 4P) + (-30 + P) = -180 + 15P$$

8.Change in Quantity Supplied vs. Change in supply

Supply refers to the entire supply schedule showing various quantities of a commodity offered for sale corresponding to different possible prices of that commodity, at a given time. On the other hand, quantity supplied refers to a specific quantity offered for sale against a specific price .

8.1.Change in Quantity Supplied(Movement)

- A movement along the supply curve is caused by changes in the price of the good, other things remaining constant.
- It is also called change in quantity supplied of the commodity.
- In a movement, no new supply curve is drawn.
- Movement along the supply curve can be of two types:
 - a. Expansion or extension of supply; and
 - b. Contraction of supply.
- **Expansion or extension** of supply refers to rise in supply due to rise in price of the good.
- **Contraction** of supply refers to fall in supply due to fall in the price of good.



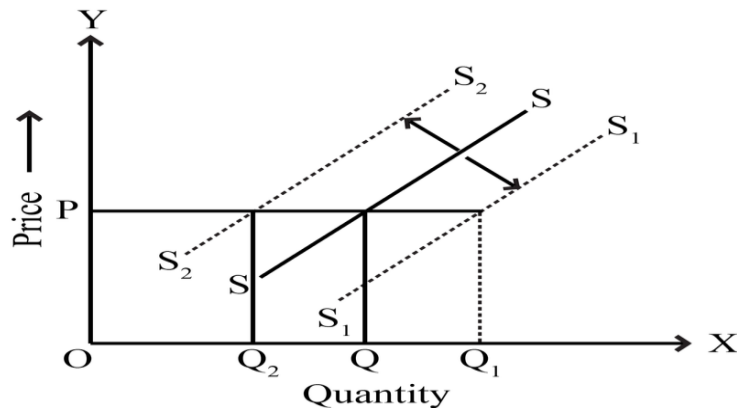
Moving from point **a** to **b** shows increase in quantity supplied from Q to Q_1 in response to increase in price (from P to P_1) It is called **extension** of supply. Likewise, moving from point **a** to **c** shows decrease in quantity supplied (from Q to Q_2) in response to decrease in price (from P to P_2) It is called **contraction** of supply.

8.2.change in supply(Shift)

A shift of the supply curve is a change in the quantity supplied of a good or service at any given price. It is represented by the change of the original supply curve to a new position, denoted by a new supply curve. These factors are:

- Price of the other commodity;
 - State of technology;
 - Cost of production;
 - Government policy, etc.
- ✓ A change in any of these above factors causes shift in the supply curve. It is also called change in supply.
- ✓ In a shift, a new supply curve is drawn.

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- ✓ A shift of the supply curve can be of two types:
 - a. Increase in supply.
 - b. Decrease in supply.

Increase in supply: when supply of a commodity rises due to favorable changes in factors other than price of the commodity, it is called increase in supply. This is due to:

- Improvement in technique of production;
 - Fall in the price of related goods;
 - Fall in the cost of production;
 - Fall in excise tax.
- ✓ Increase means more supply at the same price, or same supply at a lower price.

Decrease in supply: when supply of a commodity falls due to unfavorable changes in factors other than its price, it is called decrease in supply. The main reasons of decrease in supply are:

- Obsolete technique of production;
 - Increase in the price of related goods;
 - Increase in the cost of production;
 - Rise in excise tax.
- ✓ Decrease means same quantity supplied at higher price or less quantity supplied at the same price.

Market Equilibrium

Market equilibrium means reaching a state in which the forces of supply and demand for goods are in a state of stability, meaning that supply is completely equal to demand. If this condition is met, prices remain stable because there is no shortage or surplus on the market, and the price of the product is determined by the equilibrium between the quantity demanded of the product by buyers and the quantity supplied by sellers.

The market equilibrium exists when quantity demanded equals quantity supplied and there is no tendency for price to change. The equilibrium can be determined using two methods:

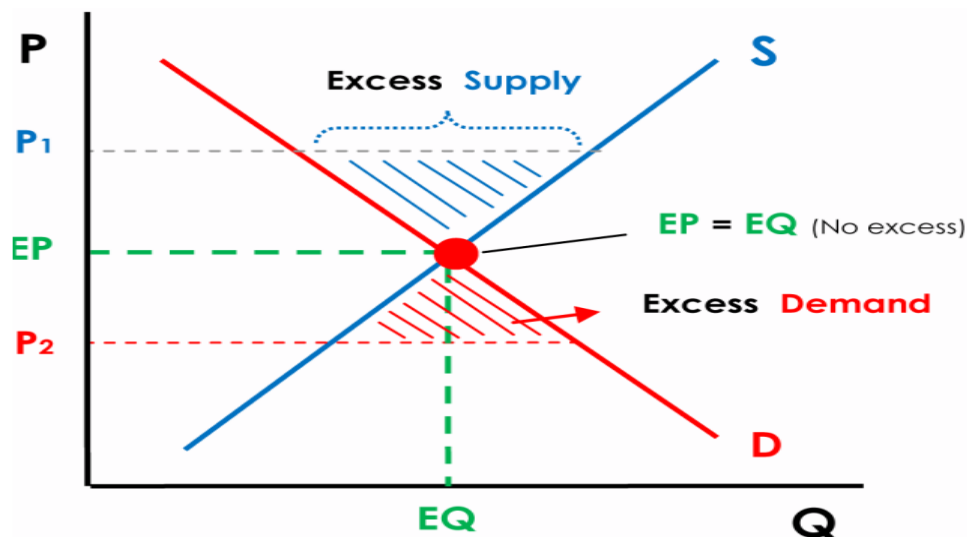
- A. Determination of Market Equilibrium Using a **Schedule**
- B. Determination of Market Equilibrium **Graphically**

In economics, when the quantity demanded of a commodity **equals** the quantity supplied equilibrium is achieved. **Graphically**, this can be represented by the **intersection** of the market demand and supply curve. This point gives us the equilibrium price and the equilibrium quantity.

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1. Determination of Market Equilibrium Graphically

The equilibrium describes a state of the market in which the price stabilises at a certain level at which the quantity supplied of a product is equal to the quantity demanded of the same product on the market. Market equilibrium is determined by the interaction of the forces of supply and demand. From an analytical point of view, market equilibrium is determined **graphically** by the intersection of the supply curve with the demand curve. The point of intersection is known as the equilibrium point. It determines the price that all buyers and sellers will accept, known as the equilibrium price, as well as the equilibrium quantity (**point E**).



- **The equilibrium point** is the point where the supply and demand curves intersect. The point reveals the optimum price and quantity.
- **Equilibrium Price:** The price at which the quantity demanded equals the quantity supplied
- **Equilibrium quantity:** The quantity bought and sold at the equilibrium price.
- **Equilibrium Point:** Where the demand curve and the supply curve intersect, we have a point. This point is known as the market equilibrium

2. Determination of Market Equilibrium Using a Schedule

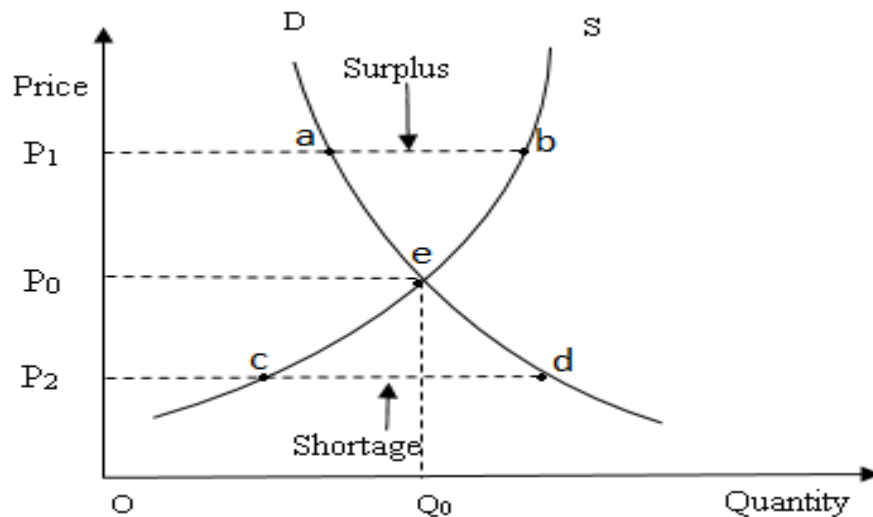
Px	QDx	QSx	Excess or surplus
10	1500	500	Excess demand (shortage) = 1000
20	1400	1100	Excess demand (shortage) = 300
30	1300	1300	Equilibrium QD = QS
40	1200	1500	Excess supply (surplus) = 300
50	1000	2000	Excess supply (surplus) = 1000

From the schedule we note the following:

- The market equilibrium is determined when $QD=QS$. The equilibrium $Q=1300$, the equilibrium $P=30$, no tendency for price to change

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- At any price lower than (the equilibrium price (such as $P=10$ or $P=20$ there will be an excess demand or a shortage ($Q_D > Q_S$), so The price will tend to increase.
- At any price higher than (the equilibrium price (such as $P=40$ or $P=50$ there will be an excess supply or a surplus ($Q_S > Q_D$), so the price will tend to decrease.



In the graph above, the vertical Y-axis is showing the market price of the commodity and the horizontal X-axis is showing the quantity. In this fig. we have a **negatively sloped** market demand curve D and a **positively sloped** market supply curve. Point **e** on the graph is **the equilibrium point** where the market demand curve intersects the market supply curve. Point **P₀** and **Q₀** are the equilibrium price and equilibrium quantity respectively.

Distance **ab** and **cd** represents **surplus**, and **shortage** of quantity supplied respectively. In a free market, there is a tendency for the price to change until the market is cleared i.e., until the quantity demanded equals the quantity supplied. This is how a market mechanism works. At the equilibrium point, there is **no excess** demand and **excess** supply, hence there is no pressure for the price to change further. It is to note that demand and supply might not be always in equilibrium depending on the situation.

Note that:

Excess supply exists when the quantity supplied exceeds the quantity demanded at the going price.

Excess demand exists when the quantity demanded exceeds the quantity supplied at the going price.

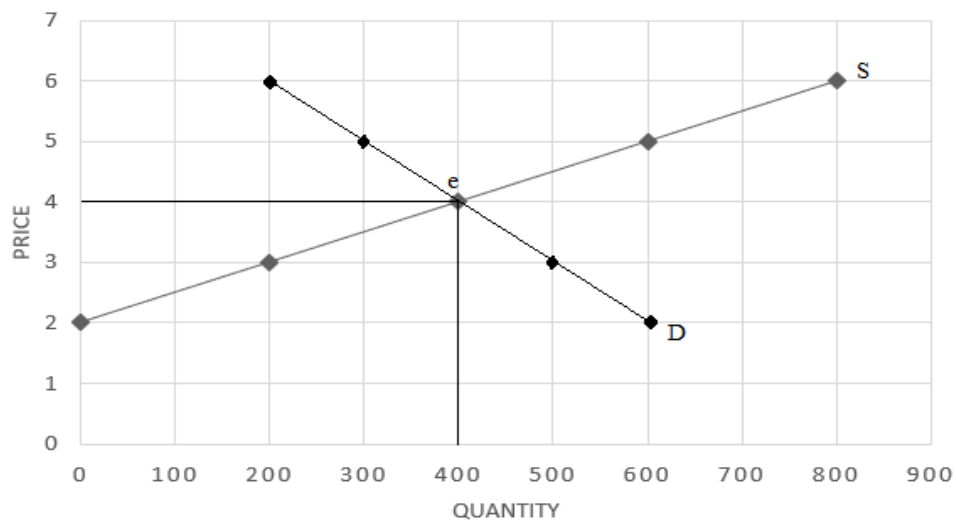
When quantity demanded exceeds quantity supplied, price tends to rise. When the price in a market rises, quantity demanded falls and quantity supplied rises until an equilibrium is reached at which quantity demanded and quantity supplied are equal.

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Example:

Price(Px)	Quantity(Qdx)	Quantity(Qsx)
2	600	0
3	500	200
4	400	400
5	300	600
6	200	800

Using both the market demand and market supply schedule above we can see that at market price of 2 the quantity demanded is 600 units and the quantity supplied is zero. Similarly, at market price of 6 the quantity demanded is 200 units and quantity supplied is 800 units. But at market price of 4 the quantity demanded is equal to the quantity supplied at 400 units. This point is our equilibrium point and there is no **shortage** or **surplus** of the commodity in the market. This market position will continue to persist until and unless some outside force pushes the demand or supply away from the equilibrium position.



3. Finding the equilibrium point mathematically

At equilibrium, supply and demand intersect, pointing to the equilibrium price and quantity. At equilibrium price:

Quantity demanded = Quantity supplied :

$$Q_s = Q_d$$

Substituting the formula for Q_s and Q_d :

$$a + bP = a - bP$$

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Solving the above gives the value of “P,” and applying the value of “P” in the Q_D or Q_S equation gives the equilibrium quantity.

Example 1 : For instance, let’s say that you are calculating the equilibrium quantity of calculators. Therefore,

the supply equation is $Q_s = 2 + 5P$

and

The demand equation is $Q_D = 16 - 2P$

$$Q_s = Q_D$$

$$2 + 5P = 16 - 2P$$

$$7P = 14 \quad \text{so} \quad P_e = 2$$

You now know that the equilibrium price, or the price where is \$2. Plug the equilibrium price into the equation and solve. You can choose either the demand equation or the supply equation (since both are equal, they will both give you the same answer). In the example below, we will use the demand equation:

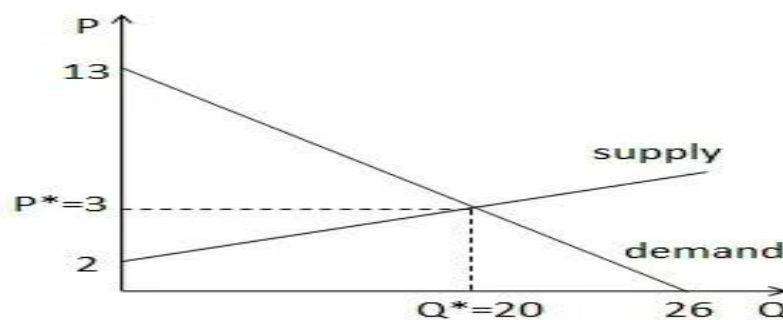
$$Q_e = 16 - 2(2) = 16 - 4 = 12$$

Example 2

$$Q_s = -4 + 8P \quad Q_D = 26 - 2P$$

$$-4 + 8P = 26 - 2P \quad P_e = 3$$

$$Q_e = -4 + 8(3) = 20$$



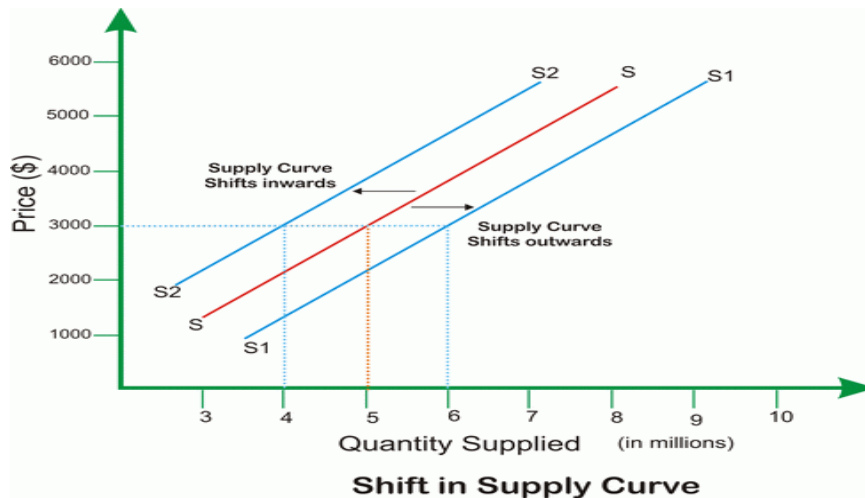
4. Changes in Market Equilibrium:

Till now, we have seen how demand and supply respond to a change in various factors such as price, cost of production, technological improvements, tastes and preferences. We have also seen how we can determine the equilibrium position from demand and supply curves and how market forces operate. Now we will understand how equilibrium position changes due to shift in the demand and supply curves.

4.1. Effects of shifts in D and S on Market Equilibrium

❖ Shift in the Supply Curve

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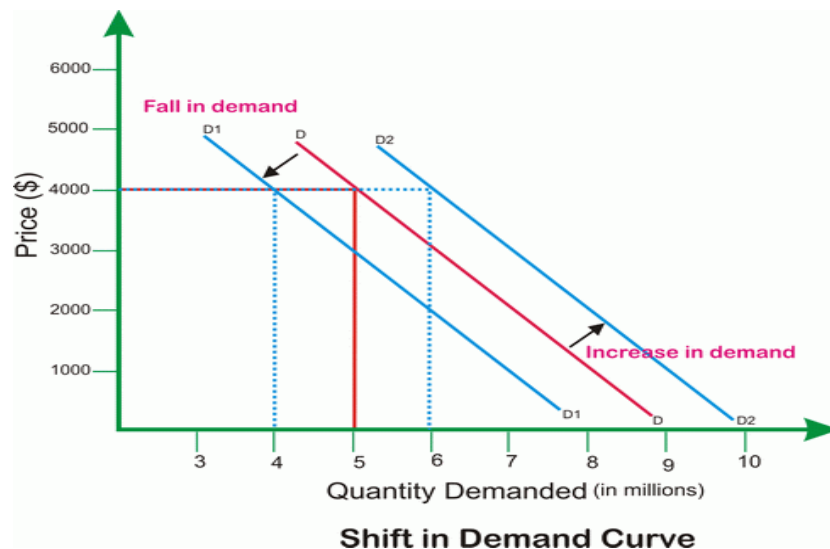
The increase in supply causes:

A rise in equilibrium price and a fall in equilibrium quantity

The decrease in supply causes:

A fall equilibrium price and a rise in equilibrium quantity

❖ Shift in the Demand Curve



The increase in demand causes:

rise in both equilibrium price and equilibrium quantity

The decrease in demand causes;

A fall in both equilibrium price and equilibrium quantity

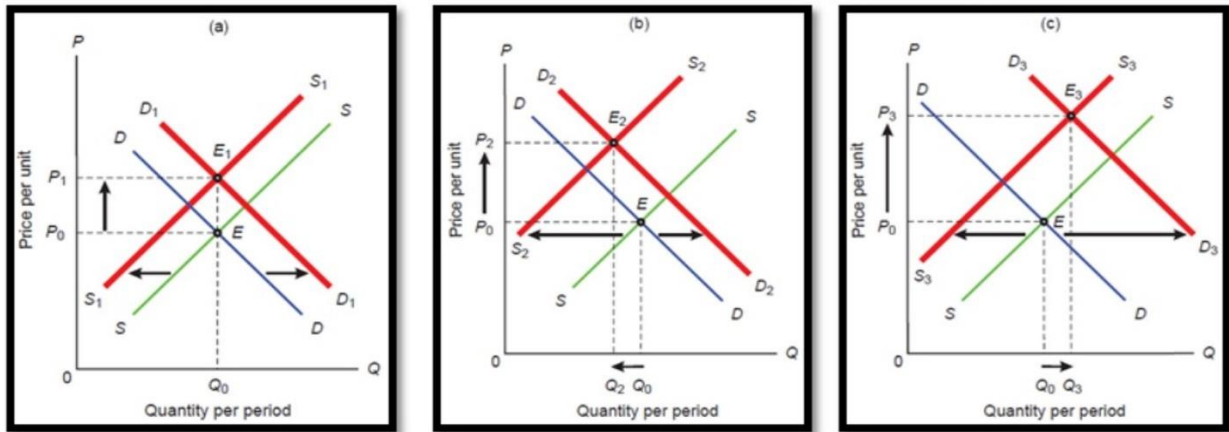
4-2-Changes in both demand and supply

❖ Effects of Simultaneous Change in Demand and Supply

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- (a) *quantity remains unchanged* at Q_0
- (b) *quantity falls* to Q_2
- (c) *quantity increases* to Q_3 .

A simultaneous increase in demand and decrease in supply

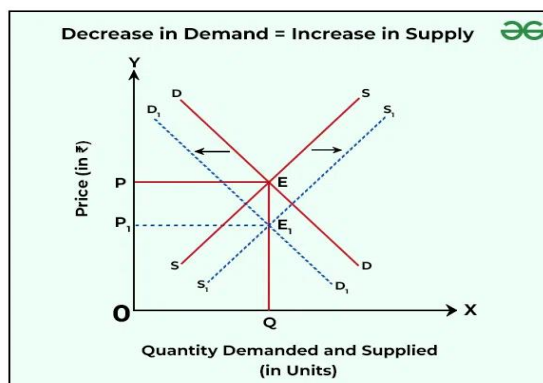


- **Decrease in Demand is equal to Decrease in Supply will cause**
A fall in equilibrium quantity; equilibrium price will stay constant
- **Decrease in Demand is greater than Decrease in Supply will cause:**
A fall in both equilibrium price and equilibrium quantity
- **Decrease in Demand is less than Decrease in Supply will cause:**
A rise in equilibrium price and a fall in equilibrium quantity
- **Increase in Demand is equal to Increase in Supply will cause**
A rise in equilibrium quantity, equilibrium price stay constant
- **Increase in Demand is greater than Increase in Supply will cause:**
A rise in both equilibrium price and equilibrium quantity
- **Increase in Demand is less than Increase in Supply will cause:**
A rise in equilibrium quantity and a fall in equilibrium price

❖ The effect of changing demand and supply in opposite directions

✓ Case I – Demand Decreases and Supply Increases

Decrease in Demand is equal to Increase in Supply

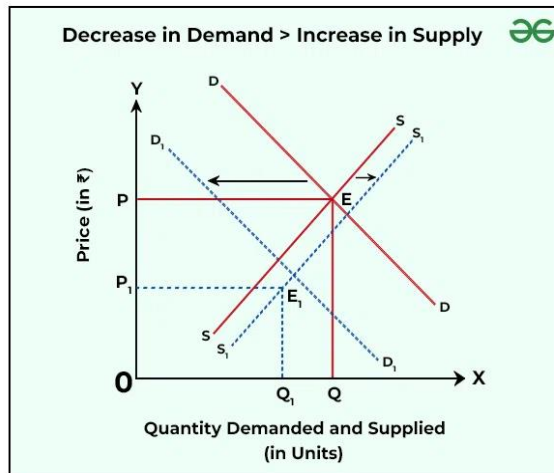


This will cause

A fall in equilibrium price equilibrium quantity will stay constant

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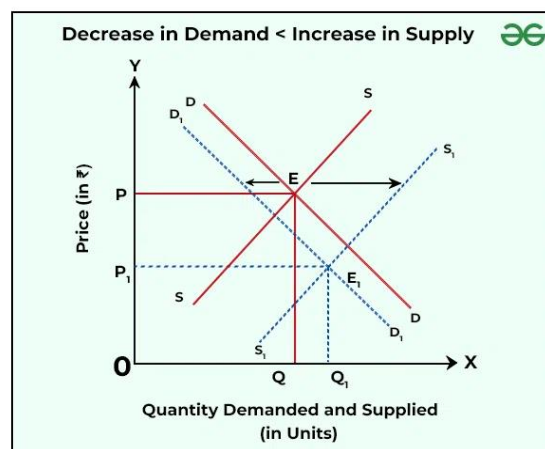
Decrease in Demand is greater than Increase in Supply



This will cause

A fall in both equilibrium price and fall in equilibrium quantity

Decrease in Demand is less than Increase in Supply

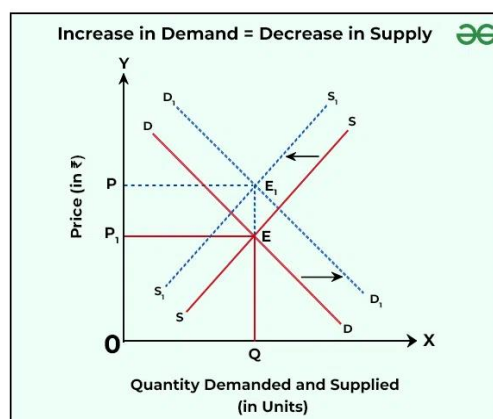


This will cause

A fall in equilibrium price And a rise in equilibrium quantity

✓ Case II – Demand Increases and Supply Decreases

Increase in Demand is equal to Decrease in Supply

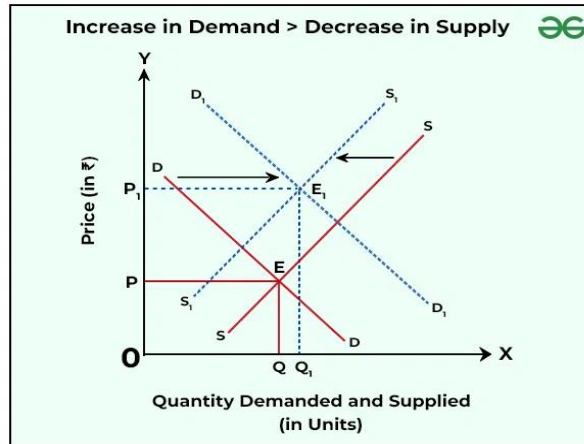


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This will cause:

A rise in equilibrium price ,equilibrium quantity will stay constant.

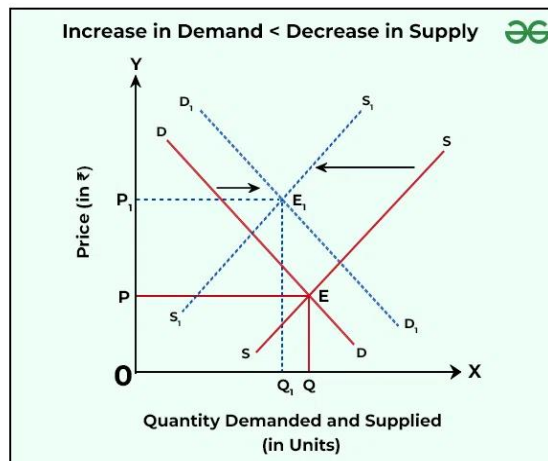
Increase in Demand is greater than Decrease in Supply



This will cause:

A rise in both equilibrium price and equilibrium quantity.

Increase in Demand is less than Decrease in Supply



This will cause

A fall in equilibrium quantity and a rise in equilibrium price.

Review Questions

Activity 01: say whether these statements are true or false with short explanation

1. The increase in the price of Toyota cars will increase **the quantity demanded** for Nissan cars. **False**
→ will increase the **demand** (not QD)
2. The increase in the price of printers will shift the demand for inks used in printers leftward. **True**
3. The decrease in price of cars will reduce the demand for gasoline. **True**
4. The quantity demanded changes when the price of the good changes. **True**
5. The desire for a commodity backed by ability and willingness to pay is demand. **True**
6. A market demand curve represents the maximum quantity that an individual would be willing to buy at different prices. **True**
7. The demand curve for a good shows the same information as the demand schedule. **True**
8. The increase in the price of printers will shift the demand for inks used in printers leftward. **True**
9. The quantity demanded changes when the price of the good changes. **True**
10. At any price below the equilibrium price, there will be an excess in demand. **True**
11. A fall in the price of (x) would cause, (other things equal), a **rightward shift in its demand curve**. **False**
→ A fall in price cause a **movement** (not shift)
12. If the consumer income increases, the quantity demanded of **any good must increase**. **False**
→ the quantity demanded of **normal good** increase and QD of **inferior good** decrease.
13. The demand for a commodity is inversely related to the price of its **substitutes**. **False**
→ (its self)
14. When an increase in the price of good Y, other factors constant, causes a decrease in the demand for good X, it means that the two goods are **substitutes**. **False**
→ it means that the two goods are **complements**.
15. Decrease in input prices cause a **leftward** shift in the supply curve. **False** → (rightward)
16. Most demand functions are of the form **$QD = a + bp$** . **False**
→ (**$QD = a - bp$**)
17. The law of demand states the relationship between the quantity demanded and price of commodity, consumers income, price of the related goods and advertisement **False**
→ (law of demand states the relationship between the quantity demanded and price of commodity, Ceteris paribus)
18. If a new medical report states that Kiwi is a very healthy fruit, the supply of Kiwi should increase **False**.. (the demand not supply)
19. Movement along the supply curve of textbook is caused by changes in prices of ink **False** → caused by changes in prices of textbook
20. For two goods to be substitutes, the increase in the quantity demanded of one good reduces the quantity demanded of the other good **False**

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→(For two goods to be substitutes, the increase in the price of one good increase the demand of the other good relation)

21. At any price above the equilibrium price, there will be an **excess in demand** **False**

→ (**excess supply**.)

22. If the actual price exceeds equilibrium price, there is a tendency for actual price **to rise**. **False**
→ to fall

Activity 02: choose the correct answer

1)The law of demand indicates that as the price of a good decreases, the quantity:

- a. buyers desire increases.
- b. buyers desire decreases.
- c. producers offer to the market decreases.
- d. producers offer to the market increases.

2)When an economist refers to a product as a "normal good," it implies that:

- a. when incomes decline, demand for that product will fall.
- b. when incomes rise, demand for that product will fall.
- c. there are many good substitutes for the product.
- d. the product is of poor quality.

3)How are the market and individual demand curves related?

- a. The market demand curve is the sum of all individual demand curves.
- b. Both curves are used in microeconomics.
- c. The market demand curve is opposite of the individual demand curve.
- d. Both curves are used in macroeconomics.

4)The more money people make, the more pairs of shoes they buy. We can conclude that:

- a. Shoes are a normal good.
- b. Shoes are an inferior good.
- c. Demand for shoes is highly price elastic.
- d. Demand for shoes has an elasticity between 0 and 1.
- e. All of the above.

5)Which of the following is the correct way to describe the equilibrium in a market?

- a. At equilibrium, quantity demanded equals quantity supplied.
- b. At equilibrium, demand equals supply.
- c. At equilibrium, scarcity is eliminated.
- d. At equilibrium, the number of buyers is exactly equal the number of sellers.

6)If the market is not in equilibrium, then which of the following is likely to occur?

- a. The price will adjust to bring the market to the equilibrium.
- b. The demand curve will shift to bring the market to equilibrium.
- c. The supply curve will shift to bring the market to equilibrium.
- d. Both a & b are correct.

7)If the demand and supply of Fish are given by the following equations:

$$Q=120 - 25P \quad (1)$$

$$Q = 30 + 50P \quad (2)$$

- a. Equation (1) is a demand equation, and Equation (2) is a supply equation.
- b. Equation (1) is a supply equation, and Equation (2) is a demand Equation.
- c. both equations would be demand or supply Equation.
- d. We do not have enough information to tell.
- e. None of the above.

8) Moving downward along a supply curve:

- a. Quantity supplied decreases as price decreases.
- b. supply decreases as price decreases.
- c. supply increases as technology increases.
- d. quantity supplied decreases as technology decreases.

9) For inferior goods, an increase in income will cause the:

- a. Demand to fall.
- b. Quantity demanded to fall.
- c. Demand to increase.
- d. Quantity demanded to increase.

10) As the price of sugar increases:

- a. Demand for tea decreases and shifts leftward.
- b. Demand for sugar decreases and shifts leftward.
- c. Demand for coffee increases and shifts rightward.
- d. Supply of sugar increases and shifts rightward.
- e. None of the above

Activity 03: Exercises

Exercise 1

Consider a hypothetical demand curve for the laser printer market. Show graphically and briefly describe what happens in correspondence of the following market changes:

- a. the price of laser printers goes down
- b. the average income of the population increases
- c. the price of ink cartridges increases
- d. the tastes of consumers are changing: they prefer to keep their photographs and documents in digital format rather than in paper format.

Exercise 2

Consider a hypothetical supply curve for the electric bicycle market. Show graphically and briefly describe what happens in correspondence of the following market changes:

- a. the price of electric bicycles increases
- b. technological progress reduces the cost of producing electric batteries
- c. the government removes subsidies for electric bicycle manufacturers
- d. the price of electric scooters increases significantly.

Exercise 3

Consider a hypothetical market (supply and demand) for air conditioners. Show graphically and briefly describe what happens in correspondence with the following market changes:

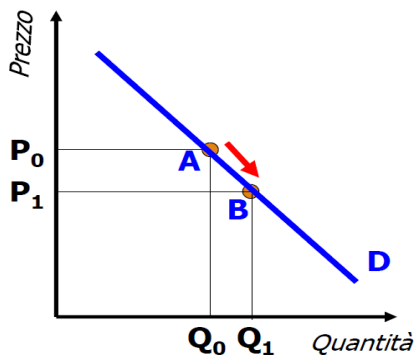
- a. climate change increases the need for cooling for consumers
- b. the government imposes a tax on those who have an air conditioner
- c. the price of copper necessary for the production of air conditioners increases
- d. the introduction of robotic assembly systems for air conditioners reduces production cost.

Solutions

Exercise 1

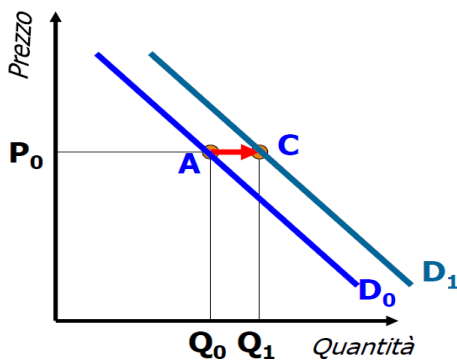
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a. the price of laser printers goes down



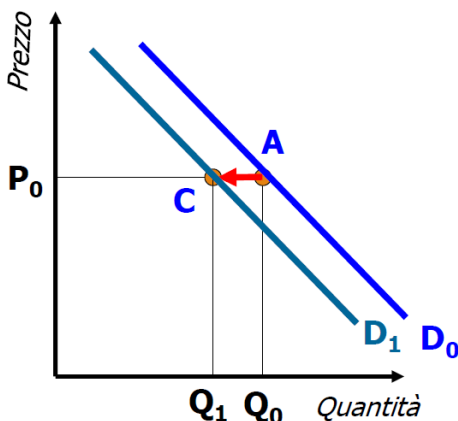
A reduction in the price of printers from P_0 to P_1 (other conditions being equal) causes the reaction of consumers in that market, who will demand printers in greater quantities, passing from quantity Q_0 to Q_1 . Graphically this change is represented by a movement along the demand curve from A to B .

b. the average income of the population increases



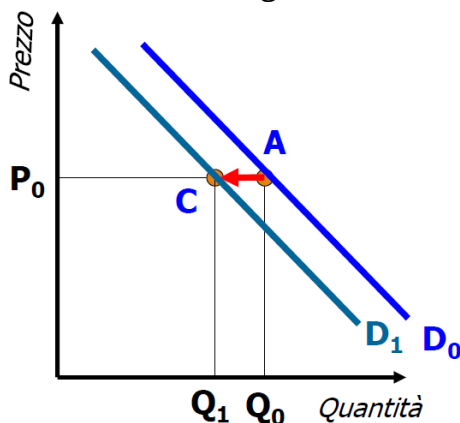
If the average income increases, the population has more resources to spend. At the same price, the population will therefore be able to afford to buy more printers. For example, for P_0 the quantity demanded increases from Q_0 to Q_1 . Graphically, this change is represented by a shift in the demand curve from D_0 to D_1 , resulting in an increase in the quantity demanded for each price level.

c. the price of ink cartridges increases



Cartridges are a related good (complementary) to printers. An increase in the price of cartridges makes printers more expensive to use and discourages their purchase. For example, for P_0 the quantity demanded decreases from Q_0 to Q_1 . Graphically, this change is represented by a shift in the demand curve from D_0 to D_1 , resulting in a decrease in the quantity demanded for each price level.

d. the tastes of consumers are changing: they prefer to keep their photographs and documents in digital format rather than in paper format

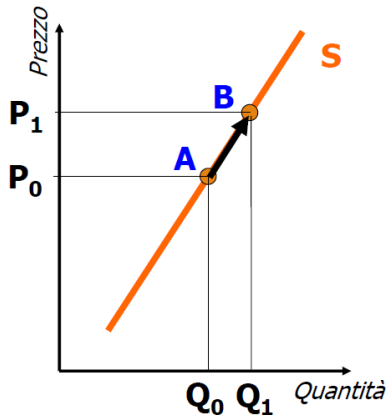


If the use of printers "goes out of fashion", regardless of the price, consumers will buy less (or even nothing) of them. For example, for P_0 the quantity demanded could decrease from Q_0 to Q_1 . As in the previous case (c), graphically this change is represented by a shift of the demand curve from D_0 to D_1 , for which there is a decrease in the quantity demanded for each price level.

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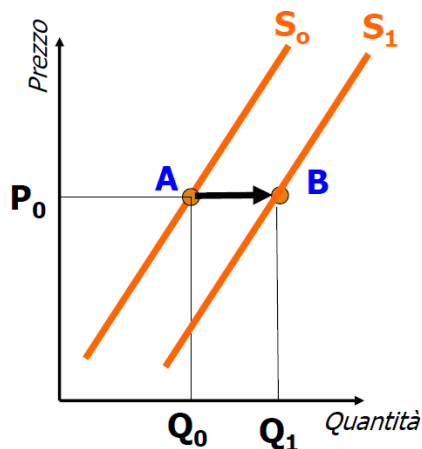
Exercise 2

a. the price of electric bicycles increases



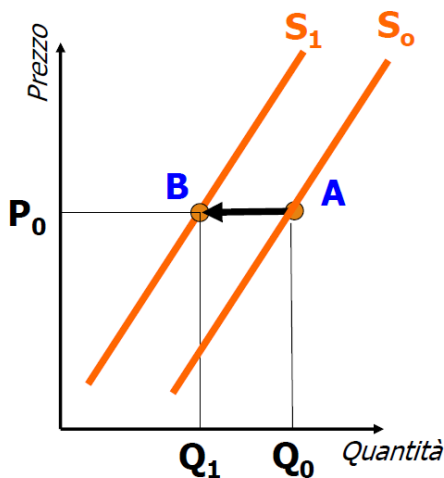
An increase in the price of electric bicycles from P_0 to P_1 (other supply conditions being equal) causes the reaction of the producers of that market, which attracted by the best profit opportunities, will produce electric bicycles in greater quantities, passing from quantity Q_0 to Q_1 . Graphically, this change is represented by a movement along the supply curve from A to B.

b. technological progress reduces the cost of producing electric batteries



Technological progress reduces production costs so that companies are incentivized to produce a greater number of electric bicycles at the same price. For example, for P_0 the quantity supplied increases from Q_0 to Q_1 . Graphically, this change is represented by a shift in the supply curve from S_0 to S_1 , so that there is an increase in the quantity offered for each price level.

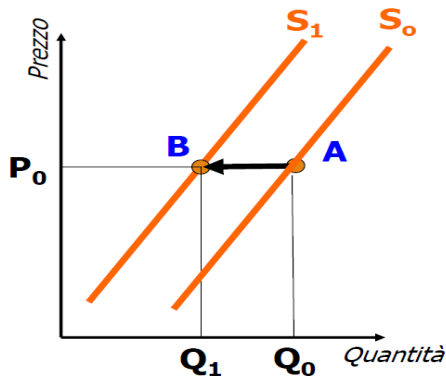
c. the government removes subsidies for electric bicycle manufacturers



The removal of government subsidies is reflected in an increase in taxes paid by companies and therefore in an increase in production costs, so that companies are incentivized to produce fewer electric bicycles at the same price. For example, for P_0 the quantity supplied decreases from Q_0 to Q_1 . Graphically, this change is represented by a shift in the supply curve from S_0 to S_1 , resulting in a decrease in the quantity supplied for each price level.

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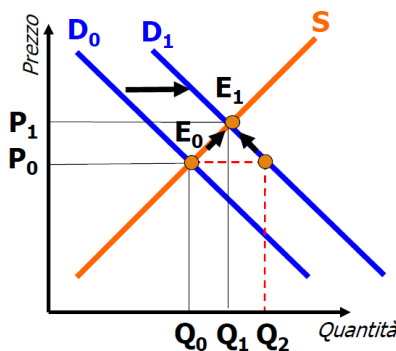
d. the price of electric scooters (monopattini) increases significantly



If the price of electric scooters (a good correlated to electric bicycles) increases, companies are encouraged by greater profit opportunities to direct part of their business to the production of scooters, reducing, at the same price, the production of electric bicycles. For example, for P_0 the quantity supplied can decrease from Q_0 to Q_1 . As in the previous case (c), graphically this change is represented by a shift of the supply curve from S_0 to S_1 , for which there is a decrease in the quantity supplied for each price level.

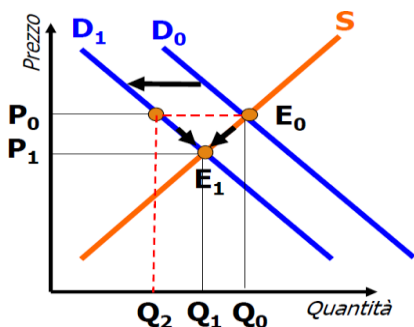
Exercise 3

a. climate change increases the need for cooling for consumers



The need for cooling pushes consumers to buy larger quantities of air conditioners at the same price. For example, for P_0 the quantity demanded increases from Q_0 to Q_2 . Graphically, this change is represented by a shift in the demand curve from D_0 to D_1 , resulting in an increase in the quantity demanded for each price level. The shortage that occurs at P_0 (the difference between Q_0 and Q_2) generates pressure on the increase in the market price from P_0 to P_1 , causing firms to increase the quantities produced from Q_0 to Q_1 and consumers to reduce the quantities demanded from Q_2 to Q_1 . The market finds a new equilibrium point by moving from E_0 to E_1 .

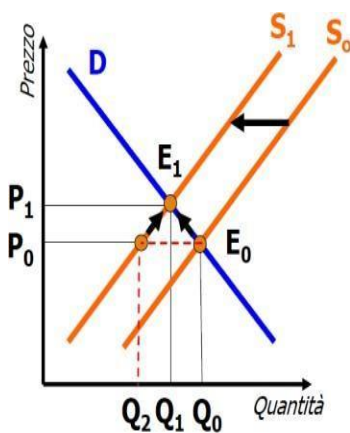
b. the government imposes a tax on those who have an air conditioner



The tax makes to own an air conditioner more expensive and discourages its purchase at the same price. For example, for P_0 the quantity demanded decreases from Q_0 to Q_2 . Graphically, this change is represented by a shift in the demand curve from D_0 to D_1 , resulting in a reduction in the quantity demanded for each price level. The surplus that occurs at P_0 (the difference between Q_0 and Q_2) generates pressure on the reduction of the market price from P_0 to P_1 , causing firms to reduce the quantities produced from Q_0 to Q_1 and consumers to reduce the quantities demanded from Q_2 to Q_1 . The market finds a new equilibrium point by moving from E_0 to E_1 .

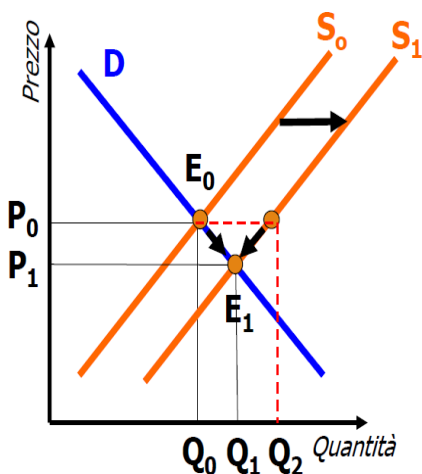
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c. The price of copper necessary for the production of air conditioners increases



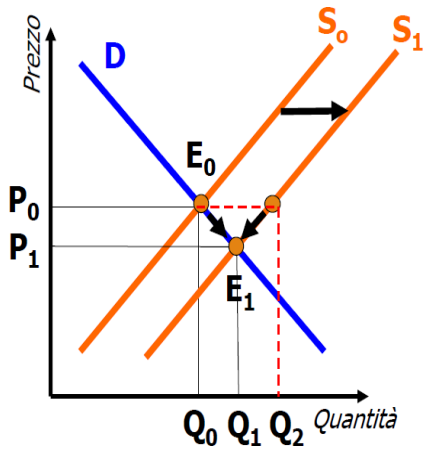
The increase in the price of copper is reflected in an increase in production costs, so companies are encouraged to produce fewer air conditioners at the same price. For example, for P_0 the quantity supplied decreases from Q_0 to Q_2 . Graphically, this change is represented by a shift in the supply curve from S_0 to S_1 , resulting in a decrease in the quantity offered for each price level. The shortage that occurs at P_0 (the difference between Q_0 and Q_2) generates pressure on the increase in the market price from P_0 to P_1 , causing firms to increase the quantities produced from Q_2 to Q_1 and consumers to reduce the quantities demanded from Q_0 to Q_1 . The market finds a new equilibrium point by moving from E_0 to E_1 .

d. The introduction of robotic assembly systems for air conditioners reduces production costs



The introduction of robotic assembly systems for air conditioners reduces production costs so that companies are encouraged to produce a greater number of air conditioners at the same price. For example, for P_0 the quantity supplied increases from Q_0 to Q_2 . Graphically, this change is represented by a shift in the supply curve from S_0 to S_1 , so that there is an increase in the quantity offered for each price level. The surplus that occurs at P_0 (the difference between Q_0 and Q_2) generates pressure on the reduction of the market price from P_0 to P_1 , causing firms to reduce the quantities produced from Q_2 to Q_1 and consumers to increase the quantities demanded from Q_0 to Q_1 . The market finds a new equilibrium point by moving from E_0 to E_1 .

e. The introduction of robotic assembly systems for air conditioners reduces production costs



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**CHAPTER 3:
Elasticity ANALYSIS**

CHAPTER 03: Elasticity ANALYSIS

Elasticity is an important concept in neoclassical economic theory, and enables in the understanding of various economic concepts, such as the incidence of indirect taxation, marginal concepts relating to the theory of the firm, distribution of wealth, and different types of goods relating to the theory of consumer choice. An understanding of elasticity is also important when discussing welfare distribution, in particular consumer surplus, producer surplus, or government surplus

Outline of this Chapter :

- ✓ Meaning/ Definition of Price Elasticity of Demand
- ✓ Determinants of Elasticity of Demand.
- ✓ Different Types of Elasticity of Demand

After studying this chapter, you will be able to understand :

- ✓ Applications of Elasticity of Demand
- ✓ Relationship between Price Elasticity and Revenue
- ✓ Importance of Price Elasticity of Demand

An **elasticity** measures the sensitivity of one variable to another. Specifically, it is a number that tells us the percentage change that will occur in one variable in response to a 01-percent increase in another variable. For example, the price elasticity of demand measures the sensitivity of quantity demanded to price changes. It tells us what the percentage change in the quantity demanded.

Elasticity is a general concept that can be used to quantify the response in one variable when another variable changes.

1. Elasticity of Demand

Shows how sensitive demand is to:

1. A change in the price of the good itself. Price Elasticity of Demand (PED)
2. A change in consumers' income. Income Elasticity of Demand (YED)
3. A change in the price of another good .Cross Elasticity of Demand (CED)

1.1) Price Elasticity of Demand

A popular measure of elasticity in Economics is the price elasticity of demand. It measures how consumers are responsive to changes in the price of a product.

- **Price elasticity of demand** is measured as the percentage change in quantity demanded, divided by the percentage change in price.
- **The price elasticity of demand** is the ratio of the percent change in the quantity demanded to the percent change in the price

$$Ep = \frac{\% \Delta Qx}{\% \Delta Px}$$

Computing the Price Elasticity of Demand

The price elasticity of demand can be written in different forms. We will use the Greek letter epsilon, ϵ , as a shorthand symbol, with a subscript **d** to denote demand, and the capital delta, Δ , to denote a change.

- We have three equations (or rules) to measure EP:

$$1-EP = \frac{\% \Delta Q_x}{\% \Delta P_x}$$

Example

If the price **rises** by 10% and the quantity demanded **falls** by 30%, calculate the demand elasticity

$$EP = \frac{\% \Delta Q_x}{\% \Delta P_x} = \frac{-30\%}{10\%} = -3$$

It means if P rises QD falls by 3%

$$2-EP = \frac{\% \Delta Q_x}{\% \Delta P_x} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \frac{\Delta Q}{Q} \cdot \frac{P}{\Delta P} = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$$

$$EP = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q} \Rightarrow \text{the point formula}$$

$$EP = \frac{\delta Q}{\delta P} \cdot \frac{P}{Q} = b \cdot \frac{P}{Q} \text{ If its an equation}$$

- Where $(\Delta Q/\Delta P)$ is **the derivative of the demand function with respect to P**. You don't really need to take the derivative of the demand function, just find the coefficient (the number) next to Price (P) in the demand function and that will give you the value for $\Delta Q/\Delta P$ because it is showing you how much Q is going to change given a 1 unit change in P.

Example

If the price of good x **falls** from 10 to 5, the quantity demanded of good x **rises** from 100 to 300, calculate the price elasticity of demand using the point formula.

$$EP = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q} = \frac{Q_2 - Q_1}{P_2 - P_1} \cdot \frac{P_1}{Q_1}$$

$$\Rightarrow EP = \frac{300 - 100}{5 - 10} \cdot \frac{10}{100} = \frac{200}{-5} \cdot \frac{10}{100} = -4$$

3- Arc Elasticity (Change between two points A and B in curve or demand schedule)

$$Edp = \frac{\Delta Q}{\Delta P} \cdot \frac{P_1 + P_2}{Q_1 + Q_2} \Rightarrow \text{the midpoint formula (Arc elasticity)}$$

- **The negative sign**
 - the sign of E must be **negative** due to the negative relationship between the Q D and the price
- **The absolute term**

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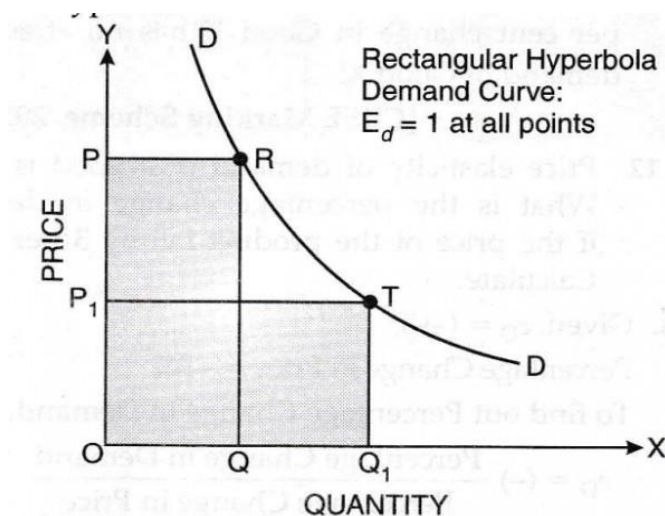
- when we compare the value of elasticity from one point to another, we neglect the **negative sign** that means we use the **absolute value** of elasticity.

1.1.1) Types of Price Elasticity of Demand

If P.E.D :	It is known as:	Which means:
Greater than 1 PED >1 %ΔQ_x > %ΔP_x	Elastic	The percentage change in demand is more than the percentage change in the price of a product A small change in price leads to relatively a larger change in quantity demanded and vice-versa
PED=1 %ΔQ_x = %ΔP_x	Unitary	The percentage change in demand is equal to the percentage change in the price
Less than 1 %ΔQ_x < %ΔP_x	Inelastic	The percentage change in demand is less than the percentage change in the price of a product. It means A greater change in price leads to relatively a larger change in quantity demanded and vice-versa
Infinity : PED = ∞	Perfectly elastic	Given the price, any quantity can be demanded..
PED = 0	Perfectly inelastic	No change in quantity demanded despite the changes in price.

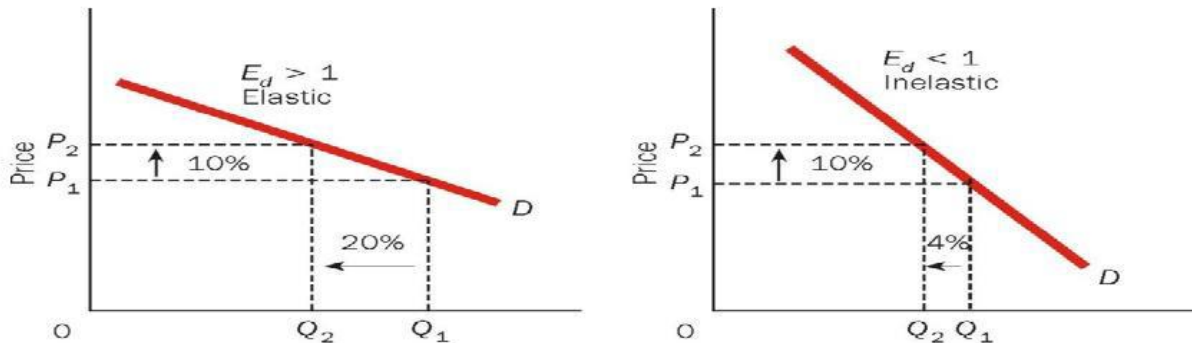
“Unit elastic demand”

Demand is unitary elastic when the percentage change in quantity demanded equals the percentage change in price. In this case, the demand demand curve is a rectangular hyperbola. At any point on this curve the value of elasticity is equal to unity.

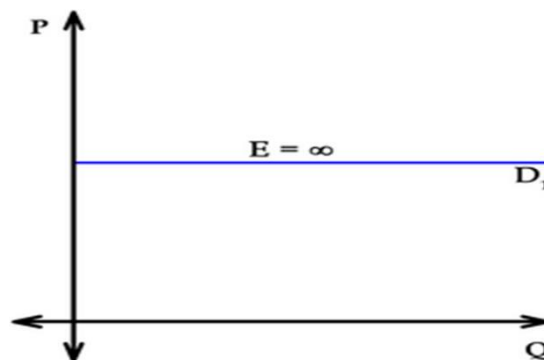


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“Elastic and inelastic demand”

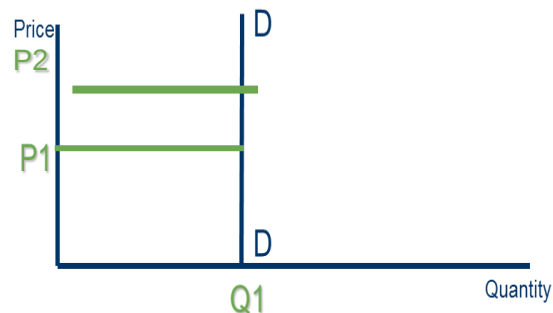


“Perfectly elastic demand”



Demand is **perfectly elastic** when the purchases are prepared to buy all that is available in the market at a particular price. In this case, the demand curve is horizontal at given price. If price increases even marginally, nothing will be purchased.

“Perfectly inelastic demand”



When the demand for a commodity is not responsive to any change in price demand is perfectly inelastic. In this case, the demand curve will be a vertical line. and E_p is equal to zero at every point on this demand curve e.g. The demand for salt is not likely to change with the change in price.

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-**Example:** very necessary goods that don't have any substitute such as life-saving medicines (such: Insulin)

Point price elasticity of demand (from demand equation)

Point elasticity is the price elasticity of demand at a specific point on the demand curve instead of over a range of the demand curve. It uses the same formula as the general price elasticity of demand measure, but we can take information from the demand equation to solve for the "change in" values instead of actually calculating a change given two points

Example 01

To find the point price elasticity of demand we begin with an example demand equation:

$$Q = 15,000 - 50P$$

Imagine that given this demand equation we are asked to figure out what the point price elasticity of demand is at two different prices,

$$P = 100 \text{ and } P = 10$$

- First we need to obtain the derivative of the demand function when it's expressed with Q as a function of P. Since quantity (Q) goes down by 50 each time price (P) goes up by 1,

This gives us $b = (\Delta Q / \Delta P) = -50$

Next we need to find the quantity demanded at each associated price and pair it together with the price: (100; 10,000), (10; 14,500)

- Then we plug those values into our point elasticity of demand formula to obtain the following:

$$e = -50(100/10,000) = -.5$$

$$e = -50(10/14,500) = -.034$$

And these results make sense, first, because they are negative (which demonstrates a downward sloping demand relationship) and second, because the higher level results in a relatively more elastic price elasticity of demand measure.

Example 2:

How to find the point price elasticity of demand with the following demand function:

$$Q = 4,000 - 400P$$

We know that $\Delta Q / \Delta P$ in this problem is -400, and we need to find the point price elasticity of demand at a price of 10 and at a price of 8.

At a price of ten, we demand 0 of the good, so the measure is undefined. At a price of 8 we will demand 400 of the good, so the associated measure is:

$$E = -400(8/400) = -8$$

1.1.2) Mid-point Method

To calculate elasticity, instead of using simple percentage changes in quantity and price, economists use the average percent change. This is called the **mid-point** method for elasticity, and is represented in the following equations:

$$Edp = \frac{\Delta Q}{\Delta P} \cdot \frac{P1 + P2/2}{Q1 + Q2/2} \Rightarrow Edp = \frac{\Delta Q}{\Delta P} \cdot \frac{P1 + P2}{Q1 + Q2}$$

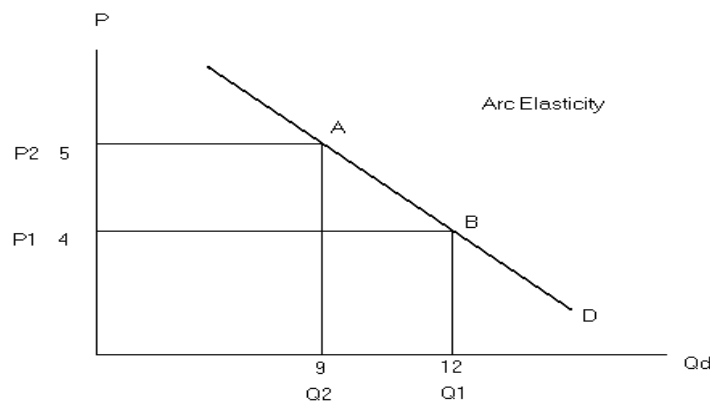
The advantage of the **mid-point method** is that one obtains the same elasticity between **two price points** whether there is a price increase or decrease. This is because the denominator is an average rather than the old value.

Example

Supposing we want to measure the elasticity between point A and point B appearing on the same curve in the figure

we assume that:

- P1 = 4, Qd1 = 12
- P2 = 5, Qd2 = 9



If we intend to calculate the elasticity between the two points, **A** and **B**, starting from point B and using the elasticity formula as illustrated above, this is what we get:

$$EdB = \frac{\Delta Qd}{\Delta P} \cdot \frac{P}{Q}$$

$$EdB = \frac{9-12}{5-4} \cdot \frac{4}{12} = -1$$

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If we intend to calculate the elasticity between the two points, **A** and **B**, starting from point **A** and using the elasticity formula as illustrated above, this is what we get:

$$EdA = \frac{12 - 9}{4 - 5} \cdot \frac{5}{9} = -1.7$$

We notice some differences in the results because the starting points were different. To avoid this difference in calculating **the Arc Elasticity**, calculating from the **middle point** between both points, **A** and **B**, could be the best way. This is known as the **Midpoint Law** which gives an average result.

$$\text{Price elasticity of demand} = \frac{\Delta Q}{\Delta P} \cdot \frac{P1 + P2}{Q1 + Q2} = -1.3$$

$$EdB = \frac{12 - 9}{4 - 5} \cdot \frac{4 + 5}{12 + 9} = -1.3$$

1.1.3) Factors Determining Price Elasticity of Demand for a Good

We defined elasticity of demand for a commodity as the degree of responsiveness of demand to changes in its determinants. The coefficient of the elasticity of demand determines the strength of responsiveness of demand to changes in its determinants. We classify elasticity into three: elastic, inelastic and unitary elastic. A number of factors determines whether demand is elastic, inelastic or unitary elastic. We will consider some of these factors.

- **Abundance of substitutes:** The more substitutes there are for a good, the more elastic the demand for it is, and the fewer the substitutes, the less elastic the demand for the good is.
- **Necessity of the commodity:** If the commodity is necessary, the demand for it will be slightly elastic, but if it is a luxury, the demand for it will be elastic.
- **The proportion of income spent on the commodity:** The greater the proportion of income spent on the commodity, the more elastic the demand for it is, and the lower the demand, the less elastic the demand.
- **Multiple uses of the good:** If the good has multiple uses, the demand for it is elastic, and if it is single-use, the demand for it is inelastic.

1.1.4) Elasticity and Total revenue

Revenue is just the price of a good times the quantity sold of that good. If the price of a good increases, then the quantity sold decreases, so revenue may increase or decrease. Which way it goes obviously depends on how responsive demand is to the price change. If demand drops a lot when the price increases, then revenue will fall. If demand drops only a little when the price increases, then revenue will increase. This suggests that the direction of the change in revenue has something to do with the elasticity of demand. Indeed, there is a very useful relationship between price elasticity and revenue change. The definition of revenue is:

$$R = P \cdot Q$$

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Total Revenue Along a Demand Curve

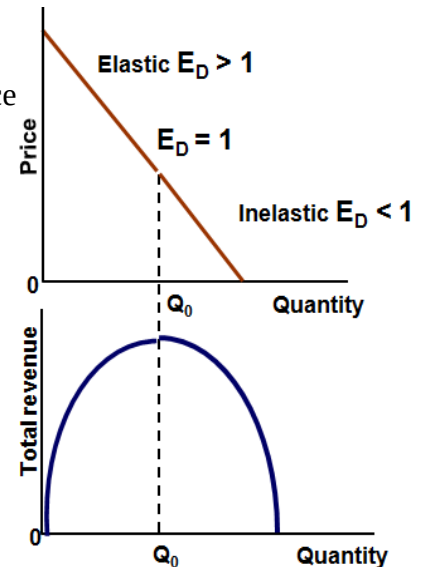
With **elastic** demand – a rise in price lowers total revenue TR increases as price

With **inelastic** demand – a rise in price increases total revenue and TR decreases as price falls.

If E_D is **inelastic** ($E_D < 1$), a rise in price increases total revenue.

If E_D is **unit elastic** ($E_D = 1$), a rise in price leaves total revenue **unchanged**

If E_D is **elastic** ($E_D > 1$), a rise in price lowers total revenue.



Elastic Demand and Total Revenue

If the percentage decline in quantity demanded following a price increase is larger than the percentage increase in price, total revenue will fall. This occurs when demand is **elastic**. The percentage price increase is outweighed by the percentage quantity decline.

Elastic Demand: **Elasticity** > 1 : Percentage change in quantity is greater than percentage change in price.

Rise Price: quantity demanded falls more → Higher price, lower total revenue **Lower**

Price: quantity demanded rises more → Lower price, higher total revenue

Example of Elastic Demand and Total Revenue

Price of Tim Horton's coffee Rises 10% from \$0.95 to \$1.05

Quantity Falls 20% from 110 to 90 cups per hour

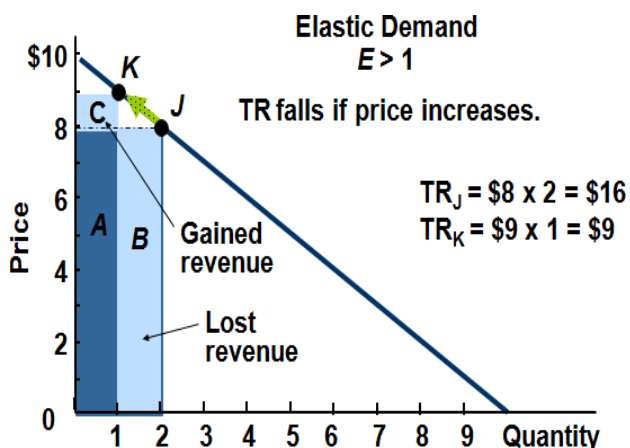
Elasticity = $20\% / 10\% = 2$

Total Revenue before the price rise:

$\$0.95 \times 110 = \104.50

Total Revenue after the price rise:

$\$1.05 \times 90 = \94.50



Inelastic Demand and Total Revenue

Because total revenue is the product of P and Q, whether TR rises or falls in response to a price increase depends on which is bigger: the percentage increase in price or the percentage decrease in quantity

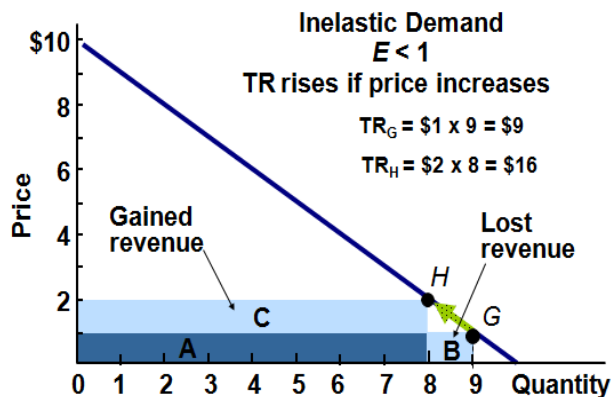
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demanded. If the percentage decrease in quantity demanded is smaller than the percentage increase in price, total revenue will rise. This occurs when demand is inelastic. In this case, the percentage price rise simply outweighs the percentage quantity decline and $P \times Q = (TR)$ rises.

Inelastic Demand: **Elasticity** < 1 :Percentage change in quantity is less than percentage change in price.

Raise Price: quantity demanded falls less → Higher price, higher total revenue

Lower Price: quantity demanded rises less → Lower price, lower total revenue



Example of Inelastic Demand and Total Revenue

Price of gasoline Rises 10% from 66.5 cents to 73.5 cents

Quantity Falls 5% from 205 to 195 liters per hour

Elasticity = $5\% / 10\% = .5$

Total Revenue before the price rise:

$\$.665 \times 205 = \136.33

Total Revenue after the price rise:

- $\$.735 \times 195 = \143.33

1.2) Cross-price elasticity of demand

Cross elasticity of demand, also known as **cross-price elasticity of demand**, is a measure of the responsiveness of the demanded quantity of one good to a change in the price of another good.

$$E_{xy} = \frac{\text{Percentage Change in Quantity of X}}{\text{Percentage Change in Price of Y}}$$

$$E_{xy} = \left(\frac{\Delta Q_x}{Q_x} \right) \div \left(\frac{\Delta P_y}{P_y} \right)$$

$$E_{xy} = \frac{\Delta Q_x}{\Delta P_y} \times \frac{P_y}{Q_x}$$

Example

The price (P) of Assam tea goes up from £2.20 to £2.50 leading to an increase in the quantity demanded (QD) of Ceylon tea from 10 to 18.

Let's calculate the cross elasticity of demand (E_{xy}) between the two goods:

Change in the QD of Ceylon tea = $(18-10) / 10 = 80\%$

Change in the P of Assam tea = $(2.50-2.20) / 2.20 = 13.64\%$

$$E_{xy} = 80\% / 13.64\% = 5.87$$

Understanding Cross Elasticity of Demand

In economics, the cross elasticity of demand refers to how sensitive the demand for a product is to changes in the price of another product. This means it determines the relationship between the quantity demanded of one good when the price for another good or product changes. Put simply, it measures how demand for one good changes when the price of another (usually related one) does.

➤ Substitute products

If the cross price elasticity of demand is **positive**, then X goods and Y are substitute:

$$E_{xy} > 0$$

Example

The price of Crest toothpaste goes up by 5%, leading to a contraction of demand. Consumers switch to Colgate toothpaste, causing an outward shift in the demand curve and an increase in the quantity demanded by 20%. The cross elasticity of demand between Colgate and Crest toothpastes is therefore: $20\% / 5\% = 4$.

➤ Complementary products

If the cross price elasticity of demand is **negative**, then X goods and Y are complement goods

$$E_{xy} < 0.$$

Example

The price of smartphones increases by 10% leading to a contraction of demand. This causes the demand curve for a complementary good (smartphone apps) to shift inwards, leading to a reduction in the demanded quantity by 20%. Cross elasticity of demand between smartphone apps and smartphones is: $-20\% / 10\% = -2$.

➤ Unrelated products

If there is no relationship between the goods, then an increase in the price of one good will not affect the demand for the other product. As such, unrelated products have a zero cross elasticity. $E_{xy} = 0$

For example, the effect of changes in taxi fares on the market demand for milk.

1.3) Income Elasticity of Demand

Income elasticity of demand measures the relationship between the consumer's income and the demand for a certain good. It measures the responsiveness of the quantity demanded to a change in consumer income.

Income Elasticity of Demand = % Change in Demand Quantity / % Change in Income of Consumer

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$$E_{XI} = (\Delta Q_x / Q_x) \div (\Delta I / I)$$

$$E_{XI} = \frac{\Delta Q_x}{\Delta I} \times \frac{I}{Q_x}$$

Income elasticity of demand may be **positive** or **negative**, or even non-responsive for a certain product. The consumer's income and a product's demand are directly linked to each other, dissimilar to the price-demand equation.

- If the income elasticity of demand is positive, then x is a normal good
- If the income elasticity of demand is equals or exceeds unity (**1**), then the good is a normal luxury good.

$$E_{XI} \geq 1$$

- If the income elasticity of demand is greater than zero but less than unity, then the good is a normal necessity

$$0 < E_{XI} < 1$$

- If the income elasticity of demand is negative, then x is an inferior good

$$E_{XI} < 0$$

Example 1

Year	Snacks consumed per month (in \$)	Income (in \$)
2021	200	4000
2022	275	5000

First, we determine individual values required for the income elasticity formula. We compute the percentage change in demand as follows:

- Percentage change in demand = $[(275-200)/ 200] \times 100 = 37.5\%$
- Percentage change in income = $[(5000-4000)/ 4000] \times 100 = 25\%$

Now, we apply the values in the income elasticity formula:

$$E_{XI} = \frac{\Delta Q_x}{\Delta I} \times \frac{I}{Q_x} = 37.5\% / 25\% = 1.5$$

Example 2

We want to calculate the income elasticity of demand for this year related to its washing machine sales. Due to an economic downturn, many community members have lost their jobs. The current average annual consumer income is \$45,000 compared to \$60,000 last year. The number of washing machines

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sold this year is 10,000 compared to 15,000 last year. Applebaum Appliances first needs to identify the percent change in demand and consumer income using the following calculations:

-Percent change in demand = $(10,000 - 15,000) / 15,000 = -33.33\%$

-Percent change in consumer income = $(45,000 - 60,000) / 60,000 = -25\%$

-Income elasticity of demand = $-33.33\% / -25\% = 1.32$

Based on this outcome, we determine that washing machines have a positive and more than unitary income elasticity of demand because it's more than one. This result means that washing machines are **luxury goods**.

Example 3

Let's consider an example. Ahmed is a software engineer who just started working at a company in Oran. Ahmed makes \$100,000 in a year. As Ahmed lives in Oran, where the living expenses are high, he has to consume a lot of fast food. In a year, Ahmed consumes 500 burgers.

The following year, Ahmed gets a rise in income from \$100,000 to \$150,000. As a result, Ahmed can afford more expensive food, such as dinners at Steakhouses. Therefore, Ahmed's consumption of burgers drops to 250 burgers in a year.

What is the income elasticity of demand for burgers?

To calculate the income elasticity of demand for burgers, let's calculate the percentage change in quantity demanded and the percentage change in Ahmed's income.

$-\% \Delta \text{Quantity} = (250 - 500) / 500 = -250 / 500 = -0.5 \times 100 = -50\%$

$-\% \Delta \text{Income} = (150,000 - 100,000) / 100,000 = 50,000 / 100,000 = 0.5 \times 100 = 50\%$

-Income elasticity of demand is equal to:

$$E_{XI} = -50\% / 50\% = -1$$

That means that when Ahmed's income increases by 1%, the amount of burgers he eats will decline by 1%. An **inferior good**.

2. Elasticity of supply

2.1) Definition

The elasticity of supply is a measure of the degree of responsiveness of the quantity supplied to the change in the price of a given commodity. It is an important parameter in determining how the supply of a particular product is affected by fluctuations in its market price. It also gives an idea about the profit that could be made by selling that product at its price difference. This elasticity is usually positive because a higher price gives producers an incentive to increase output.

2.2) Elasticity of Supply Formula

Elasticity of supply formula based on its definition.

Elasticity of Supply = PES

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$$1)Eps = \frac{\% \Delta Q_{sx}}{\% \Delta P_x}$$

Example 1

If the price of X increase **20%** and quantity supplied increase **30%** Calculate the price elasticity of supply explain your result?

$$Ep = \frac{30\%}{20\%} = 1.5$$

$$2)Eps = \frac{\Delta Q_s}{\Delta P} \cdot \frac{P_1}{Q_1} \Rightarrow \text{the point formula}$$

$$3)Eps = \frac{\delta Q}{\delta P} \cdot \frac{P_1 + P_2}{Q_1 + Q_2} \text{ the midpoint formula}$$

Example 2

As an example of elasticity of supply, let's assume that **the price of a chocolate bar increases** from \$1 to \$1.30. In response to the price increase of the chocolate bar, firms **increased** the number of chocolate bars produced from **100,000** to **160,000**.

Calculate the price elasticity of supply, using the **point** formula and **midpoint** formula

- **The point formula**

$$E_s = \frac{160,000 - 100,000}{1.30 - 1} \times \frac{1}{100,000} = 2$$

As the price elasticity of supply equals 2, it means that a change in the price of chocolate bars changes the quantity supplied for chocolate bars by **twice** as much.

- **The Midpoint formula**

$$E_s = \frac{160,000 - 100,000}{1.30 - 1} \times \frac{1 + 1.3}{100,000 + 160,000} = 1.76$$

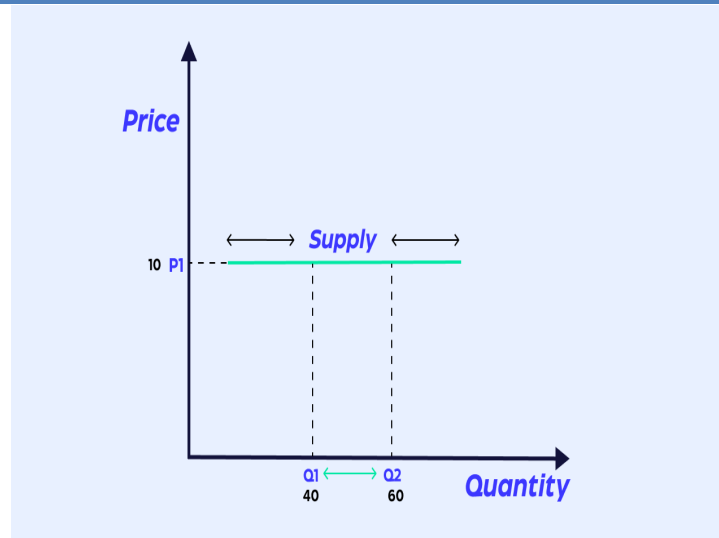
NOTE The sign of the price elasticity of supply must be positive due to the positive relationship between the quantity supplied and the price level

2.3) Types of Supply Elasticity

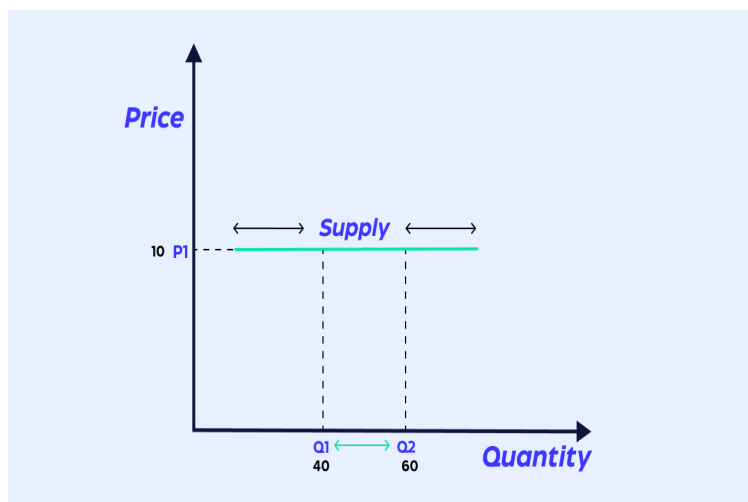
Price elasticity of supply is of 5 types :

- **Perfectly Elastic Supply (∞):** A commodity becomes perfectly elastic when its elasticity of supply is infinite. This means that even for a slight increase in price, the supply becomes infinite. For a perfectly elastic supply, the percentage change in the price is zero for any change in the quantity supplied.

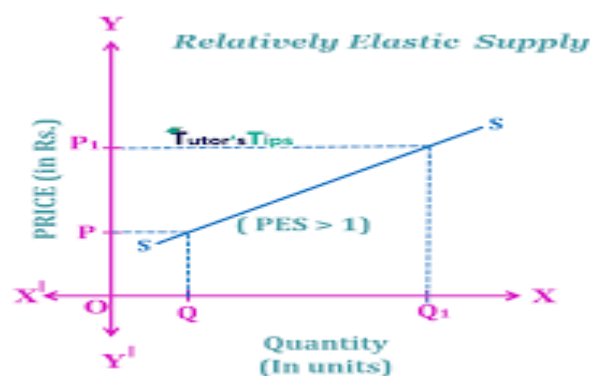
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- **Elastic Supply (More than Unit):** When the percentage change in the supply is greater than the percentage change in price, then the commodity has the price elasticity of supply greater than 1.

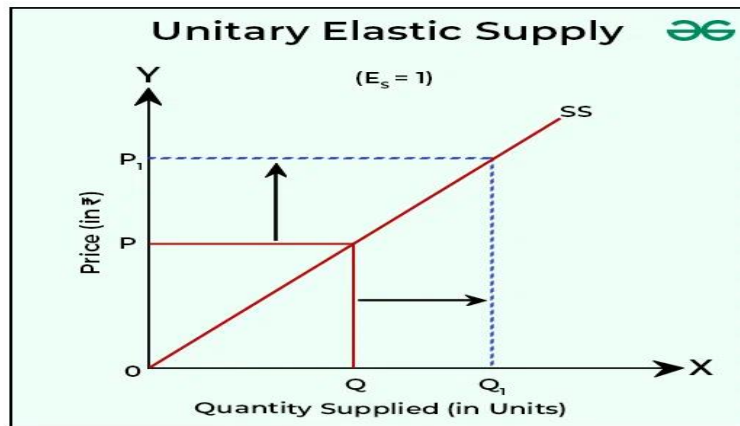


- **Unit Elastic Supply:** A product is said to have a unit elastic supply when the change in its quantity supplied is proportionate or equal to the change in its price. The elasticity of supply, in this case, is equal to 1.



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- **inelastic supply (between zero and one):** When the change in the supply of a commodity is lesser as compared to the change in its price, we can say that it has an *inelastic supply*. In such a case, the price elasticity of supply is less than 1.



- **Perfectly Inelastic Supply(0):** Product supply is said to be perfectly inelastic when the percentage change in the quantity supplied is zero irrespective of the change in its price. This type of price elasticity of supply applies to exclusive items. For example, a designer gown styled by a famous personality.



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Review Questions

Activity 01: Say whether these statements are true or false

1. If the quantity demanded for gasoline increased by 10 after a decrease in its price by 20 this means that the demand for gasoline is elastic **False**. → demand is inelastic
2. If the increase in price of fish has no effect on its Q.D this means that demand for fish is perfectly inelastic. **True** → if QD is constant, so price elasticity of demand = zero, so demand is perfectly inelastic
3. a vertical demand curve would have a price elasticity of zero **True** → vertical demand curve is called perfectly inelastic demand curve, and price elasticity of demand in this case = zero
4. the price elasticity of demand measures the change in Q D of product when the price of other product change **False** → the price elasticity of demand measures the ratio of the percentage change in the quantity demanded of any good to the percentage change in its price
5. A perfectly elastic demand is represented as a horizontal line **True**
6. if the income elasticity of demand is greater than one, it means that the good is necessary **False** → **Luxury**
7. The ratio of the percentage in quantity demanded to the percentage change in income is known as the cross elasticity of demand **False**
→ known as the income elasticity of demand
8. Income elasticity of demand describes how change in demand for any good affects income **False**
→ (Income elasticity of demand describes how change I income affects demand for any good)
9. Cross elasticity of demand measures the responsiveness of the quantity demanded of one good to a change in the price of another good **False**
→ (measures the responsiveness of the demand of one good to a change in the price of another good)
10. A negative cross elasticity indicates that two goods are complements. **True**
11. The sign of cross elasticity of demand is always positive between two goods → **False** → (could be if x y are substitutes), could be **False** -- (if x y are complements), could be zero if x y are independent)
12. Income elasticity of demand describes how change in demand for any good affects income **False**
→ Income elasticity of demand describes how change in income affects demand for any good
13. If the income elasticity of demand is greater than one, it means that the good is **necessary**. **False**
→ (**Luxury**)
14. A negative cross elasticity indicates that two goods are complements **True**

Activity 02: Choose the correct answer

- 1) The responsiveness (or percentage change) of quantity demanded of a commodity to one percentage change in its price is known as a.
 - a. Elasticity of demand.
 - b. Elasticity of supply,
 - c. Law of demand,
 - d. Law of supply.

2) The coefficient of elasticity of demand ranges from :

- a. Zero to one,
- b. Zero to infinity,
- c. One to infinity,
- d. None

3) The percentage change in quantity demanded due to percentage change in income is known as :

- a. Point elasticity of demand,
- b. Income elasticity of demand,
- c. Cross price elasticity,
- d. Arc elasticity of demand.

4) A quantitative measure of the effect on the quantity demanded of a good (x) due to change in the price of other good (y) is known as .

- a. Point elasticity of demand,
- b. Income elasticity of demand,
- c. Cross price elasticity,
- d. Arc elasticity of demand.

5) Which of the following is **not** correctly matched.

- a. If the value of $e_s = 1 \Rightarrow$ Supply is unitary elastic.
- b. If the value of $e_s < 1 \Rightarrow$ Supply is inelastic.
- c. If the value of $e_s = \infty \Rightarrow$ Supply is perfectly elastic.
- d. If the value of $e_s > 1 \Rightarrow$ Supply is perfectly inelastic.
- e. If the value of $e_s = 0 \Rightarrow$ Supply is perfectly inelastic.

Activity 03: Exercises

Exercise 01

The demand curve for a product is given by the equation:

$$Q=100-2P$$

- 1. Calculate the price elasticity of demand (PED) when the price is \$20.
- 2. How does elasticity change as the price increases or decreases along the demand curve?

Exercise 02

A company estimates the demand for its product (Good X) with the following demand function:

$$QX = 100 - 2PX + 0.5PY + 0.3I$$

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Assume the following initial values:

- $P_X=10$, $P_Y=20$, $I=50$ (i.e., income = \$5,000)
- 1. Find the quantity demanded of Good X at the given values.
- 2. Price Elasticity of Demand for Good X.
- 3. Calculate Cross-Price Elasticity of Demand .
Are Good X and Good Y substitutes or complements?
- 4. Calculate the Income Elasticity of Demand:
Is Good X a normal or inferior good? Is it a necessity or luxury?

Solutions

Exercise 01

1. Price Elasticity of Demand (PED) Formula

The price elasticity of demand is given by the formula :

$$Q=100-2P$$

$$PED = \frac{\delta Q}{\delta P} \cdot \frac{P}{Q} = -2 \cdot \frac{P}{100 - 2P}$$

Calculate PED at P=20

Now, let's calculate Q when P=20 using the demand equation:.

Substitute the values into the PED formula :

$$PED = -2 \cdot \frac{P}{100 - 2P} = \frac{-2 \cdot 10}{100 - 2(20)} = -0.67$$

So, the price elasticity of demand at P=20 is **-0.67**.

Since **PED=-0.67**, the demand is **inelastic** at this price point (because the absolute value of PED is less than 1). This means that a 1% increase in price will result in a less than 1% decrease in quantity demanded.

2. How Elasticity Changes Along a Linear Demand Curve

For a linear demand curve of the form **$Q=a-bP$** the price elasticity of demand varies along the curve.

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- **At higher prices** (on the upper part of the demand curve), the demand tends to be **more elastic** (greater absolute value of PED). This is because the percentage change in quantity is larger for a given percentage change in price when the price is high.
- **At lower prices** (on the lower part of the demand curve), the demand tends to be **more inelastic** (smaller absolute value of PED). This is because the percentage change in quantity is smaller for a given percentage change in price when the price is low.

Therefore, as the price decreases along the demand curve, the elasticity of demand tends to decrease (becomes more inelastic).

Exercise 02

$$QX = 100 - 2PX + 0.5PY + 0.3I$$

Given values:

- $P_x=10$, $P_y=20$, $I=50$

1 . Find the quantity demanded QDx

Plug the values into the demand function:

$$QA = 100 - 2(10) + 0.5(20) + 0.3(50) = 100 - 20 + 10 + 15 = 105$$

2 .Price Elasticity of Demand (PED)

$$EP = \frac{\delta Q}{\delta P} \cdot \frac{P}{Q} = -2 \cdot \frac{10}{105} = 0.19$$

Demand is **inelastic** since $0 < |EP| < 1$.

3.Cross-Price Elasticity (CED)

$$EP = \frac{\delta Q_x}{\delta P_y} \cdot \frac{P_y}{Q_x} = 0.5 \cdot \frac{20}{105} = 0.095$$

Since $CED > 0$, **Good X and Good Y are substitutes**.

4. Income Elasticity (IED)

$$EP = \frac{\delta Q}{\delta I} \cdot \frac{I}{Q} = 0.3 \cdot \frac{50}{105} = 0.143$$

- Since $IED > 0$, **Good X is a normal good**.
- Since $IED < 1$, it is a **necessity**, not a luxury.

**Chapter 04 :
Applications on Supply and
Demand : Government Intervention**

Chapter 04

Applications on Supply and Demand : Government Intervention

Government intervention refers to the regulatory action taken by a government that aims to change decisions made by individuals, organizations, or groups regarding economic and social matters. Its primary goal is to maximize a country's social welfare by correcting market failure.

The three main types of government intervention in the market: **price controls, taxes and subsidies**. Each of these government interventions are modelled to show their effects on supply and demand, and the market equilibrium for a good and service. Thus, each type of intervention will have an effect on the price of a good or service, and the quantity demanded and the quantity supplied in the market.

Outline of this Chapter:

- ✓ Price controls (Price Ceiling and Price Floor)
- ✓ Taxes and Subsidies

After studying this chapter, you will be able to understand:

- ✓ Explain price controls, price ceilings, and price floors
- ✓ Distinguish between Ad Valorem and specific tax
- ✓ Understand the quantity and price affect from a tax
- ✓ Describe why both taxes and subsidies affect price and quantity

1. Price controls:

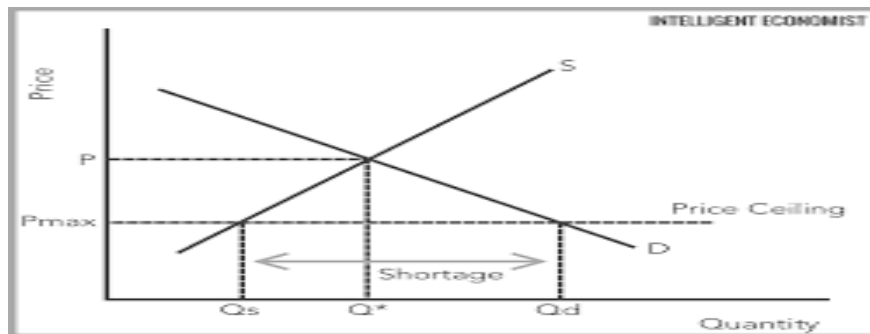
Price controls are government rules or laws that inhibit the formation of market-determined prices. Price controls come in the form of either **floors** or **ceilings**.

1.1) Price ceiling

A **price ceiling** is a legal maximum price that one pays for some good or service. A government imposes price ceilings in order **to keep** the price of some necessary good or service affordable. Price ceiling is usually set **to protect consumers from high prices**. (to subsidize food)

The aim of this pricing policy is to prevent the sale and purchase of a product at a price higher than the ceiling price. The government therefore intervenes to set compulsory prices for certain necessary goods that are below the equilibrium price for the benefit of consumers. The government often imposes a penalty on those who trade at a price higher than the officially set price. As a result of this pricing policy, there is excess demand (or a supply deficit) equal to the difference between the quantity demanded and the quantity offered.

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Price ceiling creates a shortage (an excess demand),

In the figure above, before the government intervened, the equilibrium price was P^* and the equilibrium quantity was Q^* . After the government intervened and set a **maximum** price P_{max} , producers will produce the quantity Q_s , while consumers will demand the quantity Q_d , and the difference ($Q_d - Q_s$) represents the **surplus demand**.

The question that arises in this case is: how can this surplus be disposed of?

There are several solutions, including:

- Importing this deficit (supply deficit) and selling it directly to consumers at prices below market prices
- Granting a subsidy to producers equivalent to the difference between the administratively fixed price and the market price, in order to produce the required quantity and sell it at low prices.
- Adopt a quota system in the distribution of the quantities available at low prices through the card system to guarantee a fair distribution of the specified quantities, while giving priority to people on low incomes.

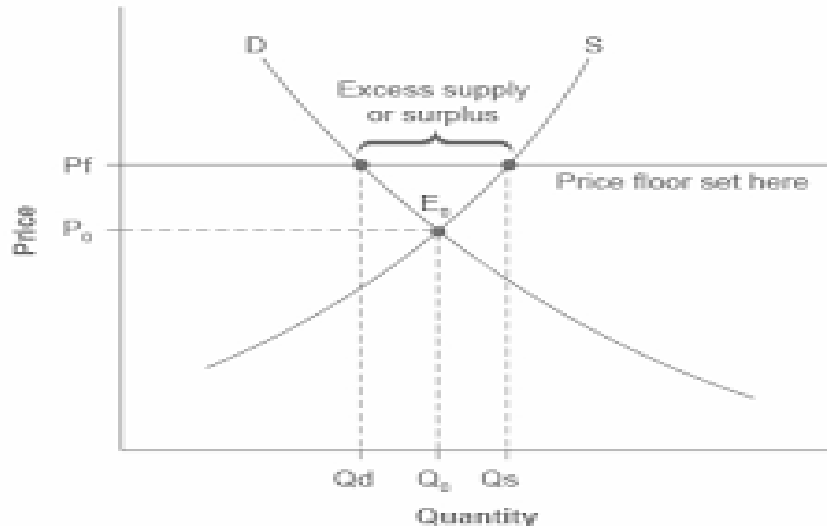
Whatever the solutions, excess demand will be disposed of in what is known as the **black (parallel) market**.

1.2) Price Floors

- A price floor is the lowest legal price that can be paid in a market for goods and services, labor, or financial capital.
- Price floor is usually set to support producers, ensuring they receive a fair income.
- Price floor creates a surplus (an excess supply) So, the government will be forced to buy the surplus products
- If the price floor is set below the equilibrium price, it will have no effect.

This pricing policy aims to prevent the buying and selling of the product below the floor price. The government can intervene to set a price above the equilibrium price in order to ensure a minimum level of income, in order to ensure a certain degree of income stability, which generally concerns farmers' incomes. Due to IMPREVIOUS changes, leading to the appearance of abundance threatening the collapse of crop prices and a reduction in the income of groups of farmers.

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In the figure above, before the government intervened, the equilibrium price was P^* and the equilibrium quantity was Q^* . After the government intervened and set a **minimum price** P_{min} , producers will produce the quantity Q_s , while consumers will demand the quantity Q_d , and the difference ($Q_d - Q_s$) represents the **excess supply**.

The abundant supply is absorbed in two ways:

Either the government directly finances its purchase and bears the difference, or it encourages and helps farmers to store this surplus, for example by bearing the storage costs.

Example

If you have the demand and market supply functions for the commodity (Q_x) as follows:

$$Q_d = 120 - 4P \quad \quad Q_s = 4P$$

1. Find the equilibrium price and quantity mathematically
2. What happens to the market if the government decides to set a maximum price of 10 \$?
3. Assuming that the government decided to impose a minimum price estimated at 20 \$, what is the impact of this on the equilibrium values?

Solution

The demand function QD is equal to the supply function QS at equilibrium.

$$QD = QS$$

$$120P - 4P = 4P \Rightarrow 120 = 8P$$

$$\text{SO} \quad P=15$$

So, the equilibrium price (P) is \$15.

Now that we have the equilibrium price, substitute this value back into either the demand or supply function to find the equilibrium quantity.

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$$Q_d - 120 - 4 \cdot 15 = 60$$

So, the equilibrium quantity (Q) is 60.

Therefore, the equilibrium price is \$15, and the equilibrium quantity is 60 units.

1. Price Ceiling of \$10

Excess Demand: Excess demand occurs when the quantity demanded (Q_d) at the maximum price is greater than the quantity supplied (Q_s).

$$Q_d = 120 - 4 \times 10 = 80 \quad Q_s = 4 \times 10 = 40$$

$$\text{Excess Demand} = Q_d - Q_s = 80 - 40 = 40 \text{ units.}$$

2. Price Floor of \$20:

Given a minimum price ($P_{\min}$) of \$20:

• **Excess supply** occurs when the quantity supplied (Q_s) at the minimum price is greater than the quantity demanded (Q_d).

$$Q_D = 120 - 4 \cdot 20 = 40 \quad Q_S = 4 \cdot 20 = 80$$

$$\text{Excess Supply} = Q_S - Q_d = 80 - 40 = 40$$

2. Taxes and subsidies

The government can influence markets and its citizens in many ways. Two of these types of tools are **taxes** and **subsidies**. Let's start off by establishing the difference between taxes and subsidies! Taxes and subsidies are two financial mechanisms the government uses; we'll cover why these exist and what implications they have for the government, citizens, and businesses.

2.1) Taxes

- Taxes are a charge the government imposes on individuals' and firms' income and goods and services, directly or indirectly against services provided to the community
- The purpose of imposing taxes is to generate government revenue.

2.1.1) Two Types of Tax Systems

- **Direct Taxation(a tax on income):** A direct tax is assessed on the income of the taxpayer and is generally collected before the taxpayer collects his wages.
- **Indirect Taxation(a tax on expenditure):** An indirect tax is an avoidable tax assessed on certain activities, such as purchasing goods or services. Examples of an indirect tax include sales tax and **VAT** (value added tax).

Specific Tax vs Ad Valorem

Specific and **Ad Valorem** Taxes are types of **indirect taxes**. Both are generally assessed on the sale of goods. These two taxes differ in :

- **specific taxes** are typically a fixed fee per unit, meaning that the government earns its revenue based on quantity sold.

Example:

the government imposes a specific tax on the product of 6 \$($T=6$)

When a specific tax T is imposed, demand remains the same while supply changes, so the supply function takes the following form:

$$QS = c + d(P - t)$$

- **Ad valorem** taxes are proportional(percentage) to the price of the good, so the government earns revenue based on the value of the good or service being sold.

Example:

the government imposes an ad valorem of 25% on the equilibrium point($r= 25\%$)

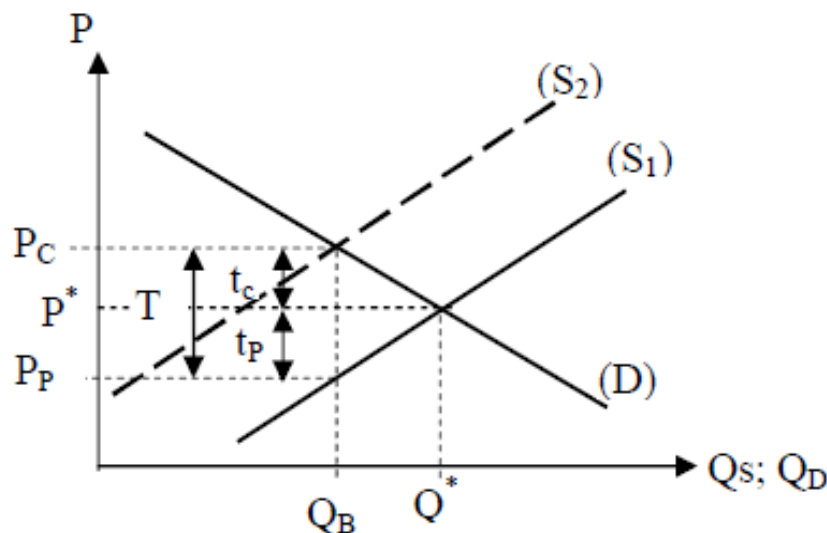
When an ad valorem r is imposed, demand remains the same while supply changes, so the supply function takes the following form:

$$QS = c + dP(1 - r)$$

2.1.2) Impact of tax on price and quantity

Taxes shift supply curve up to the **left** And we reach a new equilibrium point P_e will increase and Q_e will decrease.

First, consider a tax imposed on the seller. At a given price p , and tax t , each seller obtains $p - t$, and thus supplies the amount associated with this net price. Taking the before-tax supply to be S_1 Before, the after-tax supply is shifted up by the amount of the tax.



- The tax causes a decrease in supply which in turn causes an increase in the equilibrium price from **Pe** to **Pet**. The higher price causes a contraction in quantity demanded from **Qe** to **Qet**.
- We notice from the figure that the equilibrium point before the imposition of the tax is point A(p_e , Q_e). However, after the imposition of the tax, the **equilibrium point** has changed due to the shift of the supply curve to the left.
- The price difference between them reflects the amount of the tax, as follows: $T = p_c - p_p$. The amount of the tax can also be found using the following relationship: $T = t_c + t_p$

Where:

- p_c represents the price that the buyer pays to obtain the commodity after the tax is imposed.
- p_p represents the price received by the seller after the tax is imposed.
- T represents the amount of the tax.
- t_c represents the amount the consumer bears from the tax ($t_c = p_c - p^*$).
- t_p represents the amount the seller bears from the tax ($t_p = p^* - p_p$ or $t_p = T - t_c$).

When a t specific tax is imposed, the demand function remains the same, while the supply function becomes:

$$Q_S = c + d(P - t)$$

Finding the equilibrium price after imposing the tax:

$$Q_S = Q_D$$

$$c + d(P - t) = a + bP$$

The equilibrium price after the tax will be **P_{et}**:

$$P_{et} = \frac{a-c}{d+b} + \frac{d}{d+b} t$$

We note that the difference between the equilibrium prices before and after imposing the tax is $\frac{d}{d+b} t$ (it is zero when no tax is imposed).

Finding the equilibrium quantity after imposing the tax:

Substituting the new equilibrium price into the demand function we find:

$$Q_{et} = Q_D = a - bP_{et} \rightarrow Q_{et} = a - b\left(\frac{a-c}{d+b} + \frac{d}{d+b} t\right)$$

So

$$Q_{et} = \frac{ad + bc}{d + b} - \frac{bd}{d + b} t$$

We note that the difference between the equilibrium quantity before the tax was imposed and after it was imposed is $\frac{bd}{d+b} t$ (it is zero if no tax is imposed). This is the same amount by which the equilibrium quantity decreases.

2.1.3) Who pays for the tax?

- The tax burden is distributed between the consumer and the producer according to the **elasticity of demand and supply**:
- The consumer bears the largest part of the tax. $\frac{E_S}{E_D} > 1$
- The producer bears the largest part of the tax. $\frac{E_S}{E_D} < 1$
- Producer and consumer bear the same tax burden. $\frac{E_S}{E_D} = 1$
- The consumer bears the entire tax burden. $E_D = 0$
- The producer bears the entire tax burden. $E_S = \infty$

2.1.4) Tax revenue

Tax revenue is income generated by governments through taxes., and is expressed mathematically by the relationship:

$$T = t \cdot Q_{et}$$

Example

- The demand and supply functions of a good are given by:

$$Q_{dx} = 15 - 2P_X$$

$$Q_S = 20P_X$$

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- If you know that the market includes 1000 consumers and 50 producers;

1-Determine the equilibrium price and quantity

2-Determine the effect on the market equilibrium if the government decides to impose a fixed tax of 1.5\$ on each good price and quantity

3-explain how the tax burden is distributed between the consumer and the producer.

Solution

1-Finding the market demand and supply functions:

✓ **Demand market**

$$Q_{DX} = 1000 \cdot Q_{dX}$$

$$\Rightarrow Q_{DX} = 1000(15 - 2P_X) = 15000 - 2000P_X$$

✓ **Supply market**

$$Q_{SX} = 50 \cdot Q_{sX} = 50(20P_X) = 1000P_X$$

- Find the Initial Equilibrium (Before Tax)

The initial equilibrium is found by setting the quantity demanded equal to the quantity supplied:

$$Q_{DX} = Q_{SX}$$

$$15000 - 2000P_X = 1000P_X$$

$$P_e = 5 \quad Q_e = 5000$$

So, the initial equilibrium price is **Pe=5**, and the equilibrium quantity is **Qe=5000**

2-Find the New Equilibrium (After Tax)

Set the new supply equation equal to the demand equation to find the new equilibrium price **Pet**:

$$Q_{1S} = 1000(P_1 - t) = 1000(P_1 - 1.5)$$

$$Q_{1X} = Q_{DX} \Leftrightarrow 1000P_1 - 1500 = 15000 - 2000P_1$$

$$\Rightarrow P_1 = 5.5 \dots \dots \dots Q_1 = 4000$$

3.Calculate the Tax Burden on Consumers and Producers

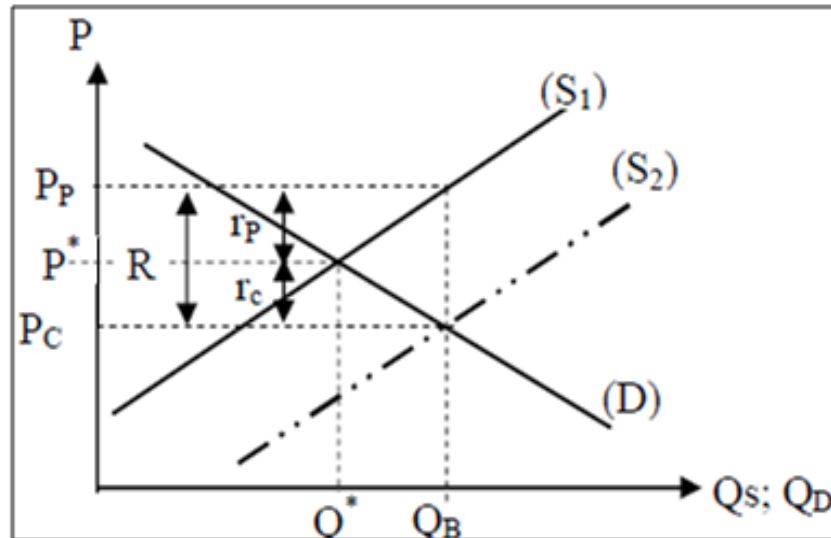
- **. Price Paid by Consumers:** After the tax, consumers pay $P_c = P_e + t = 5.5$.
- **. Price Received by Producers:** Producers receive $P_p = P_c - t = 5.5 - 1.5 = 4$
- **Consumer Tax Burden:** The initial price was $P_e = 5$, and now consumers pay $P_c = 5.5$.
- **Consumer Burden** $= P_c - P_e = 5.5 - 5 = 0.5$
- **Producer Tax Burden:** The initial price was $P_e = 5$, and now producers receive $P_p = 4$.
- **Producer Burden** $= P_e - P_p = 5 - 4 = 1$

2.2) subsidies

A subsidy is a certain amount of money given to a firm by the government in order to try and increase production or consumption of a good/service.

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The government can sometimes use production subsidies for certain industries that it wishes to encourage, so that prices fall and demand increases, and therefore supply increases. Subsidies can be seen as a negative tax, so the effect of the subsidy is the opposite of the effect of the tax.



This can be shown on the diagram above as the subsidy lowers costs of production causing supply to increase from S_1 to S_2 . As a result of this, price decreases from P_1 to P_2 and quantity increases from Q_1 to Q_2 .

When the government granted a subsidy of S for each unit sold, demand remains the same while supply changes, so the supply function takes the following form:

$$Q_S = c + d(P + t)$$

Cost of a Subsidy

If the government provides a subsidy of S on each unit bought and sold, **the total cost** of the subsidy is equal to S times the equilibrium quantity in the market after the subsidy is granted, as given by this equation.

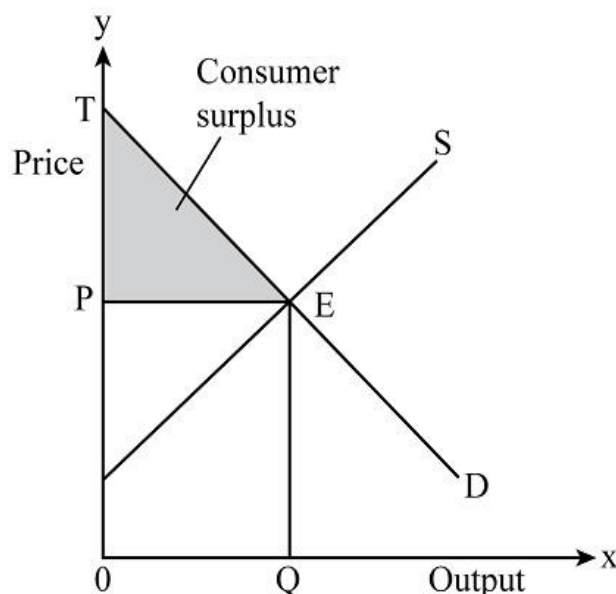
$$\text{Subsidy Cost} = S * Q_{es}$$

3. Consumer surplus and producer surplus

3.1. Consumer Surplus (CS)

Consumer surplus is the economic benefit consumers receive when they pay less than they're willing to pay for a product or service. In supply and demand diagrams, it appears as the triangular area between the demand curve and the market price line (see below). As such, it puts a number to the feeling you have when you get a good deal on something.

Graphically It's the area under the demand curve and above the price, up to the quantity sold.



This graph illustrates consumer surplus, the triangular area represents the difference between the maximum price consumers would pay (shown by the demand curve) and the actual market price they pay.

Calculating the Consumer Surplus

The basic formula for consumer surplus is the following:

Consumer Surplus = (Maximum price willing to pay - Actual price) × Quantity purchased

Economists use this formula to calculate it:

Consumer surplus = $(\frac{1}{2}) \times Q_d \times \Delta P$

Where:

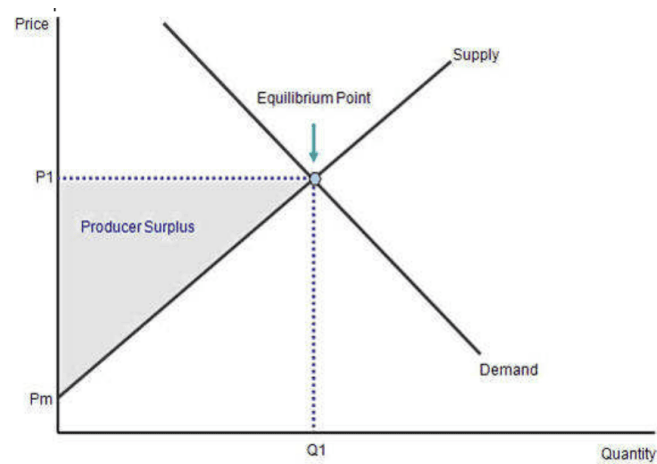
- Q_d = the quantity at equilibrium where supply and demand are equal
- ΔP = $P_{\max}$ (the price a consumer is willing to pay) – P_d (the price at equilibrium where supply and demand are equal)

3.2. Producer Surplus (PS)

Producer surplus is the difference between how much a person would be willing to accept for a given quantity of a good versus how much they can receive by selling the good at the market price. The difference or surplus amount is the benefit the producer receives for selling the good in the market.

Graphically it's the area above the supply curve and below the price, up to the quantity sold.

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The triangular area shows the area of producer surplus, which shows that the equilibrium price received in the market was more than what many of the producers were willing to accept for their products.

Total Surplus = Consumer Surplus + Producer Surplus

It represents the total benefit to society from buying and selling the good. Maximized at market equilibrium, where supply meets demand.

Review Questions

Activity 01: choose the correct answer

1) An excise tax placed on the producer of an item will:

- A. shift the supply curve to the left
- B. shift the supply curve to the right.
- C. make the supply curve steeper by rotating counterclockwise.
- D. make the supply curve flatter by rotating clockwise

2) When government imposes a price floor below the market price, the result will be that:

- A. surpluses occur.
- B. shortages become a problem.
- C. supply and demand will shift up to the new equilibrium.
- D. A price floor set below the equilibrium price will have no effect on the market equilibrium.

3) In a competitive market, the market demand is $Q_d = 48 - 5P$ and the market supply is $Q_s = 7P$. A price ceiling of \$5 will result in a shortage of:

- A. 36 units.
- B. 24 units.
- C. 16 units.
- D. None of the responses are correct

4) Price ceiling creates a shortage, which may cause:

- a. queuing
- b. the black market
- c. favored customers
- d. using ration coupons to distribute the limited quantity of the product by the government
- e. All the above

5) In 1973 the price of oil doubled. One consequence of this might be a:

- a. rightward shift of the supply curve for gasoline
- b. leftward shift of the supply curve for gasoline
- c. rightward shift of the demand curve for gasoline
- d. leftward shift of the demand curve for gasoline
- e. upward movement along the supply curve of gasoline

6) Which of the following government policies would likely cause a shortage in the market?

- A. Price ceiling
- B. Price floor
- C. Tax
- D. Subsidy

Activity 02: Say whether these statements are true or false:

1. Market price includes the impact of indirect taxes, but not of subsidies. **False**
→ Market price includes the impact of both indirect taxes and subsidies. Indirect taxes raise the market price while subsidies lower it.
2. If demand is perfectly elastic, the tax burden is shared by both the seller and the buyer in different proportions. **False**
→ The tax burden falls entirely on the producer.
3. The minimum wage is an example of a price ceiling. **False**
→ the minimum wage, on the other hand, is a government-imposed minimum price that must be paid to workers for their labor. It sets a floor, not a ceiling, on wages
4. When a production tax is imposed and the elasticity of demand is greater than the elasticity of supply, the consumer bears a greater tax burden than the producer. **False**
→ The producer bears a greater tax burden than the consumer.
5. The consumer price after the tax is imposed is the same as the equilibrium price after the tax is imposed. **True**
6. A price floor is the **maximum** price set by the government below the equilibrium price **False**
7. Price ceiling is a **minimum** price which sets by government below the equilibrium price to protect consumers **False** → maximum price

Activity 03: Exercises

Exercise

The demand and supply equations for a particular commodity are as follows:

$$QD=15-4Px$$

$$QS=6Px -1$$

1-Find the equilibrium values for this market.

2-Calculate the price elasticity of demand and supply at equilibrium point.

If we assume that the government decides to impose a tax of 2 \$ for each unit sold, find:

3-Determine the price that the consumer will pay and that the seller will receive.

4-Determine the amount of tax burden for both the consumer and the seller.

5- Determine the tax revenue generated.

Now, we assume that the government granted a subsidy of 2 \$ for each unit sold, then is required is to find:

6-The price that the consumer pays, specifying the amount of his benefit from this subsidy .

7-The price that the seller receives, specifying how much he benefits from this subsidy.

8-The cost of the subsidy.

Soution of Exercise

1- Find the equilibrium values for this market

The initial equilibrium is found by setting the quantity demanded equal to the quantity supplied:

$$Qd=Qs$$

Given: $Qd=15-4Px$ and $Qs=6Px-1$

Set $Qd=Qs$:

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$$15 - 4P_x = 6P_x - 1$$

Solve for P (equilibrium price P_e):

$$15 + 1 = 4P + 6P$$

$$16 = 10P$$

$$P_e = 16 / 10$$

$$P_e = 1.6$$

Now, substitute $P_e = 1.6$ into either the demand or supply equation to find the equilibrium quantity Q_e :

$$Q_e = 15 - 4(1.6) = 8.6$$

$$(P_e; Q_e) = (1.6, 8.6)$$

2- Calculate the price elasticity of demand and supply at equilibrium point.

$$PED = \frac{\Delta QD}{\Delta P} \cdot \frac{P}{QD} = -4 \cdot \frac{1.6}{8.6} = -0.74 \text{ Demand is inelastic}$$

$$PES = \frac{\Delta Qs}{\Delta P} \cdot \frac{P}{QS} = 6 \cdot \frac{1.6}{8.6} = 1.11 \text{ Supply is elastic}$$

3- Determine the price that the consumer will pay and that the seller will receive.

Introduce the Specific Tax

The government imposes a specific tax of \$2. This tax shifts the supply curve upward by \$2 because producers now receive \$2 less for each unit sold.

New Supply Equation :

The original supply equation is: $Q_s = 6P_x - 1$

With a tax $t=2$, the new price received by producers P_p is the market price P minus the tax: $P_p = P - 2$. So, the new supply equation is: $Q_s = 6(P - 2) - 1$

$$\text{Simplify: } Q_s = 6P - 12 - 1 = 6P - 13$$

Find the New Equilibrium (After Tax)

Set the new supply equation **equal** to the demand equation to find the new equilibrium price P :

$$6P - 13 = 15 - 4P_x$$

$$\text{Solve for P: } 6P + 4P = 15 + 13$$

$$10P = 28$$

$$P_e = 2.8$$

Substitute $P = 2.8$ into the new supply equation to find the new equilibrium quantity Q :

$$Q_s = 6(2.8) - 13 = 3.8$$

So, the new equilibrium price is $P_e = 2.8$, and the equilibrium quantity is $Q_e = 3.8$.

Price Paid by Consumers: After the tax, consumers pay $P_c = P_e = 2.8$.

Price Received by Producers: Producers receive $P_p = P_c - T = 2.8 - 2 = 0.8$

4- Determine the amount of tax burden for both the consumer and the seller.

1. **Consumer Tax Burden:** The initial price was $P_e = 1.6$, and now consumers pay $P_c = 2.8$.
Consumer Burden $P_c - P_e = 2.8 - 1.6 = 1.2$

2. **Producer Tax Burden:** The initial price was $P_e = 1.6$, and now producers receive $P_p = 0.8$.

$$\text{Producer Burden } P_e - P_p = 1.6 - 0.8 = 0.8$$

5- Determine the tax revenue generated.

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$$TR=T. Q_{et}=2.3,8=7.6$$

6-The price that the consumer pays, specifying the amount of his benefit from this subsidy .

Introduce the \$5 Subsidy

A \$2 subsidy per unit sold means that the government effectively increases the price received by producers by \$2. This subsidy shifts the supply curve rightward by \$2,

Let the new price received by producers be P_{es} , then $P_{es}=P+5$

So the new supply equation becomes: $Q_s=6(P+2)-1$

Find the New Equilibrium (After Subsidy)

Simplify the supply equation: $Q_s=6P+12-1=6P+11$

Set the new supply equation equal to the demand equation to find the new equilibrium price P_{es} (price paid by consumers):

$$6P+11=15-4P$$

$$6P+4P=15-11$$

$$10P=4$$

$$P_{es}=0.4$$

Substitute $P_{es}=0.4$ into the new supply equation to find the new equilibrium quantity Q_{es}

$$Q_{es}=6(0.4)+11=13.4$$

So, the new equilibrium price (price paid by consumers) is $P_{es}=0.4$, and the equilibrium quantity is $Q_{es}=13.4$.

Price Paid by Consumers $P_c=P_{es}=0.4$: The price consumers pay is \$0.4 per unit after the subsidy. The initial equilibrium price was \$1.6, so consumers benefit IS:

$$S_c=P_e-P_c=1.6-0.4=1.2$$

7-The price that the seller receives, specifying how much he benefits from this subsidy

Price Received by Producers P_p : The price producers receive is the price consumers pay plus the subsidy: $P_p=P_c+2=0.4+2=2.4$, The initial equilibrium price was \$1.6, so producers benefit IS:

$$S_c=P_p-P_e=2.4-1.6=0.8$$

8-The cost of the subsidy.

$$C=S.Q_{es}=2 \cdot 13,4=26.8$$

Chapter 05
Consumer Behavior Theory

Chapter 05

Consumer Behavior Theory

In this chapter, we will study the behavior of an individual consumer. The consumer has to decide how to spend his income on different goods. Economists call this the problem of choice. Most naturally, any consumer will want to get a combination of goods that gives him maximum satisfaction. What will be this 'best' combination? This depends on the likes of the consumer and what the consumer can afford to buy. The 'likes' of the consumer are also called 'preferences'. And what the consumer can afford to buy, depends on prices of the goods and the income of the consumer. This chapter presents two different approaches that explain consumer behavior : **Cardinal** Utility Analysis and **Ordinal** Utility Analysis.

Outline of this Chapter:

- ✓ Cardinal utility approach
- ✓ Ordinal utility approach

After studying this chapter, you will be able to understand:

- ✓ Analyse and use cardinal utility approach for measurement of utility
- ✓ Explain Law of Diminishing Marginal utility
- ✓ Distinguish between cardinal and ordinal utility approaches
- ✓ State ordinal utility approach for measurement of utility
- ✓ Use Indifference curve analysis to explain consumer behaviour;
- ✓ Explain the concept of Budget line
- ✓ Describe consumer equilibrium through Indifference curve approach

1. Cardinal Utility Approach

From time to time, different theories have been advanced to explain consumer's demand for a good and to derive a valid demand theorem. Cardinal utility analysis is the oldest theory of demand which provides an explanation of consumer's demand for a product and derives the law of demand which establishes an inverse relationship between price and quantity demanded of a product.

The cardinal utility theory emphasized the measurement of utility based on the satisfaction that an individual receives from consuming a good or service. An arbitrary unit called utils can be employed to measure this satisfaction (utility). This numerical measurement and summation is referred as cardinal ranking; a ranking that puts a precise numerical value on utility.

1.1) The Concepts of Utility

The term **utility** is the satisfaction or happiness a person gets from consuming a good or service.

The Difference between Total and Marginal Utility

It is important to distinguish marginal utility from total utility.

- **Total Utility (TU)** is a measure of the total satisfaction derived from consuming a given amount of goods and services. Or Total utility of a fixed quantity of a commodity (TU) is the total satisfaction derived from consuming the given amount of some commodity x. More of commodity x provides more satisfaction to the consumer. TU depends on the quantity of the commodity consumed. Therefore, TUn refers to total utility derived from consuming n units of a commodity x. Generally, more consumption gives more utility.

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Example: as the number of movies seen in a month increases, total utility from movies increase

- **Marginal Utility (MU)**, is the amount of change in **TU** which is affected by the increase in consumption of **one** additional unit.
- As the quantity consumed of a good increase, the marginal utility from consuming it decreases.
- Marginal utility from a good decreases as the quantity of the good increases.

Example:-As the number of movies seen in a month increases, marginal utility from movies decreases.

- **Utility function** is a mathematical representation of the satisfaction (utility) of consumption of a basket of goods. The function translates each bundle of products and services into an unit (utils).

In general, we can write the utility function using the following formula:

$$TU = f(Q_1, Q_2, \dots, Q_n)$$

The function states that utility is a function of the quantity (Q) of various goods, from 1 to n. Because there are many combinations of items that consumers might choose.

MU mathematically is: the first derivative of total utility

Marginal Utility (MU) is equal to the change in total utility divided by the change in quantity

Example

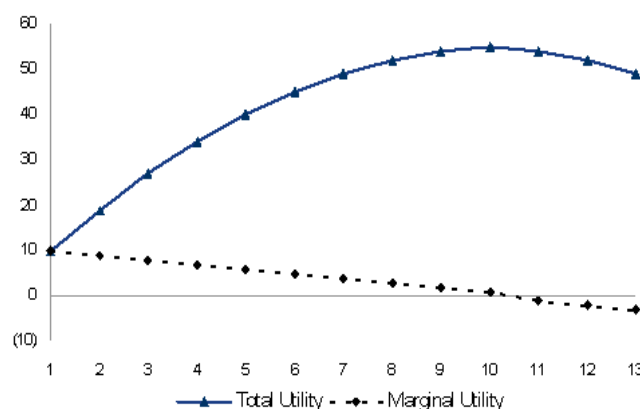
$$MU = \frac{\Delta TU}{\Delta Q} = \frac{TU_n - TU_{n-1}}{Q_n - Q_{n-1}}$$

- In the case of a utility function:

$$MU = \frac{\delta TU}{\delta Q}$$

Example

Q _x	1	2	3	4	5	6	7	8
TU _x	11	20	27	32	35	35	34	32
MU _x	-	9	7	5	3	0	-1	2-



Notice that MU₃ is less than MU₂. You may also notice that total utility increases but at a diminishing rate: The rate of change in total utility due to change in quantity of commodity consumed is a measure of marginal utility. This marginal utility diminishes with increase in consumption of the commodity from 9 to 7, 7 to 5 and so on. This follows from the law of diminishing marginal utility. **Law of Diminishing Marginal** Utility states that marginal utility from consuming each additional unit of a commodity declines as its consumption increases, while keeping consumption of other commodities constant.

Note that when the total utility curve reaches its maximum, marginal utility is **zero**. This is expected because if total utility is to decline, marginal utility must become negative.

The previous graph show that:

- Increasing TU → Diminishing MU
- Maximum TU → MU=0
- Decreasing TU → Negative MU

1.2) Law of Diminishing Marginal Utility

- The principle of **diminishing marginal utility** holds that for a given time period, the greater the level of consumption of a particular commodity, the lower the marginal utility. In other words, as you consume more units of a commodity, the additional units yield less of an addition to total utility than the preceding units did.
- **The law of diminishing marginal utility** states that: As a consumer increases the consumption of a good or service, the marginal utility obtained from each additional unit of the good or service decreases.
- In general, consumer satisfaction decreases with more consumption. **For Example** Suppose a person starts eating Apple, the first apple gives him great pleasure. By the time he is taking second he yield less satisfaction ,the satisfaction of third is less than that of second and so on . The additional satisfaction goes on decreasing with every successive apple till it drops down to zero ; and if the consumer forced to take more the satisfaction may become zero.

1.3) Law of Equi-marginal Utility: Consumer's Equilibrium

Consumers have Unlimited wants but the money income available to them at every point in time is limited. Thus they make choice about which goods and services to buy based on their budget constraint. It is generally assumed that consumers make choice in the way that maximizes their total utility. We have established the fact that the consumption of a given good depends on the amount of utility derive from it.

➤ In case of Single Commodity:

With a given money income Y, the consumer's utility is maximized when the marginal utility of a good x (MU_x) equal to the market price (P_x) of X the commodity. That is,

$$MU_x = P_x$$

If $MU_x > P_x$; the consumer can increase his welfare or satisfaction by purchasing more units of x.

If $MU_x < P_x$; the consumer can increase his total satisfaction by cutting down the quantity of x.

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➤ In case of More Commodity:

The consumer is said to be in **equilibrium** when he **maximizes** his satisfaction, given his money income and the prices of the commodities he consumes.

$$\frac{MU_x}{P_x} = \frac{MU_y}{P_y} = \dots = \frac{MU_n}{P_n}$$

Let's consider the case of consumer equilibrium for two product (good X and y) using the cardinal utility approach.

We reach Consumer equilibrium condition as following:

➤ First condition:

marginal utility of good X / price of good X = marginal utility of good Y / price of good Y

$$\frac{MU_x}{P_x} = \frac{MU_y}{P_y}$$

➤ Second condition:

Consumers should spend all their income on the two products and the formula is as follows:

Income= (quantity of X * price of product X) + (quantity of Y * price of product Y)

$$I = Q_x * P_x + Q_y * P_y$$

Example

Assume that the income allocated to spending on good (X) and good (Y) for a consumer equals (16\$).

The price of X is 2\$ dinar and the price of Y 1 \$

X, Y	1	2	3	4	5	6	7	8	9	10
TU _x	18	34	48	60	70	78	84	88	90	90
TU _y	16	31	45	58	70	81	91	100	108	115

Required:

Find the equilibrium quantity that achieves maximum satisfaction for this consumer and what is the total utility achieved?

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Q	1	2	3	4	5	6	7	8	9	10
TU _x	18	34	48	60	70	78	84	88	90	90
MU _x	-	16	14	12	10	8	6	4	2	0
TU _y	16	31	45	58	70	81	91	100	108	115
MU _y	-	15	14	13	12	11	10	9	8	7
MU _x /P _x	-	8	7	6	5	4	3	2	1	0
MU _y /P _y	-	15	14	13	12	11	10	9	8	7

From the table we notice that equilibrium can be achieved at 7 or 8 units of utility.

$$\frac{MU_x}{P_x} = \frac{MU_y}{P_y} = 7 \Rightarrow (3,10)$$

$$\frac{MU_x}{P_x} = \frac{MU_y}{P_y} = 8 \Rightarrow (2,9)$$

$$R = X \cdot P_x + Y \cdot P_y$$

$$16 = 2(3) + 1(10)$$

$$16 = 16$$

$$R = X \cdot P_x + Y \cdot P_y$$

$$16 = 2(2) + 1(9)$$

$$16 \neq 13$$

It is now verified that the second condition is met:

$$(2) \times (3) + (1) \times (10) = 16 \quad \checkmark$$

It turns out from the previous example that consumer equilibrium is achieved when consuming 3 units of good (X) and (10) units of good (Y).

2. Ordinal Utility Approach

Cardinal utility analysis is simple to understand, but suffers from a major drawback in the form of quantification of utility in numbers. In real life, we never express utility in the form of numbers. At the most, we can rank various alternative combinations in terms of having more or less utility. In other words, the consumer does not measure utility in numbers, though he often ranks various consumption bundles.

The economist Hicks particular, have applied the ordinal utility concept to study the consumer behavior. He introduced a tool of analysis called “Indifference Curve” to analyze the consumer behavior.

2.1) Definition

The Ordinal Utility approach is based on the fact that the utility of a commodity cannot be measured in absolute quantity, but however, it will be possible for a consumer to tell subjectively whether the commodity derives more or less or equal satisfaction when compared to another.

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Ordinal utility assumes that individuals can rank commodity bundles in accordance with the level of satisfaction associated with each bundle.

2.2) Indifference Schedule

An indifference schedule is a table which represents various combinations of two goods, which yield equal satisfaction to consumer. Since all the combinations give equal level of satisfaction, consumer is indifferent between them.

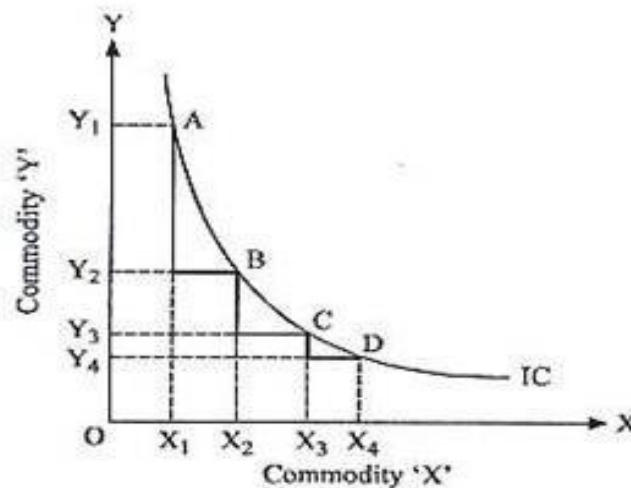
Indifference schedule of two commodities 'X' and 'Y'

Combinations	Units of 'X' Goods (Cup of Tea)	Units of 'Y' Goods (Biscuits)	Satisfaction
A	1	12	K
B	2	8	K
C	3	5	K
D	4	3	K
E	5	2	K

2.3) Indifference Curve

The graphical presentation of Indifference schedule is known as Indifference curve.

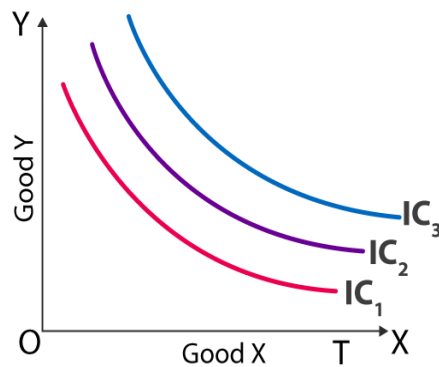
An **indifference curve** is a graph showing combination of two goods that give the consumer equal satisfaction and utility. Each point(bundles) on an **indifference curve** indicates that a consumer is indifferent between the two and all points give him the same satisfaction and utility.



2.4) Indifference Map

The **Indifference Map** is the graphical representation of two or more indifference curves showing the several combinations of different quantities of commodities, which consumer consumes, given him more or less satisfaction.

Or a **collection** of indifference curves in which each curve corresponds to a different total utility level.



Indifference Map

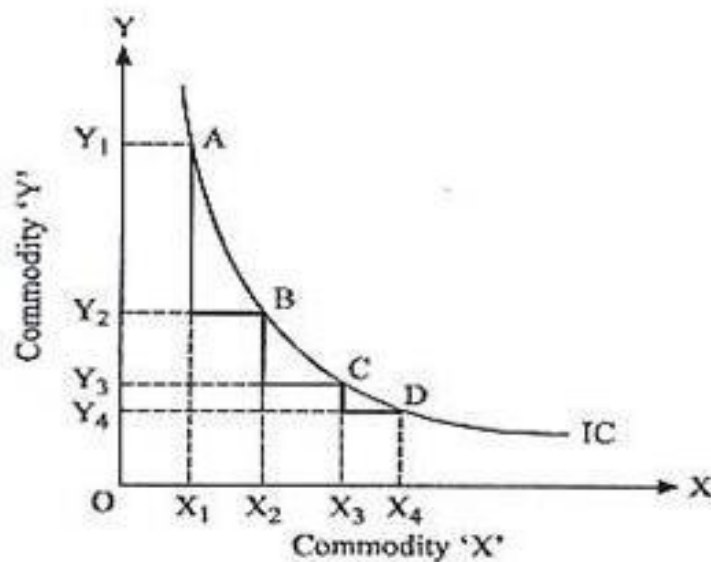
The shapes of the indifference curves depend on the preferences of the consumer, and the whole set of indifference curves is called a **preference map**. Each consumer has a unique preference map.

2.5) Properties Of Indifference Curve

a. An Indifference Curve Is Downward Sloping From Left To Right

The indifference curves must slope downward from left to right. As the consumer increases the consumption of X commodity, he has to give up certain units of Y commodity in order to maintain the same level of satisfaction

In the following graph, various combinations of commodity X and commodity Y are shown by the points A, B, C and D on the same indifference curve. Thus, the consumer is indifferent towards any of the points as they represent equal level of satisfaction.



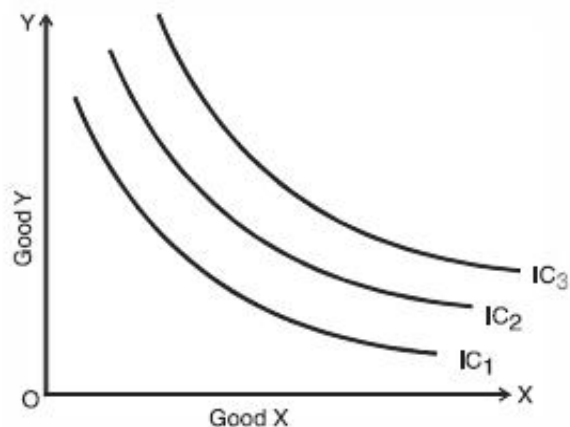
b. The Indifference Curve Is Convex To The Origin

This is an important property of indifference curves. They are convex to the origin. As the consumer substitutes commodity X for commodity Y, **the marginal rate of substitution** of X for Y (Slope of IC) diminishes along an indifference curve. In other words, Indifference curves are convex to the origin because the marginal rate of substitution diminishes. The name comes from the fact that the MRS measures the rate at which the consumer is just willing to substitute one good for the other.

c. Indifference Curve Lying To The Right Represents A Higher Satisfaction

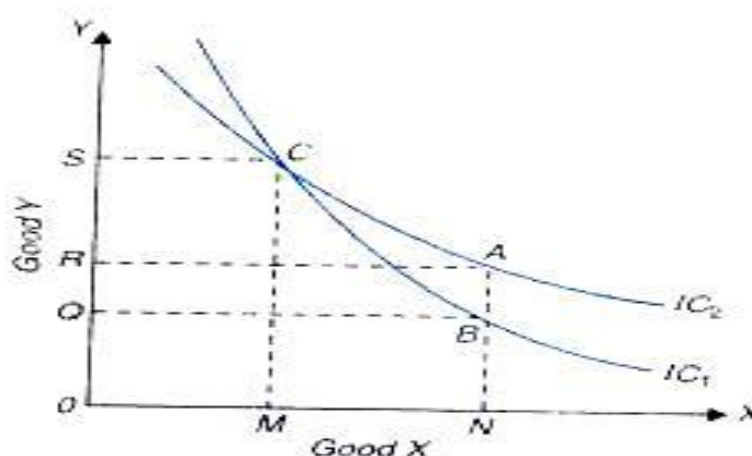
- Indifference curve that lies above and to the right of another indifference curve represents a higher level of satisfaction.
- In the following graph, there are three indifference curves, IC₁, IC₂ and IC₃ which represents different levels of satisfaction. The indifference curve IC₃ shows **greater** amount of satisfaction and it contains more of both goods than IC₂ and IC₁. In short it can be interpreted as:

$$\bullet \text{ IC}_3 > \text{IC}_2 > \text{IC}_1.$$



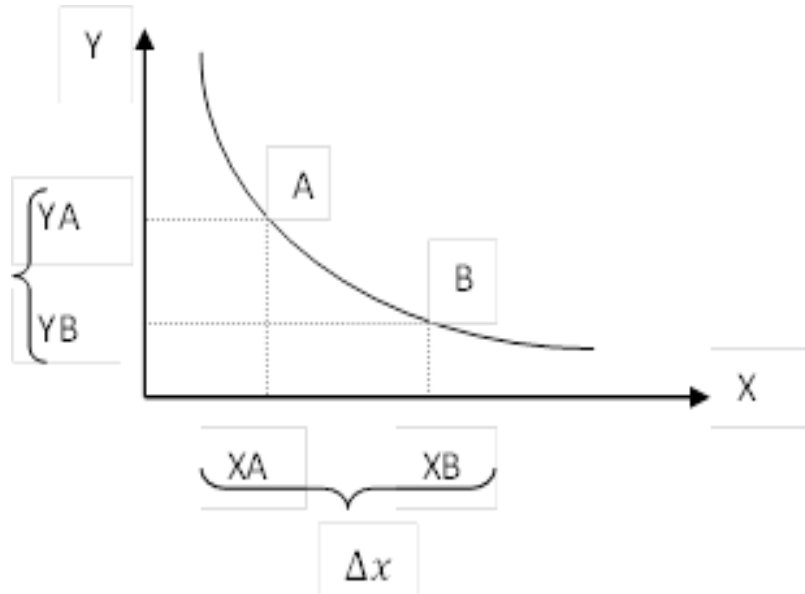
D. Two Indifference Curves never Intersect Each Other

- The indifference curves **cannot intersect each other**. It is because at the point of tangency, the higher curve will give as much as of the two commodities as is given by the lower indifference curve. This is impossible.
- In the following graph, it is shown that two indifference curves (IC₁ and IC₂) intersect at point C. By definition of IC, $C = A$ and $C = B$ but by property III (as above) $A > B$. So it is obvious that under no circumstances $A = B$. Thus, due to this inconsistency in consumer behavior which violates the fundamental feature of IC, two indifference curves cannot intersect to each other.



2.6) Marginal Rate of Substitution

- **Marginal rate of substitution MRS_{xy}** is the rate at which, in order to get the additional units of a commodity, the consumer is willing to sacrifice or give up to get one additional unit of another commodity.
- In case of goods X and Y, the **MRS_{xy}** is the amount of good Y that the consumer is willing to give up in order to gain **one additional unit** of good X and still obtain the same amount of satisfaction.



**The Marginal Rate of Substitution can
symbolically be represented as :**

$$MRS_{xy} = - \frac{\Delta y}{\Delta x}$$

It is the slope of the Indifference Curve

More formally, the marginal rate of substitution is defined as the negative ratio of marginal utilities,

meaning:

$$MRS_{xy} = - \frac{MUX}{MUY}$$

Units of 'X' Good	Units of 'Y' Good	MRS of 'X' for 'Y'
1	10	-
2	7	-3
3	5	-2
4	4	-1

2.7) Budget Line

A **budget line** defines all bundles of goods that the consumer can afford with a given budget. The budget line consists of all bundles that are affordable at the given prices and income.

The equation of the budget line equation can be represented as follows:

$$I = P_x \times Q_x + P_y \times Q_y$$

• Where,

P_x = price of product X. Q_x = the quantity of product X.

P_y = Price of product Y. Q_y = quantity of product Y.

I = consumer's income.

$$I = P_x Q_x + P_y Q_y$$

The equation above can also be written as:

$$Y = \frac{I}{P_y} - \frac{P_x}{P_y} X$$

The budget line is a straight line with horizontal intercept $\frac{I}{P_x}$ and vertical Intercept $\frac{I}{P_y}$. The horizontal intercept represents the bundle that the consumer can buy if he spends his entire income on good x. Similarly, the vertical intercept represents the bundle that the consumer can buy if he spends his entire income on good y. The slope of the budget line is $-\frac{P_x}{P_y}$.

- The slope of budget line is equal to 'Price Ratio' of two goods.
- **Price Ratio = Price of X (P_x)/Price of Y (P_y) = $-P_x/P_y$**

The budget line can be drawn based on:

- We assume that the consumer spends his entire income on **x**, i.e. he does not buy anything of Y, so we get the point of intersection of the budget line with the horizontal axis B ($\frac{I}{P_x}; 0$)
- We assume that the consumer spends his entire income on **Y**, i.e. he does not buy anything of X, so we get the point of intersection of the budget line with the vertical axis L ($0; \frac{I}{P_y}$)
- **Join the two points B and L and you get the budget line**
- **BL** is called the Budget Line or the Consumption Line (See graph below). The line **BL** has important characteristics. Every point on it shows a possible distribution of the consumer's income (I) between X and Y.

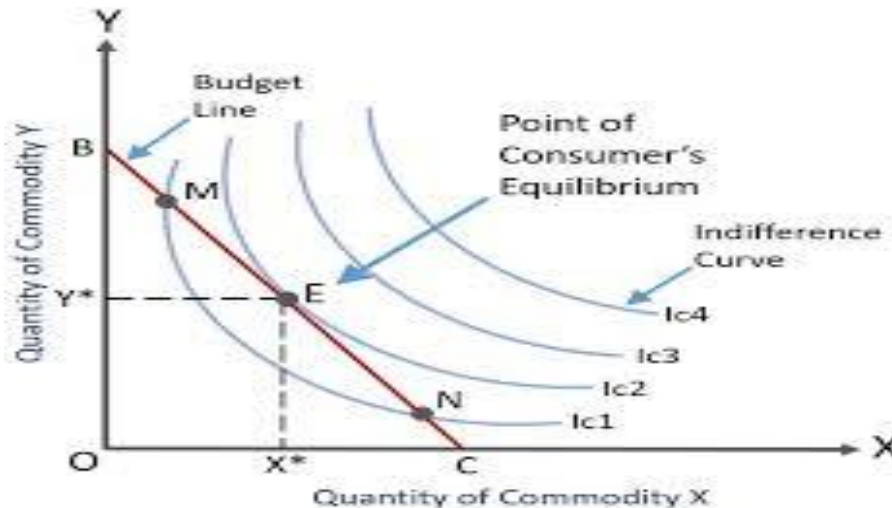
2.8) Consumer's Equilibrium through Indifference Curve (IC) Analysis:

"The term **consumer's equilibrium** refers to the amount of goods and services which the consumer may buy in the market given his income and given prices of goods in the market". The aim of the consumer is to get maximum satisfaction from his money income. Given the price line or budget line

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and the indifference map, "A consumer is said to be in equilibrium at a point where the price line is **touching** the highest attainable indifference curve from below".

Consumers will choose the combination of X and Y that maximizes total utility. **Graphically**, the consumer will move along the budget constraint until the highest possible indifference curve is reached. At that point, the budget constraint and the indifference curve are tangent. This point of tangency occurs at X* and Y* (point E).



The budget constraint constrains the individual to points on or below BC. The highest level of satisfaction attainable is IC2, where the budget constraint just touches, or is just tangent to, it. At this optimum the slope of the budget constraint ($-P_x/P_y$) equals the MRS.

E is the optimum: the point on the budget constraint that touches the highest possible indifference curve.

This tangency between the **budget constraint** and an **indifference curve** requires that the slopes of each be the same at the point of tangency. We have already established that the slope of the budget constraint is the negative of the price ratio ($=-P_x/P_y$). The slope of the indifference curve is the marginal rate of substitution **MRS**. It follows, therefore, that the consumer optimizes where **the marginal rate of substitution equals the slope of the price line**.

$$\text{MRS} = -P_x / P_y \Rightarrow -\frac{M_{UX}}{M_{UY}} = -\frac{P_x}{P_y}$$

2.9) Changes in the Budget Line

When prices and incomes change, the set of goods that a consumer can afford changes as well. How do these changes affect the budget line?

➤ Change in income

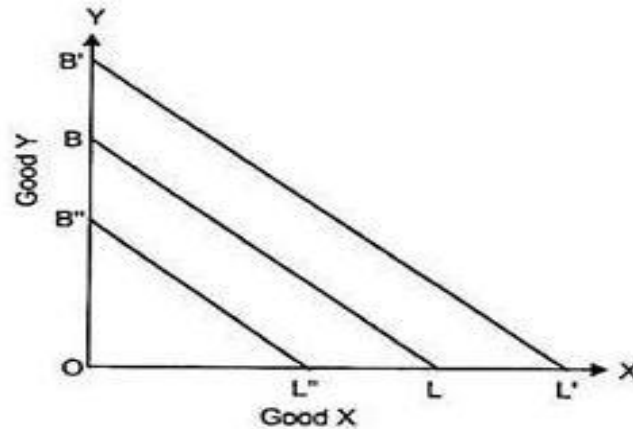
Suppose the consumer's income changes from **I** to **I'** but the prices of the two goods remain unchanged. With the new income, the consumer can afford to buy all bundles (x, y) such that $P_x \cdot X + P_y \cdot Y \leq I'$. Now the equation of the budget line is :

$$Y = \frac{I'}{P_y} - \frac{P_x}{P_y} X$$

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.

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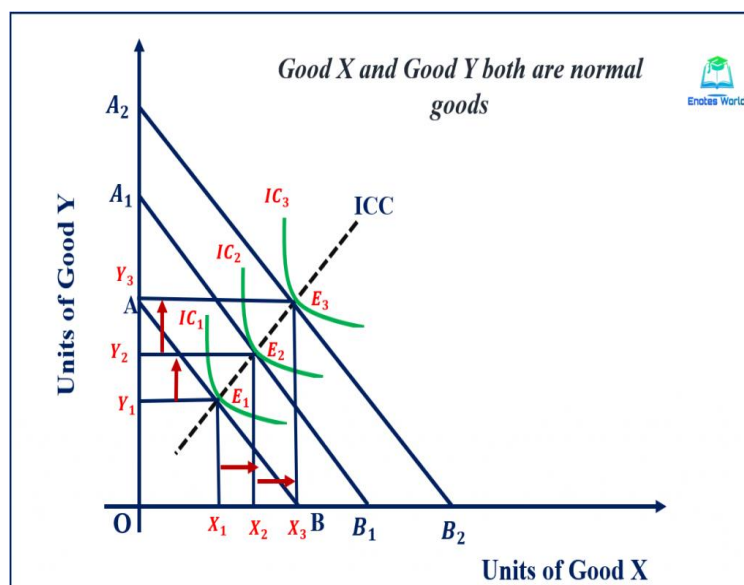
- When income increase the budget line will move to the right(shift outward).
- When income decrease the budget line will move to the left (shift inward).
- higher income leads to parallel shifts of the budget line outward (without changing its slope)
- lower income leads to parallel shifts the budget line inward (without changing its slope)



The effect of changing income

Income effect refers to the change in consumer's purchases of the goods as a result of a change in his money income which is reflected by the Income Consumption Curve (**ICC**).

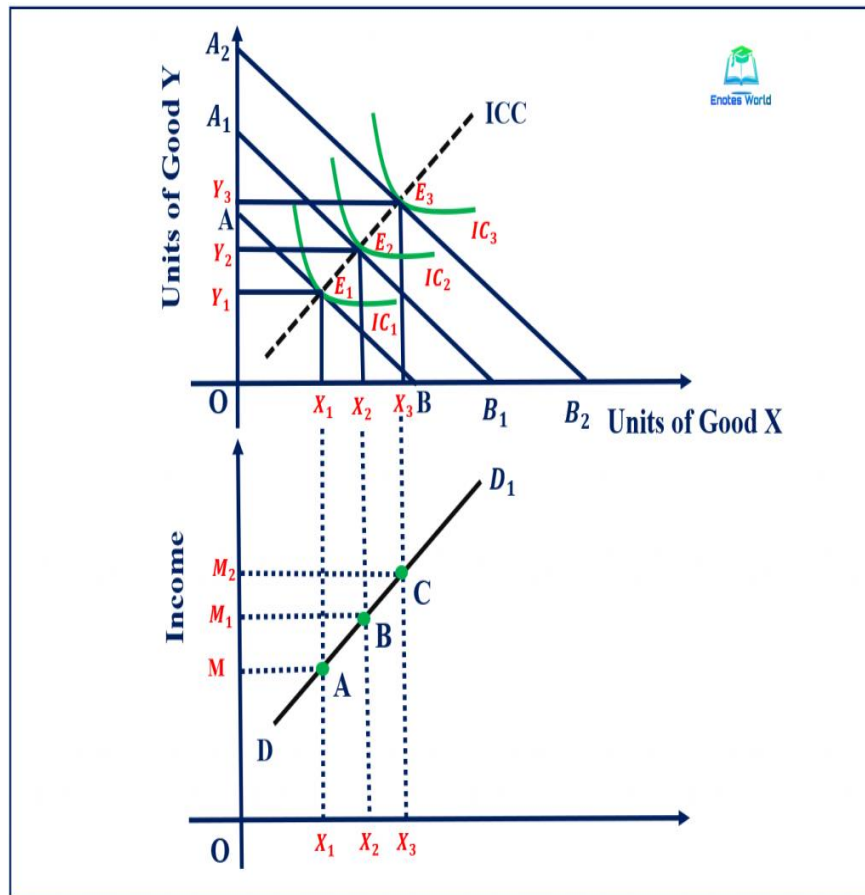
The various points (E1, E2 & E3) showing consumer's equilibrium at various level of income are connected together to get the **Income Consumption Curve (ICC)**.



The parallel shift in budget line from original budget line AB to A1B1 and A2B2 indicates change in income and the point of tangency of IC1, IC2 and IC3 on the respective budget lines represents equilibrium point as shown in the following graph above. The ICC derived in this figure is for Normal goods.

Derive Engel curve from income consumption curve

- **The income consumption curve (ICC)** can be used to derive the relationship between the level of consumer's income and the quantity purchased of a commodity by him.
- the curve showing the relationship between the levels of income and quantity purchased of particular commodities can be called as **Engel curve**.



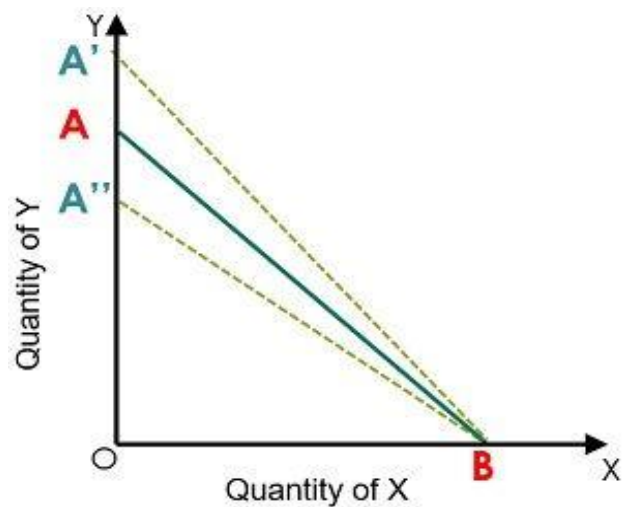
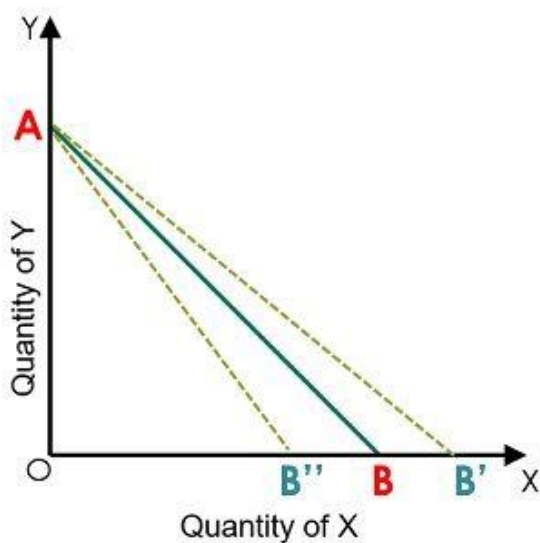
➤ Change in prices

A change in relative price of two commodities changes **the slope** of the budget line. With a given income level, a change in the price of one commodity only affects the quantity of that commodity that can be purchased but not the quantity of the second commodity.

An increase in the price of one commodity causes the budget line intercept to move closer to the origin, reflecting the fact that less of that commodity can be purchased with the constant income. A decrease in the price of the commodity would mean more of it could be purchased and the intercept would move away from the **O** reflecting increase in the potential consumption of the commodity. An increase in the price of a commodity causes the individual to substitute that commodity for the other his consumption pattern. This is termed the substitution effect. However, with increase in the price of one commodity, the real income decreases meaning that with the same amount of money, less of both commodities can be purchased. This is termed as income effect.

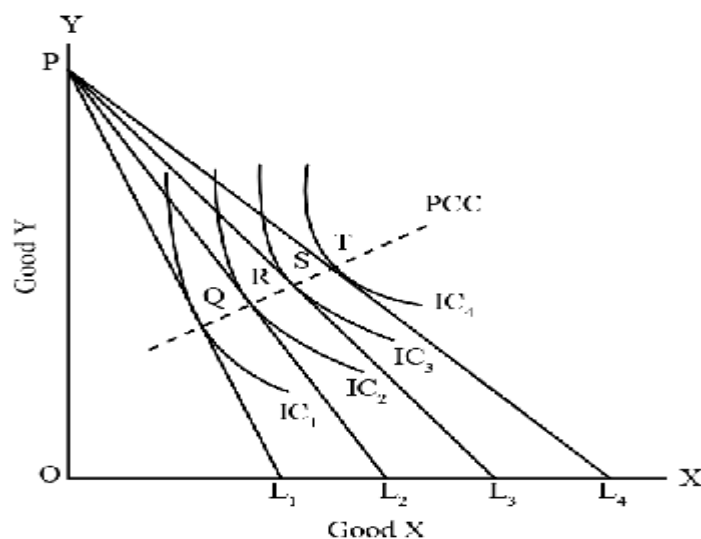
Note that:

- The budget line will turn from **one side** only depending on the change in price.
- A decrease in price of goods X rotate the budget line outwards.
- Increase in price of goods X rotate the budget line inwards.



The effect of changing prices

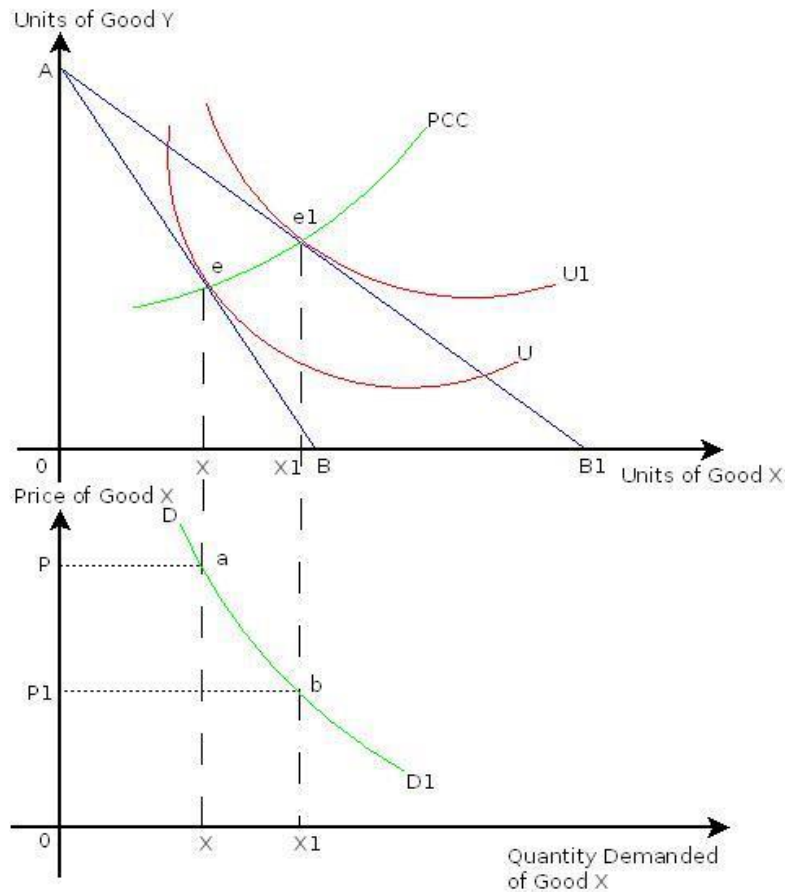
- Each time the P_x Increase the budget line rotates to the left and the Q_{Dx} decreases leading to a new equilibrium point.
- Each time the P_x decreases the budget line rotates to the right and the Q_{Dx} increases leading to a new equilibrium point.
- By connecting the equilibrium points that relates P_x to the Q_{Dx} ,we obtain the **price Consumption curve PCC**
- The **price Consumption curve (PCC)** shows the quantities of two goods a consumer will purchase as the price of one of the goods changes
- Is the curve made by joining the equilibrium quantities of two commodities at different price levels.



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From the PCC we can derive the consumer's demand curve for. It shows the relationship between the price of a good and the quantity demanded, all other factors being equal.

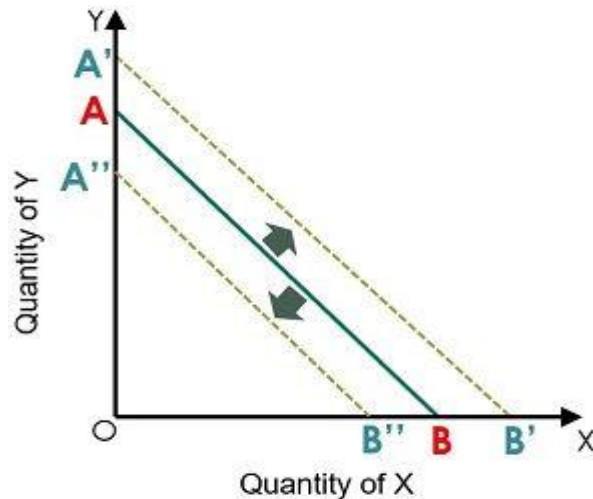
A demand curve shows the quantity of a single good, X in this case, that a consumer will demand at various prices. To derive the demand curve, we need to confront our consumer with several alternative prices for X while keeping other prices, income, and preferences constant.



➤ Price and income changes together.

If there is a **simultaneous change** in the prices of the two commodities, by equal proportion and in the same direction, wherein the consumer's income remains the same, then these two possibilities may take place:

- If the price of good X and Y falls by an equal proportion, and in the same direction, then the price line will shift right. This will happen because the consumer will be able to buy more units of the two commodities with the same budget.
- If the price of good X and Y rises by an equal proportion, and in the same direction, then the price line will shift left. This is because, the consumer will have to forego some units of both the commodities, as the budget is fixed.



What happens if both prices go up and income goes down? Think about what happens to the horizontal and vertical intercepts. If I decreases and P_x and P_y both increase, then the intercepts I/P_x and I/P_y must both decrease. This means that the budget line will shift **inward**. What about the slope of the budget line? If price y increases more than price x , so that $-P_x/P_y$ decreases (in absolute value), then the budget line will be **flatter**; if price y increases less than price x , the budget line will be **steeper**.

2.10) Substitution Effect (SE) and Income Effect (IE):

As discussed above, a consumer's equilibrium position is affected by the changes in his income, prices of substitute and changes in the price of goods consumed. These effects are known as:

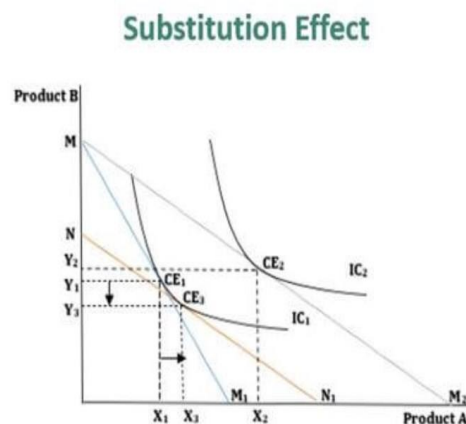
- **Income effect**
- **Substitution effect**

2.10.1) Substitution Effect (SE) :

Hicks explained the substitution effect in terms of changes in the money income of the consumer. Thus, when the price of one good changes the money income of the consumer is also changed in such a way that the consumer has the same level of satisfaction.

This is known as 'compensating variation'. It is defined as 'the amount by which the money income of the consumer is changed so that the consumer is neither better off nor worse off than before'.

That is, the consumer remains on the same indifference curve. The Figure below shows the substitution effect.



In the above figure MM1 is the original price line. The consumer is in equilibrium at **CE₁**. He purchases OY₁ units of B and OX₁ units of A. As the price of A falls while that of B remains the same, the budget line shifts to MM2. Using the compensating variation, the new budget line is NN1. This line is parallel to the budget line MM2 indicating that the relative prices are the same. At point **CE₂** the indifference curve IC is tangent to the budget line. The consumer now purchases OX₃ units of A and OY₃ units of B. The consumer would always prefer to buy more of the cheaper good. The substitution effect is always positive.

2.10.2) Income Effect (IE):

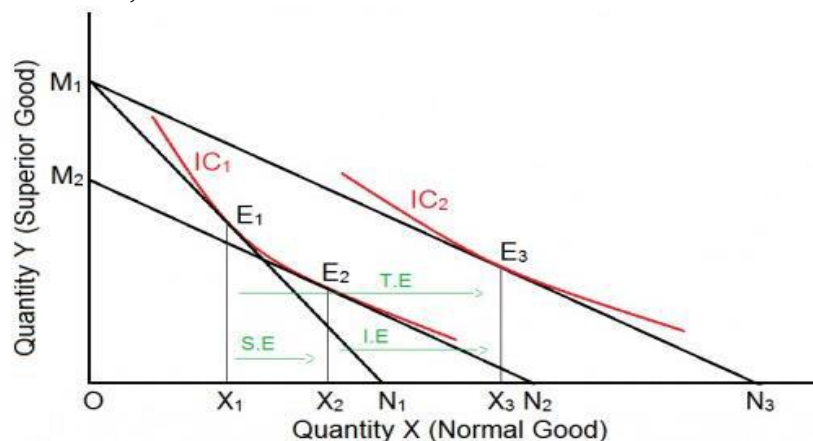
In the analysis of the consumer's equilibrium, it is assumed that the income of the consumer remains constant, and the prices of the goods X and Y are given. Thus, given the tastes and preferences of the consumer and the prices of the two goods, if the income of the consumer changes, the effect it will have on his purchases is known as the Income effect.

The Income effect may be defined as the effect on the purchases of consumer caused by the changes in income, if the prices of goods remain constant. If the income of the consumer increases his budget line will shift upward to the right, parallel to the original budget line. On the contrary, a fall in his income will shift the budget line inward to the left. The budget lines are parallel to each other because relative prices remain unchanged.

Kinds of Income Effect

Income effect may be of three types:

- **Positive Income effect:** When an increase in income leads to an increase in demand for a commodity or for both the commodities the income effect is positive. In case of Normal goods, income effect is positive and Income consumption curve slopes upwards to the right.
- **Negative Income effect:** Income effect is negative, when with the increase in his income, the consumer reduces his consumption of the good. Income effect is negative in case of inferior goods.
- **Zero Income effect:** If with the change in income, there is no change in the quantity purchased of a commodity, then the income effect is said to be zero. Zero income effect is in case of goods like medicines, necessities like salt etc.



For **normal goods**, the income and substitution effects work in the same direction. Higher prices lead to a lower quantity demanded, and lower prices lead to a higher quantity demanded

Review Questions

Activity 01 : Say whether these statements are true or false, and correct the false ones

1. Utility means want satisfying power of a commodity. **True**
2. A change in total utility resulting from a one unit change in the consumption of a commodity at particular point of time is called marginal utility. **True**
3. Total utility is the sum of marginal utility. **True**
4. $MU = TU_n + TU_{n-1}$ **False**
 $MU = TU_n - TU_{n-1}$
5. When total utility reaches at maximum marginal utility becomes zero. **True**
6. The **ordinalist school** states that utility is measurable. **False**
 The **cardinalist school** states that utility is measurable
7. The Law of diminishing marginal utility states that as the consumer consumes more of a commodity, the utility of every additional unit (MU) consumed diminishes. **True**
8. A higher indifference curve represents a higher level of satisfaction. **True**
9. Indifference curves are convex to the origin. **True**
10. Price effect is split into two components- substitution effect and income effect. **True**

Activity 02 : Choose the correct answer

1. Utility of every additional unit is called a.
 - a. Marginal utility
 - b. Total utility
 - c. Average utility
 - d. None of these.
2. When total utility reaches at maximum marginal utility becomes
 - a. Positive
 - b. Negative
 - c. Zero
 - d. All may be possible.
3. The cardinalist school postulated that utility can
 - a. Be measured
 - b. Not be measured
 - c. Both a and b may possible
 - d. None.
4. The ordinalist school postulated that utility is :
 - a. Measurable
 - b. Not measurable
 - c. Both a & b may be possible
 - d. None.
5. As the consumer consumes more of a commodity, the utility of every additional unit (MU) consumed diminishes. This is :
 - a. Law of diminishing marginal utility
 - b. Equi- marginal utility
6. The cardinal utility approach is based on .
 - a. Rationality
 - b. Constant marginal utility of money
 - c. Diminishing marginal utility
 - d. All of the above.
7. What is/ are true for indifference curves :
 - a. Indifference curve slopes downward to the right;
 - b. Indifference curves are convex to the origin;
 - c. A higher indifference curve represents a higher level of satisfaction;
 - d. All of the above are correct.

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8. The convexity of indifference curve is due to.
 - a. Diminishing MRS
 - b. Increasing MRS
 - c. Constant MRS
 - d. None.
9. The slope of indifference curve is known as.
 - a. Marginal Rate of Substitution;
 - b. Marginal Utility;
 - c. Elasticity of Substitution;
 - d. None.
10. In indifference curve analysis, the consumer will be in equilibrium when.
 - a. A given budget line must be tangent to an indifference curve
 - b. The indifference curve must be convex to the origin at the point of tangency
 - c. Both a & b
 - d. None of the above.
11. A change in price of good X brings about a change in the quantity demanded of it, ceteris paribus. This change in the quantity demanded is called.
 - a. Price effect;
 - b. Income effect;
 - c. Substitution effect;
 - d. None
12. The increase in the quantity bought as the price of the commodity falls, after adjusting income so as to keep the real purchasing power of the consumer the same before is known as.
 - a. Price effect;
 - b. Income effect;
 - c. Substitution effect;
 - d. None.

Activity 03 :Exercises

Exercise 01:

We suppose that utility is measurable and quantifiable. The satisfaction a consumer gets from consuming a good X is as follows :

Q _x	0	1	2	3	4	5	6	7
TU _x	0	10	17	23	27	29	29	27

1- Calculate MU

2- Draw the TU and MU curves and indicate the saturation point, analyse and draw your conclusions.

Exercise 02:

Let the consumer's utility function be represented as :

$$TU = XY.$$

1-What do X and Y represent?

2-Calculate the marginal utilities. Are they increasing, decreasing, or constant?

3-Calculate the level of satisfaction for the consumer at the combination (X = 2, Y = 3).

Exercise 03:

If the consumer's utility function is:

$$TU = X^{1/2} Y$$

and the quantities that achieve maximum satisfaction are X = Y = 4,

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-calculate the prices of the goods when ($I= 24$).

Exercise N°04

The utility equation for a particular commodity is as follows:

$$TU=X^2Y$$

Where:

$$P_x=6 \quad P_y= 2 \quad I= 54$$

- 1-Write down the equation of the budget line.
- 2- What is the slope of the budget line?
- 3-Find the equilibrium quantities of x and y that maximize the consumer's utility.
- 4-Calculate the marginal rate of substitution $MRS(x; y)$, explain.

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Solutions

Exercise 01:

1-Marginal utility is therefore the ratio of the change in total utility to the change in the quantity consumed of a given good X.

$$MU(X) = \Delta TU / \Delta X = (17 - 10) / (2 - 1) = 7$$

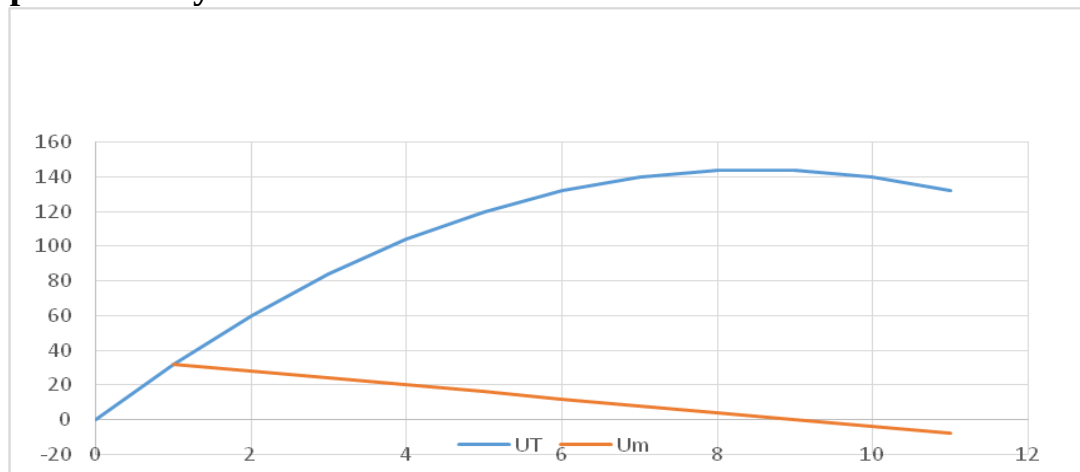
In the same way, all MU values will be obtained:

Q _x	0	1	2	3	4	5	6	7
TU _x	0	10	17	23	27	29	29	27
MU _x	-	10	7	6	4	2	0	-2

The consumer's consumption behaviour follows the law of diminishing marginal utility : MU (1st apple) > MU₂ > MU₃ > MU₄ > MU₅ > MU₆ > MU₇, 10 > 7 > 6 > 4 > 2 > 0 > -2.

The consumer is not rational because he consumed the 6th unit, which did not increase his satisfaction, and the 7th unit, which, more seriously, reduced his total utility. He should have stopped at the 5th unit.

2-Graphical Analysis



Exercise 02:

Let the consumer's utility function be represented as **TU = XY**.

1- X and Y represent the goods that the consumer chooses to consume.

2- Calculate the marginal utilities.

$$MUX = \frac{\delta TU}{\delta x} = Y$$

$$MUY = \frac{\delta TU}{\delta y} = X$$

Are they increasing, decreasing, or constant.

$$MUX = \frac{\delta^2 TU}{\delta^2 x} = 0$$

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$$MU_Y = \frac{\delta^2 TU}{\delta^2 y} = 0$$

The marginal utilities are constant

3- Calculate the level of satisfaction for the consumer at the combination (X = 2, Y = 3).

$$TU = XY = 2 \times 3 = 6$$

Exercise 03:

First, we have to find the equilibrium demand functions:

The consumer is said to be in equilibrium when he maximizes his satisfaction given his money income and the prices of the commodities he consumes.

$$\begin{cases} \frac{MU_x}{MU_y} = \frac{P_x}{P_y} \dots\dots\dots 01 \\ I = X P_x + Y P_y \dots\dots\dots 02 \end{cases}$$

$$MU_x = \frac{\delta TU}{\delta x} = \frac{1}{2} X^{-1/2} Y$$

$$MU_y = \frac{\delta TU}{\delta y} = X^{1/2}$$

$$01 \Rightarrow \frac{\frac{1}{2} X^{-1/2} Y}{X^{1/2}} = \frac{P_x}{P_y}$$

$$01 \Rightarrow \frac{\frac{1}{2} Y}{X} = \frac{P_x}{P_y}$$

$$01 \Rightarrow \frac{1}{2} Y P_y = X P_x \Rightarrow X = \frac{\frac{1}{2} Y P_y}{P_x}$$

We substitute X on the budget line equation

$$02 \Rightarrow \left(\frac{\frac{1}{2} Y P_y}{P_x} \right) P_x + Y P_y = I$$

$$02 \Rightarrow \frac{3}{2} Y P_y = I \Rightarrow Y = \frac{2I}{3P_y}$$

We have:

$$X = \frac{\frac{1}{2} Y P_y}{P_x} \Rightarrow X = \frac{\frac{1}{2} \frac{2I}{3P_y} P_y}{P_x} = \frac{2I}{6P_x}$$

If X = Y = 4, calculate the prices of the goods when (I = 24).

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$$X=4=24/3P_x \Rightarrow P_x=2$$

$$Y=4=2*24/3P_y \Rightarrow P_y=4$$

Exercise 04

1- Write down the equation of the budget line

The consumer has a budget of \$54, and the prices of goods x and y are \$6 and \$2 per unit, respectively. The budget Line (Constraint) is:

$$I = X P_x + Y P_y \dots\dots 6x + 2y = 54 \dots\dots\dots$$

2--The slope of the budget line

The budget line is equal to the price ratio

$$s = -\frac{P_x}{P_y} = -\frac{6}{2} = -3$$

3-Find the equilibrium quantities of x and y that maximize the consumer's utility

The consumer is said to be in equilibrium when he maximizes his satisfaction given his money income and the prices of the commodities he consumes.

$$\left\{ \begin{array}{l} \frac{MU_x}{MU_y} = \frac{P_x}{P_y} \dots\dots\dots 01 \\ I = X P_x + Y P_y \dots\dots\dots 02 \\ MU_x = \frac{\delta TU}{\delta x} = 2XY \end{array} \right.$$

$$MU_y = \frac{\delta TU}{\delta y} = X^2$$

$$01 \Rightarrow \frac{2XY}{X^2} = \frac{6}{2}$$

$$01 \Rightarrow \frac{2Y}{X} = 3$$

$$01 \Rightarrow 2Y = 3X \Rightarrow X = \frac{2Y}{3}$$

We substitute X on the budget line equation

$$02 \Rightarrow 6\left(\frac{2Y}{3}\right) + 2Y = 54$$

$$02 \Rightarrow 4Y + 2Y = 54 \Rightarrow 6Y = 54 \Rightarrow Y = 9$$

We have:

$$X = \frac{2Y}{3} \Rightarrow X = \frac{2(9)}{3} = 6$$

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The consumer maximizes utility by purchasing 6 units of good X and 9 units of good Y

4- Calculate the marginal rate of substitution $MRS(x; y)$

$$MRS_{xy} = \frac{MUX}{MUY} = \frac{2XY}{X^2} = \frac{2Y}{X} = \frac{2(9)}{6} = 3 \text{ ...Or..... } MRS_{xy} = \frac{MUX}{MUY} = \frac{PX}{PY} = \frac{6}{2} = 3$$

The consumer must give up 3 units of Y in order to get 1 additional unit of X while keeping the same level of satisfaction .

Chapter 06
Theory of Producer

Chapter 06

Theory of Producer Behavior

In this chapter, we will focus on the supply side and examine the behavior of producers. We will see also how firms can produce efficiently and how their costs of production change with changes in both input prices and the level of output.

Chapter Outline:

- ✓ Meaning of Production and Production Function;
- ✓ Production in the Short- Run- 1. Production with one variable input (Labor) - TPL, MPL and APL and 2. Relationship between TPL, MPL and APL Curves;
- ✓ Law of Variable Proportion;
- ✓ Production in the Long- Run- 1. Production with two variable inputs- the concepts of isoquants and 2. Features of isoquants
- ✓ Isocost Line;
- ✓ Producer's Equilibrium;
- ✓ Expansion Path;
- ✓ Returns to Scale and Reasons behind Returns to Scale- Economies and Diseconomies of Scale

After studying this chapter you will be able to-

- ✓ Understand the concepts of production function;
- ✓ Understand the concepts of short- run and long- run production functions;
- ✓ Understand the meaning of TPL, MPL and APL and Relationship between TPL, MPL and APL Curves;
- ✓ Understand Law of Variable Proportion and Returns to Scale
- ✓ Understand how producer reaches at equilibrium position.

1. Definition Of Production :

Production is an important economic activity. It is the process (or processes) a firm uses to transform **inputs** (e.g. labor, capital, raw materials) into/Creates **outputs**, (the goods or services) the firm wishes to sell.

Production is the process by which inputs are combined, transformed, and turned into outputs. Firms vary in size and internal organization, but they all take inputs and transform them into goods and services for which there is some demand.

1.1) Production Process

- Economists define production broadly as "the act of making things, creating things, producing things, and, in particular, the act of making products that will be traded or sold commercially".
- For economists, this can include manufacturing, storing, shipping, and packaging.

- They see every commercial activity, other than the final purchase, as some form of production.

1.2).Factors of Production :

Production of a commodity or service requires the use of certain resources. Resources, which we shall call **factors of production**, are combined in various ways, by firms or enterprises, to produce goods and services.

1.3)Fixed Inputs and Variable Inputs :

- **Variable inputs** are the factors that **can be changed during the course of the short run**. Variable factors vary with the level of output. An increase in variable factors leads to more production and vice-versa. Employment of variable factors is not required when there is no production. Variable factors include labor, power, fuel, etc.
- **Fixed inputs** are the factors that can not be changed in the short run and can be used for long period. Fixed factors include land, capital, building, etc.

1.4)Short-Run Versus Long-Run Decisions

- **Short Run** is a period of time where output can only be changed by changing the level of **variable** inputs. In the short run, some factors are variable and some are fixed. Fixed factors remain constant in the short run like land, capital, plant, machinery, etc. Production can be raised by only increasing the level of variable inputs like labor.
- 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 factor. Long run is enough time to alter all the factors of production. **All factors are said to be variable in the long run.**

There is no specific time interval implied here. What is the long run and what is the short run depends on what kinds of choices we are examining. In the short run at least some factors are fixed at given levels, but in the long run the amount used of these factors can be changed.

2.Production in the short run

2.1)The production function relates physical output of a production process to physical inputs or factors of production. Production function denotes an efficient combination of inputs and outputs.

The Production function is a mathematical function that links the quantity of output with the input used in the production process. Usually, economists assume capital and labor are the only production inputs

$$Q = f(K, L)$$

where

- Q is the quantity of output.
- K is the quantity of capital.
- L is quantity of labor.

The production function is of two types such as Short-run and Long run production functions. in short run one factor normally capital (K) is constant (or fixed) and the other i.e. labor is assumed as variable factor $Q = f(\bar{K}, L)$ But in long run all the factors of production are variable.

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The behavior of short-run production function is explained by Law of Variable Proportion or Law of Diminishing MPL whereas the behavior of long-run production function is explained by Law of Returns to scale.

A production is technologically efficient if the maximum quantity of a commodity can be produced by each specific combination of inputs. Thus, production specified by production function is technologically efficient. If a firm is rational, it will always operate in a technologically efficient way to produce outputs.

2.2) Concept of Product

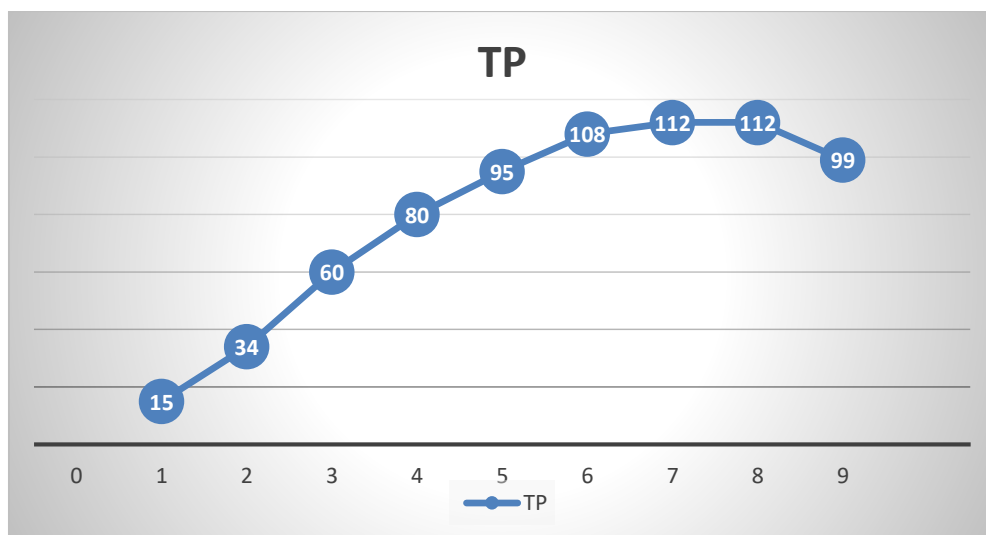
The concept of product can be looked at from three different angles: Total Product, Marginal Product, and Average Product.

1. **Total Product TP:** refers to the total quantity of goods that the firm produced during a given course of time with the given number of inputs. Total Product is also known as **Total Output or Total Return**

The Total Product (TP) curve, is a graphical representation of the relationship between the quantity of a variable input (usually labor) and the resulting total output. In the short run, where at least one factor of production is fixed, the Total Product curve illustrates how the total output changes as the variable input is increased.

Example

L	0	1	2	3	4	5	6	7	8	9
Q	0	15	34	60	80	95	108	112	112	99



Total Product curve for labor. When all other inputs are held constant, it shows the different output levels obtainable from different units of labor.

2-The Average Product (AP)

- **Average product** is the average amount produced by each unit of a variable factor of production.
- **APL** Is the output per worker

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$$APL = \frac{Q}{L}$$

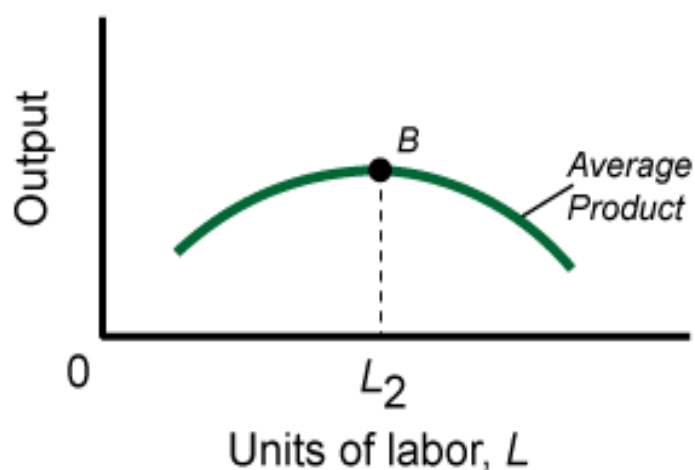
- **APK** Is the output per machine

$$APK = \frac{Q}{K}$$

2-The Average Product (AP)

Example

L	0	1	2	3	4	5	6	7	8	9
Q	0	15	34	60	80	95	108	112	112	99
APL	0	15	17	20	20	19	18	16	14	10



3)The Marginal Product (MP)

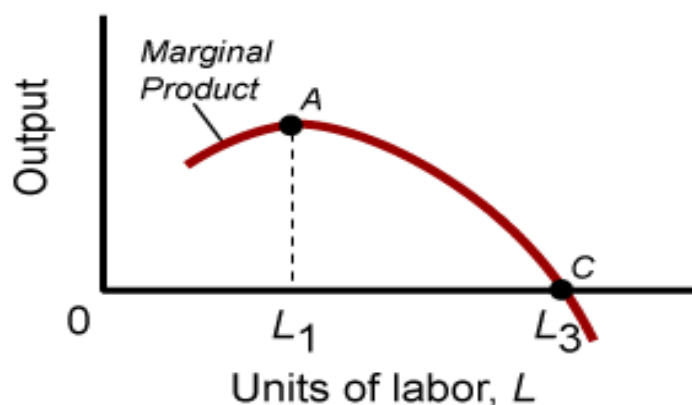
Marginal product is the additional output that can be produced by adding one more unit of a specific input, *ceteris paribus*.

$$MPL = \frac{\Delta Q}{\Delta L} \text{ Or } MPL = \frac{\delta Q}{\delta L} \text{ If it is a function}$$

$$MPK = \frac{\Delta Q}{\Delta K} \text{ Or } MPK = \frac{\delta Q}{\delta K} \text{ If it is a function}$$

Example

L	0	1	2	3	4	5	6	7	8	9
Q	0	15	34	60	80	95	108	112	112	99
MPL	-	15	19	26	20	15	13	4	0	-13



We notice that at a certain level of labor, our marginal gains from an extra worker begin to fall.

To understand the reason behind this pattern, consider that a **one-man** barber shop is a very busy operation. The single barber needs to do everything: say hello to people, answer the phone, cut hair, clean up, and run the cash register. A **second** barber reduces the level of disruption from jumping back and forth between these tasks, and allows a greater division of labor and specialization. The result can be greater increasing marginal returns. However, as other barbers are added, the advantage of each additional barber is less, since the specialization of labor can only go so far. The addition of a sixth or seventh or eighth barber just to greet people at the door will have less impact than the second one did. This is the pattern of **diminishing marginal returns**. As a result, the total costs of production will begin to rise more rapidly as output increases. At some point, you may even see negative returns as the additional barbers begin bumping elbows and getting in each other's way. In this case, the addition of still more barbers would cause the output to decrease.

This pattern of **diminishing marginal returns** is common in production. As **another example**, consider the problem of irrigating a crop on a farmer's field. The plot of land is the fixed factor of production, while the water that can be added to the land is the key variable cost. As the farmer adds water to the land, output increases. But adding more and more water brings smaller and smaller increases in output until at some point the water floods the field and reduces output. Diminishing marginal returns occur because we are ultimately constrained by some fixed factor.

2.3) The Law of Diminishing Marginal Returns

The **law of diminishing marginal returns** states that:

When additional units of a variable input are added to fixed inputs, the marginal product of the variable input declines.

(For e.g.) Water are very vital for a plant's life, the next unit of water will keep the plant healthy & growing smartly. But as more & more water gets added, the soil becomes water-logged and most crops will perish.

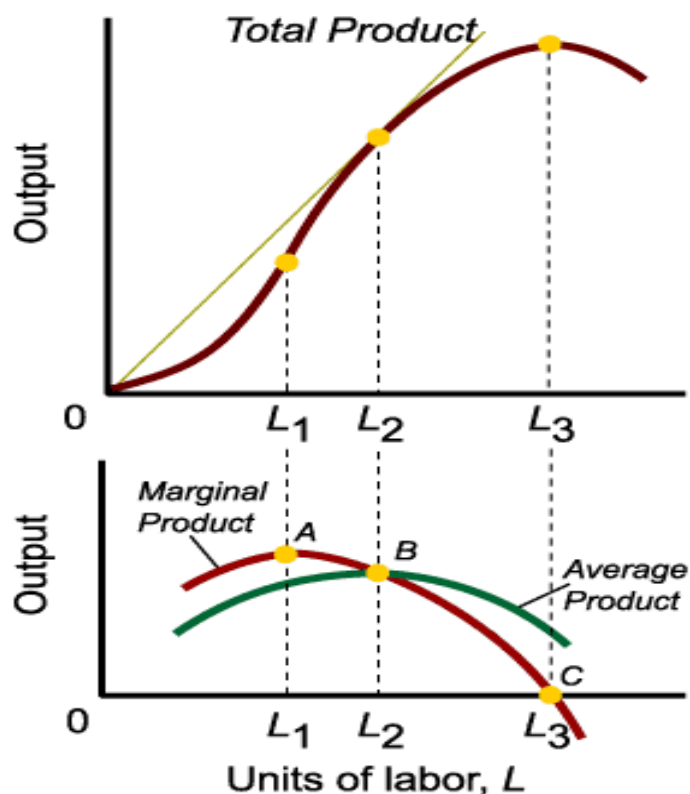
The law of diminishing returns can be understood with this example.

Example

L	TP	MPL	(APL	Production Stage
0	0	-	-	Increasing Marginal Returns
1	15	15	15	
2	34	19	17	
3	60	26	20	

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4	80	20	20	Diminishing Marginal Returns
5	95	15	19	
6	108	13	18	
7	112	4	16	
8	112	0	14	Negative Marginal Returns
9	99	13-	10	



Stages of production

To simplify the interpretation of a production short run, it is common to divide its range into **3 stages**:

Stage 1: starts from the origin and ends at the third unit of labor, during which the total output increases at an increasing rate, The marginal product is also increasing, and reaches **its maximum** at the end of this stage, and this point is called **the inflection point**. In this stage, average output is increasing, but at a rate less than the rate of increase of marginal production.

Stage 2: It begins from the third unit of labor to the eighth unit, in which total production is increasing but at a decreasing rate, Average production at this stage is increasing and reaches its maximum, where marginal production equals average production of labor. After that, average production decreases, but it remains positive and greater than marginal production. The optimum input/output combination for the price-taking firm (or rational producer) will be in **stage 2**.

Stage 3, too much variable input is being used relative to the available fixed inputs: variable inputs are over-utilized (MP of Labor is negative) in the sense that their presence on the margin obstructs the production process rather than enhancing it. The TP and AP of variable inputs are found decreasing in this stage and MP of variable input (i.e. Labor) is found negative in this stage

The second stage is preferred by rational producer as optimum stage

Stage-1: Increasing Returns to variable proportion

- TP increases at an increasing rate.

- MPL increases to Maximum
- APL increases
- $MPL > APL$

Stage-2: Diminishing Returns to variable proportion

- TP increases at a decreasing rate to Maximum.
- MPL decreases to Zero
- APL increases then decreases
- $MPL = APL$ then $APL > MPL$

Stage-3: Negative Returns to variable proportion

- TP decreases
- $MPL < 0$ (Negative)
- APL decreases

2.4) The producer equilibrium

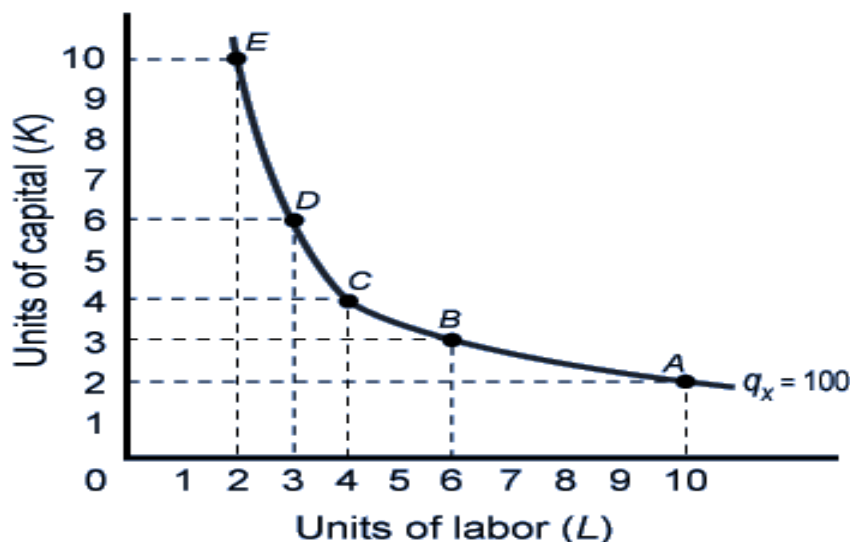
The producer point of equilibrium (maximum production) is when the **TP** (Point H) reaches its peak (the highest possible output), which corresponds to the end of the second stage when the marginal product of labor is zero.

3. Production in the Long run

In the long run, all factors (including capital, K and Land L) are variable, inputs used in the production process can be varied or adjusted by a firm. This includes inputs such as labor, capital, technology, and raw materials. so our production function is $Q=f[L,K,T,\dots]$.

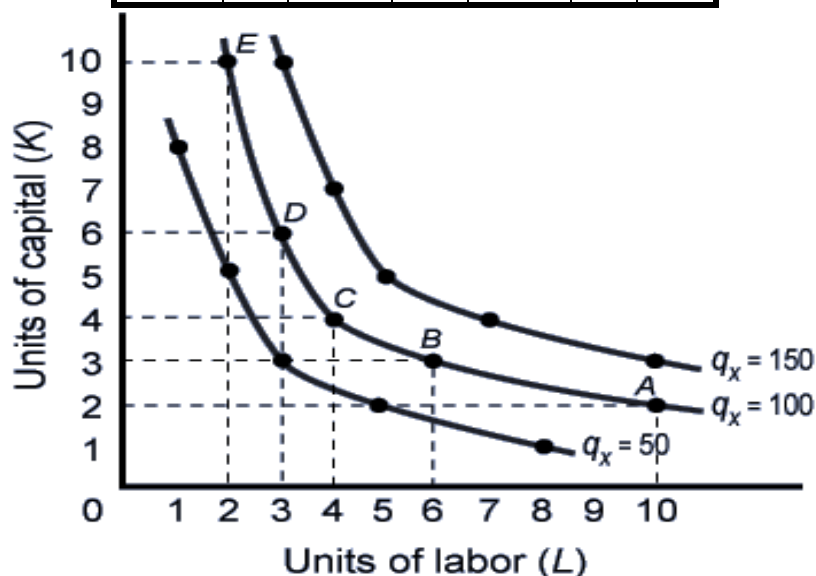
3.1) Isoquants: Equal Output Curves

Isoquant is a curve that shows the varying combinations of factors of production such as labor and capital that can be used to produce a given quantity of a product with a given state of technology (where factor inputs can be substituted for one another in the production process).



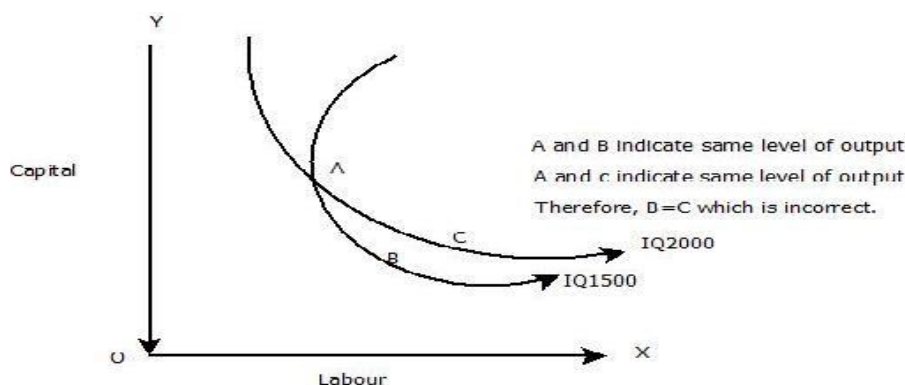
3.2) Isoquants Map

	$q_x = 50$		$q_x = 100$		$q_x = 150$	
	K	L	K	L	K	L
A	1	8	2	10	3	10
B	2	5	3	6	4	7
C	3	3	4	4	5	5
D	5	2	6	3	7	4
E	8	1	10	2	10	3



Properties of Isoquants

- **Isoquants are negatively sloped** : It means when the amount of one factor input is increased that of other input must be decreased in order to maintain a given level of output so that any combination two factors (lying on the same isoquant) chosen will yield the same level of output
- **Isoquants are convex to the origin** (Diminishing $MRTS_{(L-K)}$): The convexity of isoquant indicates that $MRTS$ is diminishing which means that as the quantities of one factor (such as Labor) is increased, the less of another factor is (such as Capital) will be given up,
- **Higher isoquant represents a higher level of output and vice-versa** : Iso-quant map represents a set of isoquants describing production of a firm where a higher isoquant represents a larger quantity of output than the lower one .
- **Two isoquants cannot intersect to each other**: by definition each isoquant represents a specific quantity of output. Therefore, if two isoquants intersect to each other it would involve logical contradiction as a particular isoquant at a time may be representing a small as well as a large quantity of output.



3.3) Marginal Rate of Technical Substitution (MRTS)

The technical rate of substitution measures the tradeoff between two inputs in production. It measures the rate at which the firm will have to substitute one input for another in order to keep output constant.

The MRTS shows the **rate at which one input (eg capital or labor) may be substituted for another**, while maintaining the same level of output.

- Mathematically, $MRTS_{LK}$ can be derived from the condition that, along an isoquant, quantity of output produced is held constant

$$\Delta Q = MP_L \times \Delta L + MP_K \times \Delta K = 0$$

- Rearranging to find the slope of the isoquant yields the $MRTS_{LK}$

$$MP_K \times \Delta K = -MP_L \times \Delta L \rightarrow MRTS_{LK} = -\frac{\Delta K}{\Delta L} = \frac{MP_L}{MP_K}$$

- Moving down an isoquant, the amount of capital used declines
- $MRTS_{LK}$ describes the rate at which labor must be substituted for capital to hold the quantity produced constant

Example

- The following table shows the different combinations of the two factors of production, labor L and capital K, to produce the same quantity of good x.

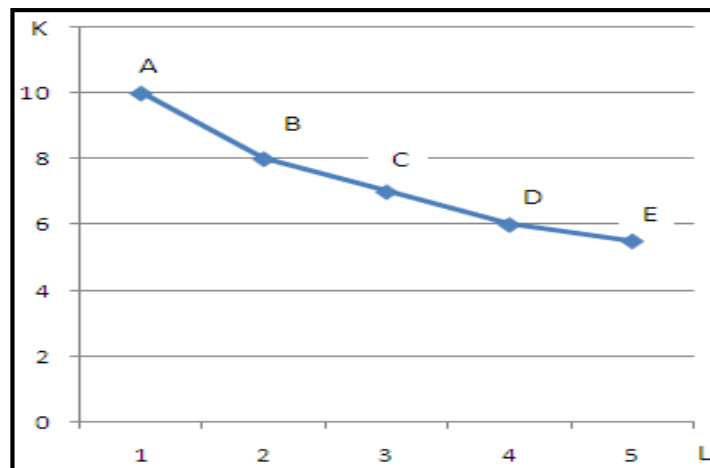
-Find the marginal rate of technical substitution of labor for capital when moving from point A to point B.

We have:

$$MRTS = -\frac{\Delta K}{\Delta L} = -\frac{8 - 10}{2 - 1} = -2$$

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Combinations	TP	L	K	MRST
A	200	1	10	-
B	200	2	8	2
C	200	3	6.5	1.5
D	200	4	5.5	1
E	200	5	5	0.5



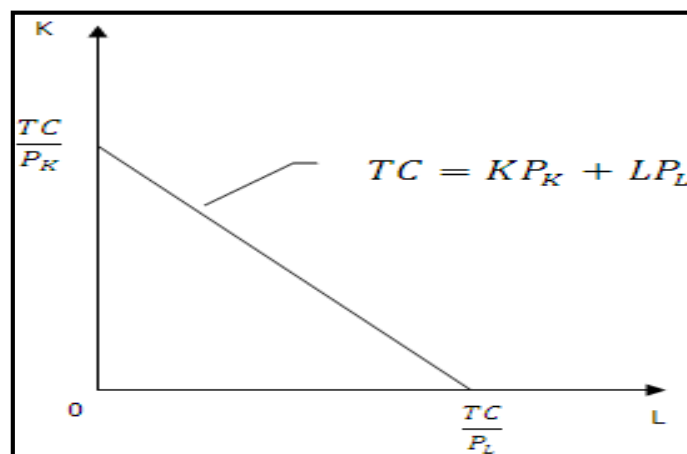
3.4) Isocost line

The isocost line illustrates all the possible combinations of two factors that can be used at given costs and for a given producer's budget. In simple words, an isocost line represents a combination of two inputs that can be purchased for the same total money outlay.

The equation of an isocost line is typically expressed as:

$$TC = LP_L + KP_K$$

- ✓ When $K = 0 \Rightarrow TC = LP_L \Rightarrow L = \frac{TC}{P_L}$
- ✓ When $L = 0 \Rightarrow TC = KP_K \Rightarrow K = \frac{TC}{P_K}$



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Its slope reflects the relative prices of two factors of production (i.e. Ratio of Price of labor to Price of capital = PL/PK)

3.5) Producer's Equilibrium or Optimization.

Producer equilibrium is achieved when a firm optimally combines inputs to minimize the cost of producing a given level of output. The graphical representation involves the concept of an isocost line and its **tangent** point with an isoquant.

Mathematically, tangency occurs where the slope of the isocost line is equal to the slope of the isoquant,

First condition:

$$\frac{MPL}{PL} = \frac{MPK}{PK}$$

Second condition

$$TC = LP_L + KP_K$$

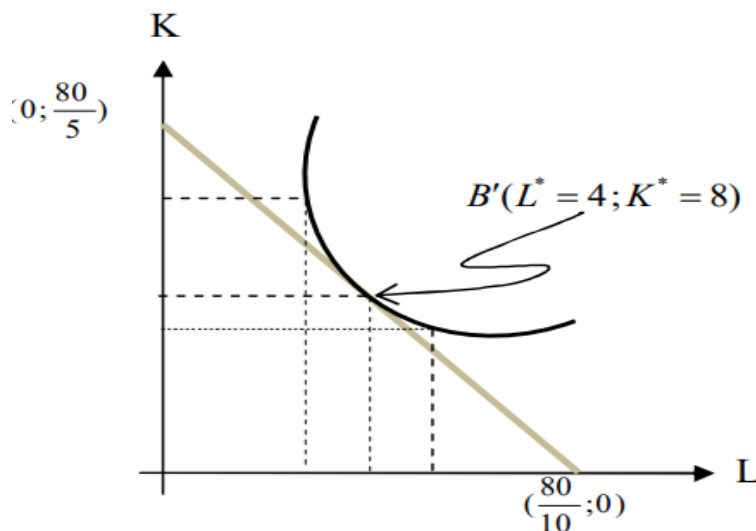
Example 01

Combinations	L	K	MRTS
A	3	10	/
B	4	8	2
C	5	6,3	1.7

$$TC=80 \quad PL=10 \quad PK=5$$

$$80=10L+5K$$

$$MRTS(L, K) = \frac{MPL}{MPK} = \frac{PL}{PK} = 2 \Rightarrow L = 4, K = 8$$

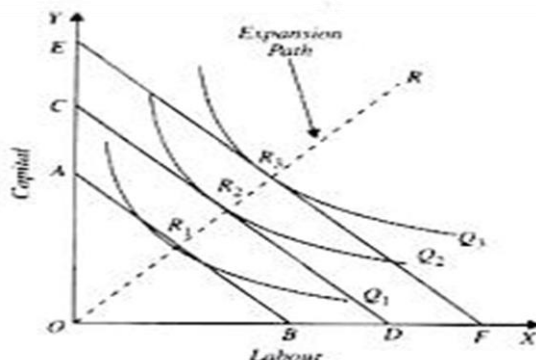


3.6) Expansion Path

Expansion path is the locus of various points where each point represents the producer's equilibrium. Suppose, after attaining equilibrium, if a producer is willing to increase its production, then he/she needs to determine the combination that is required to reach a new equilibrium state. Let us consider the following figure in which the producer is willing to produce Q_1 units of output and achieves its equilibrium at point R_1 . Now, the producer wants to produce Q_2 units of output instead of Q_1 units.

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In such a case, the equilibrium would be achieved at the point R2, as shown in the Figure. Similarly, the equilibrium point for producing Q3 is R3. When the points R1 , R2 and R3 are joined, a straight line is obtained, which is called **expansion path**.



Expansion path can be interpreted as the locus of all equilibrium points when expenditure on inputs increases keeping input prices constant. The expansion path is a very useful concept. It gives an idea of how input proportion changes with increases in expenditure of producer, input prices being constant.

It shows the change of optimum factor combination when a firm expands its level of output at the given factor prices.

Along the EP, slope of iso product curve = slope of iso cost line

$$MRTS(L,K) = P_L/P_K$$

Expansion path for a linear homogeneous PFs will be a straight line showing constant proportion of the input used while increasing the level of output.

Expansion path for a non-homogeneous PFs will be a curve showing different factor proportions at different stages of production.

3.7) Returns to Scale - Concept

The term returns to scale arises in the context of a firm's production function. It explains the behavior of the rate of increase in output (**production**) relative to the associated increase in the inputs (**the factors of production**) in the long run. In the long run all factors of production are variable and subject to change due to a given increase in size (scale). Return to scale refers to how the increase in input factors affects the output of a production process.

The returns to scale are of the following three types:

- ✓ **increasing returns to scale:** This occurs when an increase in inputs leads to a more than proportionate increase in output. In other words, if all inputs are doubled and output more than doubles, this is known as increasing returns to scale. **For example**, if a factory doubles its inputs, its output may more than double.
- ✓ **constant return to scale:** This occurs when an increase in inputs leads to a proportional increase in output. If all inputs are doubled and output also doubles, this is known as constant returns to scale. **For example**, if a factory doubles its inputs (labor, capital, etc.), its output will also double.

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- ✓ **diminishing returns to scale:** This occurs when an increase in inputs leads to a less than proportionate increase in output. If all inputs are doubled and output increases by less than double, this is known as decreasing returns to scale. **For example**, if a factory doubles its inputs, its output may increase by less than double.

Returns to scale can be checked in the following way if a production function is a homogeneous function, i.e.

$$F(\lambda L, \lambda K) = \lambda^t F(L, K)$$

- if $t < 1$, $F(K, L)$ displays DRS,
- if $t = 1$, $F(K, L)$ displays CRS,
- if $t > 1$, $F(K, L)$ displays IRS.

Example

Suppose : $F(L, K) = Q = 5K^{1/3} L^{2/3}$

Then

$$F(\lambda L, \lambda K) = 5(\lambda L)^{1/3} (\lambda K)^{2/3} = 5\lambda^{1/3} L^{1/3} \lambda^{2/3} K^{2/3} = \lambda 5L^{1/3} K^{2/3} = \lambda F(L, K)$$

Since $t = 1$, it is **constant return to scale**

3.8) Cobb–Douglas production function

The Cobb-Douglas production function is a widely used mathematical model in economics to describe the relationship between inputs (typically labor and capital) and output in a production process. The Cobb-Douglas function takes a specific form, known for its simplicity and flexibility in capturing various aspects of production.

Here's the basic form of the Cobb-Douglas production function:

$$Q = AL^\alpha K^\beta$$

Where:

$$1 > \beta > 0$$

$$1 > \alpha > 0$$

Q = total production

L = labor input (the total number of person-hours worked in a year)

K = capital input (the real value of all machinery, equipment, and buildings)

A = total factor productivity (i.e Constant)

β and α are the output elasticities of labor and capital respectively.

Output elasticity measures the responsiveness of output to a change in levels of either labor or capital used in production, ceteris paribus

$$\alpha = EL = \frac{\Delta Q}{\Delta L} \cdot \frac{L}{Q}$$

$$\beta = EK = \frac{\Delta Q}{\Delta K} \cdot \frac{K}{Q}$$

If, $\alpha + \beta = 1$, Constant Returns to Scale

If, $\alpha + \beta > 1$, Increasing Returns to Scale

If, $\alpha + \beta < 1$, Decreasing Returns to Scale

Review Questions

Activity 01: Say whether these statements are true or false, correct the false ones

1. Total product reaches maximum when marginal product reaches zero. **True**
2. When the average product APL is increasing, marginal product MPL must be above the average product. **True**
3. The law of diminishing returns states that employing one more worker (with a fixed number of machines) will eventually cause the marginal product of labor (MPL) to increase. **False**
→The law of diminishing returns states that employing one more worker (with a fixed number of machines) will eventually cause MPL to decrease.
4. Producer must work in the first stage of production (increasing marginal returns) **False**
→Producer must work in the second stage of production (diminishing marginal returns)
5. When the average product is increasing marginal product must be increasing too. **False**
→When the AP is increasing, MP could be increasing or decreasing
6. When the total product is increasing, average product must be increasing too. **False**
When TP is increasing, APL could be increasing or decreasing
7. Marginal product MPL equals average product APL at the maximum value of the marginal product. **False**
→ $MPL = APL$ at the maximum value of the APL
8. When the total product is increasing, marginal product must be increasing too. **False**
→When TP is increasing at an increasing rate, MP is increasing, but when TP is increasing at a decreasing rate, MP is decreasing (stage 2)
9. Total product reaches maximum when marginal product is equal to average product. **False**
→TP is maximum when MPL is zero But when MPL is equal to APL, TP is still increasing but at a decreasing rate.
10. A rational producer will always operate in diminishing returns (Stage II). **True**

Activity 02: Choose the correct answer

1. Which of the following is a characteristic of the short run-in production?
 - a. All factors of production are variable
 - b. All factors of production are fixed
 - c. At least one factor of production is fixed
2. Which of the following is a fixed factor of production?
 - a. Capital
 - b. Labor
 - c. Raw materials
3. If the Total Product (TP) is increasing at a decreasing rate, the Marginal Product (MPL) is:
 - a. Negative
 - b. Positive but decreasing
 - c. Increasing
4. Which of the following represents the concept of returns to scale?
 - a. The proportionate increase in output when all inputs are increased proportionately
 - b. The impact of one input when other inputs are held constant
 - c. The relationship between input and output in the short run
5. If the Average Product (APL) is at its maximum, then the Marginal Product (MPL):
 - a. Is zero
 - b. Is equal to APL
 - c. Is greater than APL

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6. In the long run, all factors of production are:

- Fixed
- Variable
- Partially fixed and partially variable

7. When the Marginal Product (MP) of labor is negative, it implies that:

- Total Product (TP) is decreasing
- Total Product (TP) is at its maximum
- Total Product (TP) is increasing

8. Which of the following best describes the Isoquant curve?

- Represents the total cost of production
- Shows combinations of inputs and costs
- Shows combinations of two inputs that yield the same level of output

Activity 03: Exercises

Exercise 01

A textile company produces shirts using two inputs: labor (L) and capital (K), represented by sewing machines. Their production function is given by: $Q = 50L^{\frac{1}{3}}K^{\frac{2}{3}}$

Assume the wage rate for labor is \$4 per hour and the rental cost of a sewing machine is \$6 per day, and total cost is 72\$

- What is the organization's optimal production?
- What type of returns to scale does it exhibit?
- Calculate the MRTS (l.k).
- Find the output elasticities of labor and capital respectively.

Exercise 02

Suppose the short-period production function takes the following form $Q = 12L^2 - L^3K$

Where: K=2

- Identify the value of L at which MPL starts decreasing.
- Find the value of L that maximizes APL.
- Determine the equilibrium point of the producer
- Determine the stages of production
- The production function is given by:

$$Q = 2L^{1/2}K^{1/2}$$

Assume the wage rate for labor is \$2 per hour and the rental cost of a Capital is \$4 per day, and total cost is 200 \$

- .What is the organization's optimal production
- Derive the MRTS between labor and capital and interpret its economic meaning.

Solutions

Exercise 01

We are given the production function: $Q = 50L^{\frac{1}{3}}K^{\frac{2}{3}}$

The total cost is given as \$72, with the cost of labor (PL) being \$4 per hour and the cost of capital (PK) being \$6 per day.

The cost constraint is: $72 = 4L + 6K$

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Step 1: Marginal Product of Labor (MPL) and Marginal Product of Capital (MPK)

The Marginal Product of Labor (MPL) is the partial derivative of Q with respect to L:

$$MPL = \frac{\partial Q}{\partial L} = 50 \times \frac{1}{3} L^{-\frac{2}{3}} K^{\frac{2}{3}} = \frac{50}{3} L^{-\frac{2}{3}} K^{\frac{2}{3}}$$

The Marginal Product of Capital (MPK) is the partial derivative of Q with respect to K:

$$MPK = \frac{\partial Q}{\partial K} = 50 \times \frac{2}{3} L^{\frac{1}{3}} K^{-\frac{1}{3}} = \frac{100}{3} L^{\frac{1}{3}} K^{-\frac{1}{3}}$$

Step 2: Set Up the Cost-Minimization Condition

To minimize the cost for a given level of production, the ratio of the marginal products should be equal to the ratio of input prices:

$$\frac{MPL}{MPK} = \frac{PL}{PK} = \frac{\frac{50}{3} L^{-\frac{2}{3}} K^{\frac{2}{3}}}{\frac{100}{3} L^{\frac{1}{3}} K^{-\frac{1}{3}}} = \frac{4}{6} = \frac{2}{3}$$

Simplifying:

$$\frac{L^{-\frac{2}{3}} K^{\frac{2}{3}}}{2 L^{\frac{1}{3}} K^{-\frac{1}{3}}} = \frac{2}{3}$$

Simplifying further:

$$\frac{k^{\frac{1}{3}} K^{\frac{2}{3}}}{2 L^{\frac{1}{3}} L^{\frac{2}{3}}} = \frac{2}{3}$$

$$\frac{k}{2 L} = \frac{2}{3}$$

This tells us that the optimal ratio of capital to labor should be: $K = \frac{4}{3} L$

Step 3: Substitute K into the Cost Constraint : Substitute $K = \frac{4}{3} L$ into the cost constraint:

$$72 = 4L + 6K : 72 = 4L + 6\left(\frac{4}{3} L\right) . 72 = 4L + 8 L . 12L = 72 : L = \frac{72}{12} = 6$$

Step 4: Find the Corresponding Capital Input K

Now, substitute $L=6$ back into the equation $K = \frac{4}{3} L$: $K = \frac{4}{3} (6) = \frac{24}{3} = 8$

$$72 = 4(6) + 6(8) = 24 + 48 = 72 \text{ Confirmed}$$

Step 5: Calculate the Optimal Production Level

Finally, substitute $L=6$ and $K=8$ back into the production function:

$$Q = 50 L^{\frac{1}{3}} K^{\frac{2}{3}} = 50 6^{\frac{1}{3}} 8^{\frac{2}{3}} = 363.42 \text{ units of shirts}$$

2. type of returns to scale exhibits this function

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The sum of the exponents in the production function:

We've

$$n = \alpha + \beta \Rightarrow n = \frac{1}{3} + \frac{2}{3} = 1$$

So the function exhibits constant returns to scale

3. Calculate the MRTS (l,k).

$$MRTS(l, k) = \frac{MPL}{MPK} = \frac{K}{2L} \Rightarrow MRTS(l, k) = \frac{8}{2.6} = \frac{8}{12} = \frac{2}{3}$$

The producer give up 2/3 units of K in order to get 1 additional unit of L keeping the same level of output.

4. Find the output elasticities of labor and capital respectively. Output elasticity of Labor EL

$$EL = MPL \cdot \frac{L}{Q} = \frac{50}{3} L^{-\frac{2}{3}} K^{\frac{2}{3}} \cdot \frac{L}{50 L^{\frac{1}{3}} K^{\frac{2}{3}}} = \frac{1}{3}$$

Output elasticity of Capital EK

$$EK = MPK \cdot \frac{K}{Q} = \frac{100}{3} L^{\frac{1}{3}} K^{-\frac{1}{3}} \cdot \frac{K}{50 L^{\frac{1}{3}} K^{\frac{2}{3}}} = \frac{2}{3}$$

Exercise 02

Production Function and Setup

Given the short-period production function:

$$Q = 12L^2 - 2L^3 K$$

When K=2, the production function simplifies to: $Q = 12L^2 - 2L^3$

1. Identify the value of L at which MPL starts decreasing

$$\text{Max } MPL \Rightarrow MPL' = 0 \text{ and } MPL'' < 0$$

Calculate the Marginal Product (MPL)

Marginal Product of Labor (MPL): The derivative of Q with respect to L:

$$MPL = \frac{dQ}{dL} = 24L - 6L^2$$

$$MPL' = 0 \Rightarrow 24 - 12L = 0 \Rightarrow L = \frac{24}{12} = 2$$

$$MPL'' = -12 < 0$$

2-Find the value of L that maximizes APL.

$$\text{Max APL} \Rightarrow APL' = 0 \text{ and } APL'' < 0$$

Calculate the Average Product of Labor (APL)

Average Product of Labor (APL): The total product divided by the number of labor units L.

$$APL = \frac{dQ}{dL} = 12L - 2L^2$$

$$APL' = 0 \Rightarrow 12 - 4L = 0 \Rightarrow L = \frac{12}{4} = 3$$

$$APL'' = -4 < 0$$

3. Determine the Equilibrium Point

The equilibrium point occurs where the Marginal Product (MPL) is equal to zero, indicating that adding more labor does not increase output.

$$\text{Set } MPL = 0 \Rightarrow 24L - 6L^2 = 0 \Rightarrow L(24 - 6L) = 0$$

$$\Rightarrow L = 0 (\text{rejected}) \vee L = \frac{24}{6} = 4$$

4-Stages of Production

- Stage I:** From L = 0 to L = 2, where MPL > APL and both are increasing.
- Stage II:** From L = 2 to L = 4, where MPL > 0 but decreasing, and TP is still increasing.
- Stage III:** From L = 4 to L = ∞, where MPL < 0, and TP is decreasing, indicating negative returns.

5-We are given the production function:

$$Q = 2L^{1/2}K^{1/2}$$

The total cost is given as \$200, with the cost of labor (PL) being \$2 per hour and the cost of capital (PK) being \$4 per day.

The cost constraint is: **200=2L+4K**

Step 1: Marginal Product of Labor (MPL) and Marginal Product of Capital (MPK)

$$MPL = \frac{\delta TP}{\delta L} = 2 \frac{1}{2} L^{-1/2} K^{1/2} = L^{-1/2} K^{1/2}$$

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$$MPK = \frac{\delta TP}{\delta K} = 2 \frac{1}{2} L^{1/2} K^{-1/2} = L^{1/2} K^{-1/2}$$

Step 2: Set Up the Cost-Minimization Condition

To minimize the cost for a given level of production, the ratio of the marginal products should be equal to the ratio of input prices:

$$\frac{MPL}{MPK} = \frac{PL}{PK} \Rightarrow \frac{L^{-1/2} K^{1/2}}{L^{1/2} K^{-1/2}} = \frac{2}{4}$$

Simplifying:

$$\frac{L^{-1/2} K^{1/2}}{L^{1/2} K^{-1/2}} = \frac{2}{4} \Rightarrow \frac{K^{1/2} K^{1/2}}{L^{1/2} L^{1/2}} = \frac{1}{2}$$

Simplifying further:

$$\frac{K}{L} = \frac{1}{2}$$

This tells us that the optimal ratio of capital to labor should be:

$$L=2K$$

Step 3: Substitute L into the Cost Constraint :

$$200 = 2L + 4K \Rightarrow 200 = 2(2K) + 4K \\ \Rightarrow 200 = 8K \Rightarrow K = \frac{200}{8} = 25$$

Step 4: Find the Corresponding Capital Input K

Now, substitute **K=25** back into the equation

$$L=2K=2(25)=50$$

$$(L,K)=(50,25)$$

Step 5: Calculate the Optimal Production Level

Finally, substitute L=50 and K=25 back into the production function:

$$Q = 2(50)^{\frac{1}{2}}(25)^{\frac{1}{2}} = 70.71$$

5. Calculate the MRTS (l.k).

$$MRTS(l, k) = \frac{MPL}{MPK} = \frac{K}{L} \Rightarrow MRTS(l, k) = \frac{25}{50} = 0.5$$

The producer give up 0.5 units of K in order to get 1 additional unit of L keeping the same level of output.

Chapter 07
Costs Analysis

Chapter 07

Costs Analysis

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.

Production activity requires costly inputs, both fixed and variable. Variable inputs such as labor and raw materials generate **variable costs** (also known as operating expenses) while fixed inputs that do not change with the level of output such as the number of telephone lines and salaried managers generate **fixed costs** (sometimes called overhead). It is in the interest of a profit-maximizing firm to produce a given level of output in the cheapest way possible.

Chapter Outline:

- ✓ The main Concepts of costs and profit (Explicit and Implicit Costs, Accounting and Economic Profit)
- ✓ The structure of costs in the short run
- ✓ The structure of costs in the long run

After studying this chapter you will be able to-

- ✓ Distinguish between Explicit and Implicit Costs, Accounting and Economic Profit
- ✓ Analyze short-run costs as influenced by total cost, fixed cost, variable cost, marginal cost, and total average cost
- ✓ Interpret graphs of different costs types curves

1. Which costs matter?

Before we can analyze how firms minimize costs, we must clarify what we mean by cost in the first place and how we should measure it.

1.1) Accounting & Economic Costs:

- **Accounting Cost(direct cost)** is also known as **explicit cost** or **out-of-pocket costs**; that is explicitly paid for factors of production such as salary, maintenance, prices of raw material, electricity and water bills and transportation, advertisement, and other payments such as insurance and taxes
- **Economic Costs (implicit and explicit costs)** **Total cost** include out-of-pocket costs and opportunity cost of all inputs or factors of production. Out-of-pocket costs are sometimes referred to as explicit costs or accounting costs. These refer to costs as an accountant would calculate them. Economic costs include the opportunity cost of every input. These opportunity costs are often referred to as implicit costs..

For example,

- If you own your own building implicit costs of running a small store include the rent that could have been earned if the building was leased to another firm.
- Piece of land may be used either for building a residential flat or for constructing a hospital. If the land is used for constructing a hospital then its opportunity cost is the cost of residential flat foregone.
- Interest that could be earned by lending money to someone else.

1.2) Accounting and Economic Profit

As a result of differentiating between economic and accounting costs, we must differentiate between Accounting and economic profit.

- Accounting profit = total revenue – explicit (accounting) costs.
- Economic profit = total revenue – Total cost (implicit and explicit costs).
- If total revenue > Total costs, the company gains economic profit.
- If total revenue < Total costs, the company gains economic loss.
- If total revenue = the total cost, $\longrightarrow$ economic profit = 0, and the company gains only accounting profit.

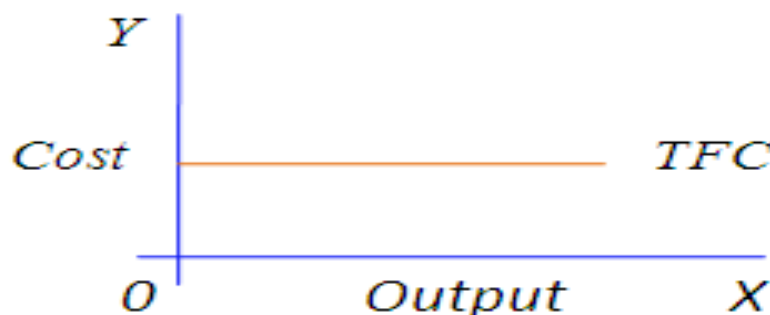
2. Costs in the Short Run

In short run, all firms (competitive and noncompetitive) have costs that they must bear regardless of their output. In fact, some costs must be paid even if the firm stops producing—that is, even if output is zero. These costs are called fixed costs, and firms can do nothing in the short run to avoid them or to change them. In the long run, a firm has no fixed costs because it can expand, contract, or exit the industry.

Firms also have certain costs in the short run that depend on the level of output they have chosen. These kinds of costs are called variable costs. Total fixed costs and total variable costs together make up total costs:

2.1) Fixed cost and variable cost

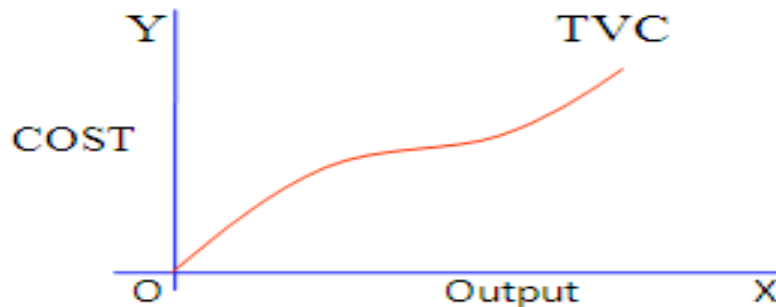
- **Fixed cost** is any cost that does not depend on the firm's level of output. These costs are incurred even if the firm is producing nothing. (**Related to Fixed input**)
- Fixed Cost is the cost which is fixed irrespective of the level of output produced.
- **Total fixed costs (TFC)** or **overhead** refers to the total of all costs that do not change with output, even if output is zero.
- Another name for fixed costs in the short run is **sunk costs** is because firms have no choice but to pay for them.
- **The fixed costs include:** salaries of administrative staff, depreciation (wear & tear) of machinery, expenses for building and repairs, rental payments, interest on a firm's debts.



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The total fixed cost remains constant; this shows that the total fixed cost will be incurred even if the output is zero, Total fixed cost is independent of the amount of output produced and remains constant for all levels of production.

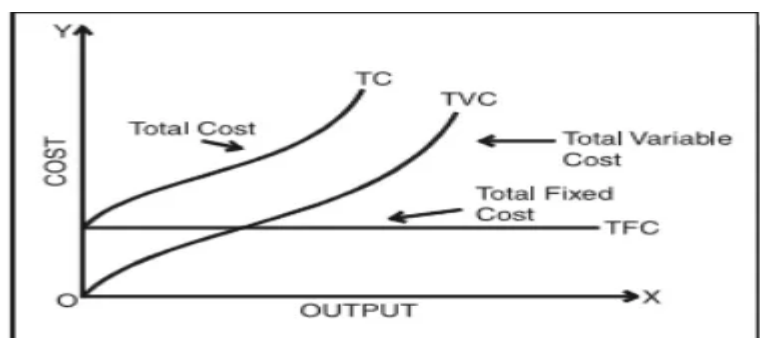
- **Variable cost** is a cost that depends on the level of production chosen. (**Related to Variable input**)
- **The variable costs include:** the raw materials, fuel, power, ordinary repairs and routine maintenance, transportation services etc.
- The **total variable cost (TVC)** is derived from production requirements and input prices.
- The **total variable cost curve** is a graph that shows the relationship between total variable cost and the level of a firm's output.



- TVC varies with the **variation in the output**
 - TVC begin from the starting point, this shows when output is zero the variable cost are nil
 - After that it starts rising upwards showing that as output increases the total variable cost also increases
- **Total cost TC** is defined as the total actual cost incurred by an entrepreneur to produce a given quantity of output
 - Total cost are composed of two major elements, total fixed cost **TFC**, total variable costs **TVC**.

$$\text{Total Cost} = \text{Total Fixed cost} + \text{Total Variable cost}$$

$$\text{TC} = \text{TFC} + \text{TVC}$$



-The FC is denoted by the horizontal line and the Variable cost has broadly an inverse-S shape which reflects the law of variable proportion.

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- The Vertical distance between (TC) and (TVC) is always constant because it represent the **TFC**.
- Both (TC) and (TVC) are increasing at decreasing rate then increasing at increasing rate.
- By adding the TFC and TVC we obtain the TC of the firm.

2.2) Average Costs

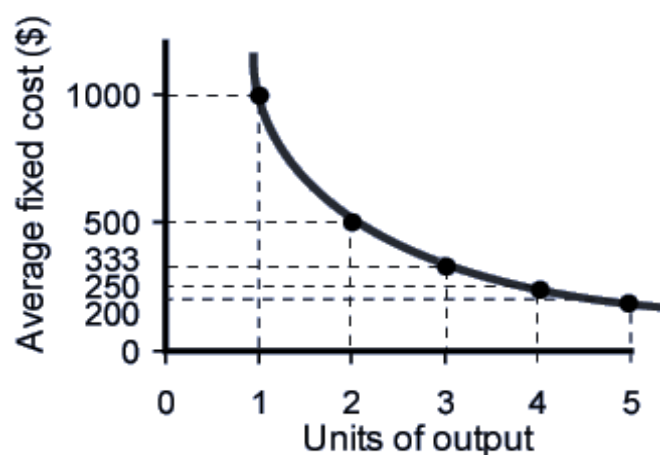
➤ Average Fixed Cost (AFC)

- **Average fixed cost (AFC)** is the total fixed cost incurred per unit of output produced.
- **Average fixed cost (AFC)** is the total fixed cost (TFC) divided by the number of units of output (q or TP):

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

- Average fixed cost declines as quantity rises, but it is never zero.
- The greater the output of the firm, the smaller will be the AFC.

(1) q	(2) TFC	(3) $AFC (TFC/q)$
0	\$1,000	-
1	1,000	1,000
2	1,000	500
3	1,000	333
4	1,000	250
5	1,000	200



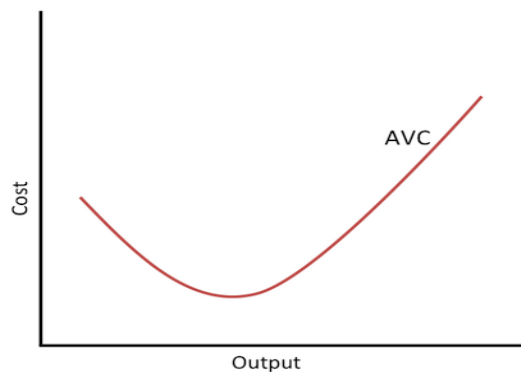
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➤ Average Variable Cost (AVC)

- **Average variable cost (AVC)** is the total variable cost incurred per unit of output produced.
- **Average variable cost (AVC)** is the total variable cost divided by the number of units of output.

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

Labor	Quantity	Variable Cost	Average Variable Cost
1	16	\$80	\$5.00
2	40	\$160	\$4.00
3	60	\$240	\$4.00
4	72	\$320	\$4.40
5	80	\$400	\$5.00
6	84	\$480	\$5.70



AVC initially falls because of increasing marginal returns but then rises because of diminishing marginal returns.

➤ Average Total Cost ATC

- **Average total cost (ATC)** is total cost divided by the number of units of output (q).

$$ATC = \frac{TC}{q}$$

or

$$ATC = \frac{VC+FC}{q}$$

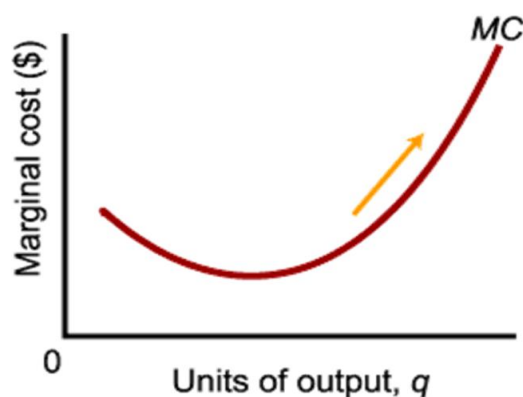
or

$$ATC=AVC+AFC$$

2.3) Marginal Cost (MC)

- **Marginal cost (MC)** is the change in total cost that results from producing more unit of output.
- Marginal cost reflects changes in variable costs.

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\Delta TVC}{\Delta Q}$$

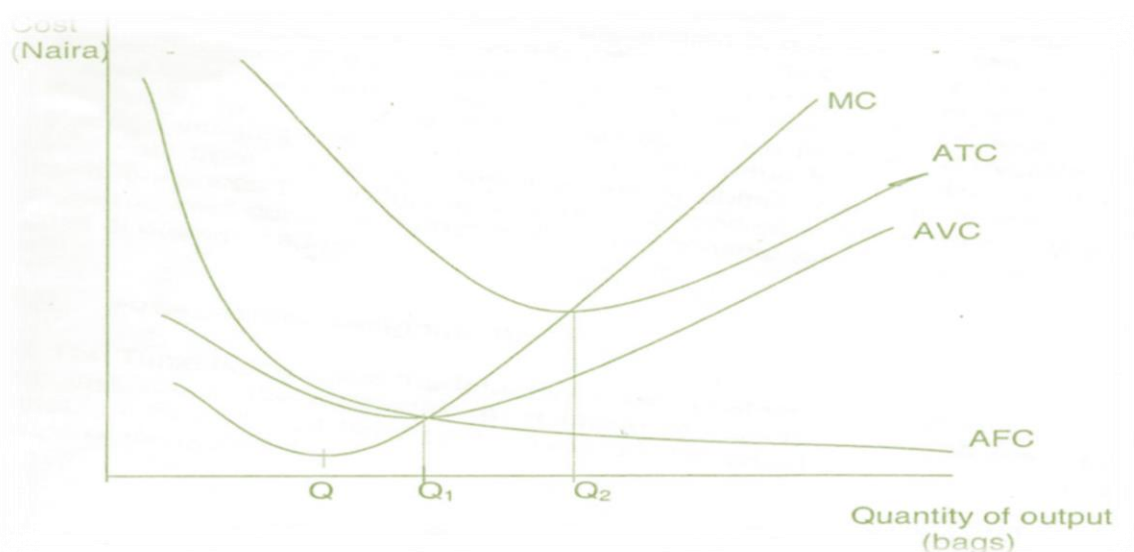


- The marginal product first rise reaches a maximum & then decline.
- This ensures that marginal cost curve of a firm decline first reaches a maximum & then rises.
- That is why marginal cost curve of a firm has a U shape.

2.4) The Relationship Between AVC, MC and ATC

Graphically, the **AFC** is a rectangular hyperbola, which implies that, at all points on the AFC curve, the same total fixed cost is being divided by an increasing quantity of output. The AFC decreases continuously without touching either axis.

The **AVC** starts to decline with increase in output, reaches a minimum, and as larger quantities of the variable factor is applied to the fixed factor, eventually, **AVC** begin to rise in response to the law of variable proportion. **ATC** has the same shape as the **AVC**, inverted **U shape**. However, the minimum point of the **ATC** is to the right of that of the **AVC** as can be observed in Figure below. The level of output at the minimum **AVC** is Q_1 while that of **ATC** is Q_2 . The reason for this is that when **AVC** reaches its minimum and begun to rise, the marked decrease in **AFC** causes **ATC** to continue to decline. However, successive increases in the **AVC** may become so strong and more than offset the fall in the **AFC** such that the **ATC** begins to fall. As **AFC** approaches the quantity axis, the **AVC** approaches the **ATC**. This is expected because as more and more units of output is produced the **AFC** becomes smaller and smaller and thus the **AVC** approaches the **ATC**.

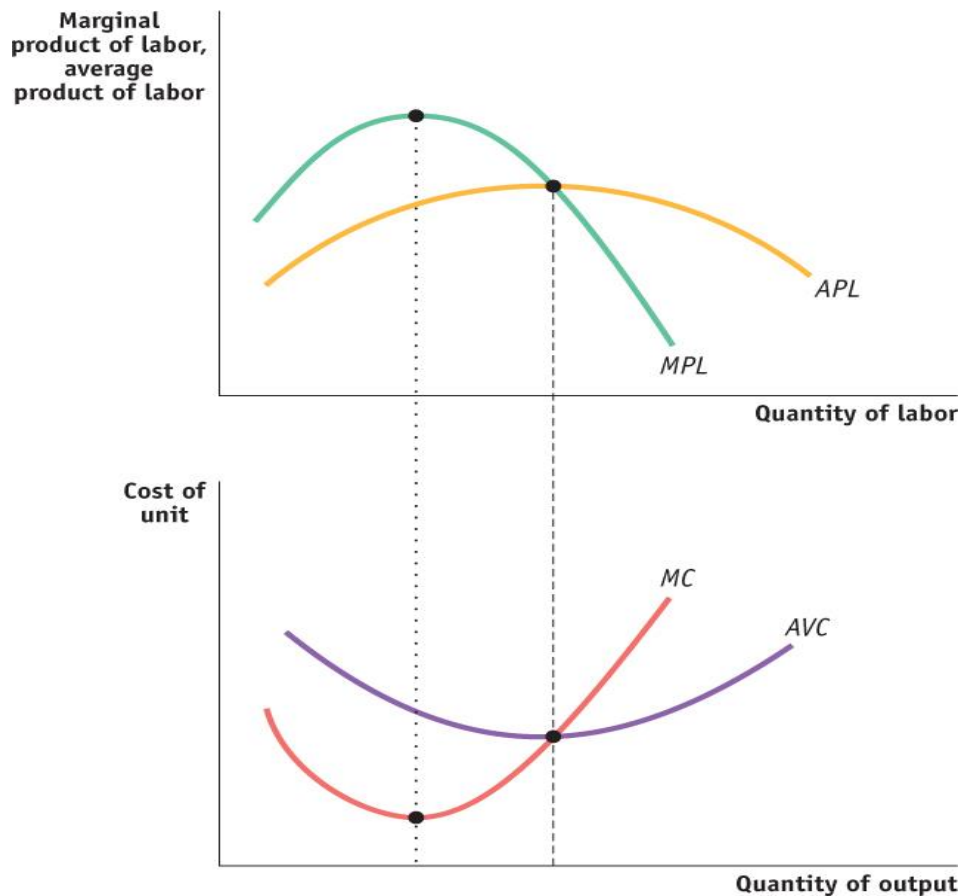


The MC curve is U-shaped like the AVC and ATC curves. The MC curve first decreases, reaches its minimum and then rises thereafter. MC is decreasing when total cost is increasing at a decreasing rate

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it reaches a minimum and starts increasing when TC starts increasing at an increasing rate. MC is equal to the AVC and ATC at the minimum points of the AVT and AVC. In other words, the MC must cut AVC and ATC at their minimum points.

2.5) Relation Between Production and Cost Curves:



The marginal cost curve is **U-shaped**, with the cost of additional units of output first falling, reaching a minimum, and then rising. The shape of the marginal cost curve is attributable to the law of diminishing marginal returns. To see why, recall the MC is defined as

$$MC = \Delta TVC / \Delta q$$

We know $TVC = LPL$ where PL is the wage rate and L is the amount of the variable input (labor). Thus $\Delta TVC = \Delta LPL$, yielding

$$MC = \frac{\Delta TVC}{\Delta q} = \frac{\Delta LPL}{\Delta q} = \frac{PL}{MPL}$$

Thus MC and MPL have a reverse relationship. Because of the law of diminishing marginal returns, MPL varies with the amount of output and therefore, so must MC. At low levels of output MPL is rising; so, correspondingly, ($MC = PL/MPL$) must be falling. When MPL reaches a maximum, then MC must be at a minimum. After that MPL falls, and then MC must rise. That is, MPL rises and then falls; and correspondingly MC will first fall and then rise.

The relationship between average labour productivity **APL** and average variable cost **AVC** can be stated more precisely: Using PL to define the wage, and L the amount of labour employed, the AVC can be written as follows:

$$AVC = \frac{TVC}{q} = \frac{LPL}{q} = \frac{PL}{APL}$$

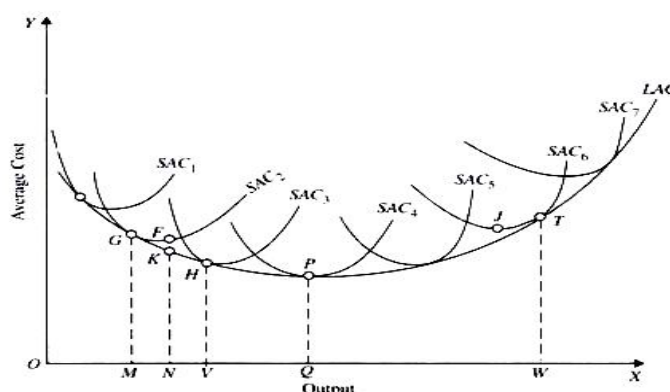
Writing the relationship in this way enables us to see the key role played by the productivity of workers in determining the shape of the **AVC** curve: When the denominator (**APL**) rises relative to the constant numerator (**PL**), then the **AVC** must fall, and vice versa. This is exactly what happens when production expands. Initially, average productivity increases relative to the fixed wage rate **PL**, and therefore the **AVC** initially falls. At higher output levels, the average productivity falls relative to the wage, and therefore **AVC** increases..

3. Long Run Average Cost: The 'Envelope' Curve

In the long run all factors are assumed to become variable. Thus the long-run cost curve is said as a **planning curve**, in the sense that it is a guide to the entrepreneur in his decision to plan the future expansion of his output.

Long-run average total cost (**LRAC**) represents the average cost per unit of output over the long run, where all inputs are considered to be variable and the scale of production is changeable. The long-run average cost curve shows the lowest total cost to produce a given level of output in the long run.

The long-run cost curve **LAC** is derived from the short-run cost curves. Each point on the **LAC** corresponds to a point on a short-run cost curve, which is tangent to the **LAC** at that point.



The Long Run Average Cost (**LATC**) curve of a firm shows the minimum or lowest average total cost at which a firm can produce any given level of output in the long run (when all inputs are variable).

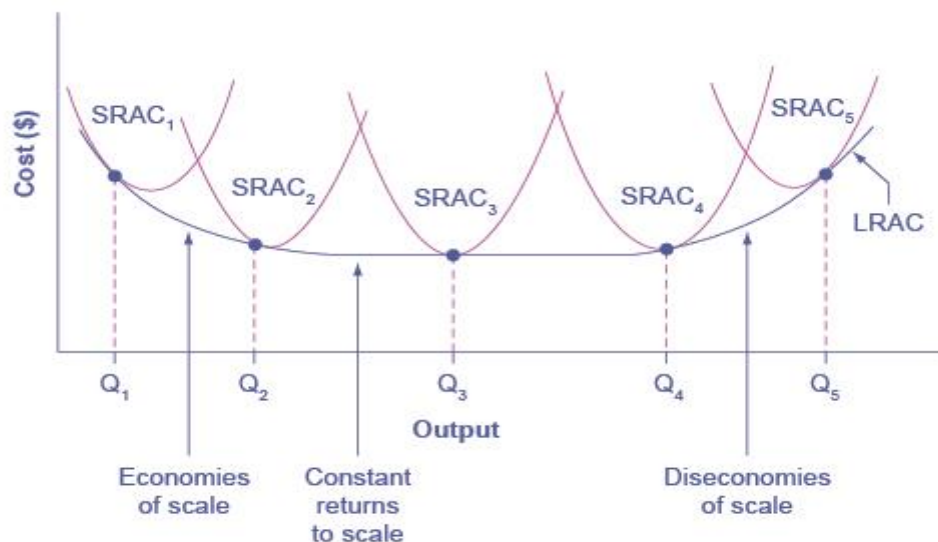
The long-run curve, **LATC**, is the lower envelope of all short-run **ATC** curves. It defines the least cost per unit of output when all inputs are variable. Minimum efficient scale is that output level at which the **LATC** is a minimum, indicating that further increases in the scale of production will not reduce unit costs.

Shapes of Long-Run Average Cost Curves

The **long-run average cost (LRAC)** curve is actually based on a group of **short-run average cost (SRAC)** curves, each of which represents one specific level of fixed costs. More precisely, the long-run average cost curve will be the least expensive average cost curve for any level of output. shows how we build the long-run average cost curve from a group of short-run average cost curves. Five short-run-average cost curves appear on the diagram. Each SRAC curve represents a different level of fixed costs. **For example**, you can imagine **SRAC₁** as a small factory, **SRAC₂** as a medium factory, **SRAC₃** as a large factory, and **SRAC₄** and **SRAC₅** as very large and ultra-large. Although this diagram

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shows only five SRAC curves, presumably there are an infinite number of other SRAC curves between the ones that we show. Think of this group of short-run average cost curves as representing different choices for a firm that is planning its level of investment in fixed cost physical capital—knowing that different choices about capital investment in the present will cause it to end up with different short-run average cost curves in the future.



In the long-run, the firm can choose among different possible sizes of plant as determined by short run average cost curves such as SAC1, SAC 2 and SAC3. The LAC-curve is flatter U shaped and it is often called the 'envelope curve' because it 'envelopes' the SAC curves.

Why does LAC fall in the beginning: Economies of Scale

The question is why we first get increasing returns to scale due to which long-run average cost falls and why after a certain point we get decreasing returns to scale due to which long-run average cost rises. In other words, what are the reasons that the firm first enjoys internal economies of scale and then beyond a certain point it has to suffer internal diseconomies of scale? Three main reasons have been given for the economies of scale which accrue to the firm and due to which cost per unit falls in the beginning.

First, as the firm increases its scale of operations, it becomes possible to use more specialized and efficient form of all factors, especially capital equipment and machinery. For producing higher levels of output, there is generally available a more efficient machinery which when employed to produce a large output yields a lower cost per unit of output.

Secondly, when the scale of operations is increased and the amount of labour and other factors becomes larger, introduction of a great degree of division of labour or specialization becomes possible and as a result the long-run cost per unit declines.

Thus, when the short-run cost decreases (the downward sloping segment of the short-run average cost curve) occur due to the fact that the ratio of the variable input comes nearer to the optimum proportion, decrease in the long-run average cost (downward segment of the long-run average cost curve) take place due to the use of more efficient forms of machinery and other factors and to the introduction of a greater degree of division of labor in the productive process.

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Review Questions

Activity 01: Say whether these statements are true or false, correct the false ones :

1. Marginal cost represents the average cost of producing one unit of output in the short run
False
Marginal cost represents the additional cost of producing one more unit of output, not the average cost
2. The Long-Run Average Cost (LRAC) curve is always downward-sloping. **False**
The LRAC curve is typically U-shaped. It slopes downward at first (economies of scale), flattens (constant returns), and then slopes upward (diseconomies of scale).
3. Total variable costs increase proportionally with the level of production in the short run. **True**
4. Average fixed costs decrease as production levels rise in the short run. **True**
5. Total fixed costs change as production levels fluctuate in the short run. **False**
Total fixed costs remain constant in the short run regardless of changes in production levels.
6. Accounting profit includes both explicit and implicit costs. **False**
Accounting profit only considers explicit costs.
7. In the long run, all costs are considered to be variable. **True**
8. In the long run, a firm can adjust its level of capital and labor to achieve the most cost-effective production process. **True**
9. The marginal cost curve intersects the average cost curve at its minimum point. **True**
10. The actual expenditure incurred by a firm to purchase or hire the inputs it needs in the production process is called implicit cost. **False**
The actual expenditure incurred by a firm to purchase or hire the inputs it needs in the production process is called **explicit cost**.

Activity 02: Choose the correct answer

1. Total cost (TC) is equal to a.
a. TFC + TVC b. MC + AC
c. TFC + MC d. TFC + AC
2. Which of the following is rectangular hyperbola
a. TFC b. TVC
c. AFC d. AVC
3. An addition made to the TC or TVC as output is increased by one more unit is called:
a. ATC b. MC
c. AVC d. AFC
4. When MC is falling, MC is a.
a. Below AC b. Above AC
c. Equal to AC d. All may be possible.
5. MC curve cuts AC curve at its a.
a. minimum point; b. Maximum point.
c. Any point; d. Never cuts.
6. Shift in cost curves is/are due to—
a. Change in input supply; b. Change in technology
c. a + b d. None of these.

7. In the long run, which of the following is true about costs?
- All costs are fixed
 - All costs are variable
 - Marginal cost is always constant
 - Firms cannot change input levels
8. What shape does the long-run average cost (LRAC) curve usually take?
- Downward sloping
 - L-shaped
 - U-shaped
 - S-shaped
9. When marginal cost is less than average cost, what happens to average cost?
- It increases
 - It decreases
 - It stays the same
 - It becomes zero
10. Which cost remains unchanged in the short run regardless of output?
- Variable cost
 - Marginal cost
 - Fixed cost
 - Total cost

Activity 01: Exercises

Exercise 01

A company's cost function is given as:

$$TC = 100 + 20Q + 5Q^2$$

- Calculate the total cost for producing 10 units.
- Determine the marginal cost function.
- Determine the average cost function .
- Find the output level that minimizes average cost.

Exercise 02

The demand curve is given as :

$$Q = 90 - 2P$$

and the firm's total cost curve as :

$$TC = Q^3 - 8Q^2 + 57Q + 2$$

- Determine the Marginal cost function **MC**.
- Determine the Average variable cost **AVC** .

3. Determine the level of output Q that Maximizes the firm's profit.

Solutions:

Exercise 01

Given:

The company's cost function is:

$$TC = 100 + 20Q + 5Q^2$$

1. Calculate the total cost for producing 10 units

Substitute $Q=10$ into the equation:

$$TC = 100 + 20(10) + 5(10)^2 = 800$$

So, the total cost for producing 10 units is **\$800**.

2. Determine the marginal cost function.

Marginal cost is the derivative of the total cost function with respect to Q . So :

$$MC = \frac{\delta TC}{\delta Q} = 20 + 10Q.$$

3. Determine the average cost function .

The average cost is the total cost divided by the quantity of units produced.

The formula for average cost is:

$$ATC = \frac{TC}{Q} = \frac{100 + 20Q + 5Q^2}{Q} = \frac{100}{Q} + 20 + 5Q$$

4. Find the output level that minimizes average cost

To find the output level that minimizes average cost, we need to set the derivative equal to zero and solve for Q .

To find the critical point, set the derivative equal to zero:

$$\begin{aligned} ATC' = 0 &\Rightarrow \frac{-100}{Q^2} + 5 = 0 \Rightarrow \frac{-100 + 5Q^2}{Q^2} = 0 \\ &\Rightarrow 100 = 5Q^2 \Rightarrow Q^2 = \frac{100}{5} = 20 \end{aligned}$$

Solving for Q:

$$Q^2 = 20 \Rightarrow Q = \sqrt{20} = 4.47$$

So, the output level that minimizes the average cost is approximately **4.47 units**.

Exercise 02

1. Marginal Cost (MC):

MC is the derivative of TC with respect to Q:

$$MC = \frac{\delta TC}{\delta Q} = 3Q^2 - 16Q + 57$$

2. Average Variable Cost (AVC):

Fixed cost = 2, so Variable Cost :

$$TVC = Q^3 - 8Q^2 + 57Q$$

$$AVC = \frac{TVC}{Q} = \frac{Q^3 - 8Q^2 + 57Q}{Q} = Q^2 - 8Q + 57$$

3. Profit Maximizing Output Level:

We have :

$$\pi = TR - TC$$

And

$$TR = P \cdot Q$$

Therefore :

$$\pi = PQ - TC$$

Step 1: Inverse demand function:

$$Q = 90 - 2P \Rightarrow P = \frac{(90 - Q)}{2} \Rightarrow P = 45 - \frac{1}{2}Q$$

Step 2: Total Revenue

$$TR = P \times Q = \left(45 - \frac{1}{2}Q\right) Q = 45Q - \frac{1}{2}Q^2$$

Step 3: Profit = TR - TC:

$$\pi = 45Q - \frac{1}{2}Q^2 - Q^3 + 8Q^2 - 57Q - 2$$

$$\pi = -Q^3 + \frac{15}{2}Q^2 - 12Q - 2$$

Step 4: Maximize profit , take derivative and set to zero

$$\text{Max } \pi \Rightarrow \pi' = 0 \text{ and } \pi'' < 0$$

$$\pi' = 0 \Rightarrow -3Q^2 + 15Q - 12 = 0$$

$$\Delta = (15)^2 - 4(-3)(-12) = 225 - 144 = 81$$

$$\sqrt{\Delta} = 9$$

$$Q_1 = \frac{-b - \sqrt{\Delta}}{2a} = \frac{-15 - 9}{-6} = 4$$

$$Q_2 = \frac{-b + \sqrt{\Delta}}{2a} = \frac{-15 + 9}{-6} = 1$$

To determine which of two values actually maximizes profit, we use second derivative test :

$$\pi'' < 0 \Rightarrow -6Q + 15 < 0$$

$$\text{At } Q = 1 \Rightarrow \pi'' = 9 > 0$$

$$\text{At } Q = 4 \Rightarrow \pi'' = -9 < 0 \Rightarrow \text{correct choice}$$

Therefore, profit is maximized **at Q = 4**.

References

- 1.D.N.Dwivedi, Dorling Kindersley, Microeconomics Theory and Application, , INDIA , 2006 .
- 2.Paul Krugman, Robin Wells, Microeconomics, Worth Publishers, 2009.
- 3.Douglas Curtis and Ian Irvine , Microeconomics Markets, Methods & Models,2017,lyrycs.
- 4.Boudiaf Hafid, Handout in Microeconomics : Lessons and applications, 2023/ 2024 , University of Algiers 3.
- 5.HAL R. VARIAN, intermediate microeconomics : A modern Aproach, w,w,Norton Company. New York. London. 8 edition .
- 6.Siraj Anwar, Introductory Microeconomics, National Council of Educational Research and Training, 2007, New Delhi.
- 7.TOUAT Othmane , Handout in Microeconomics 1 Lectures AND Exercises, University of Algiers 3 .
- 8.W. M. Semasinghe , Long run Analysis of Production Theory of Production ECON 53015 Advanced Economic Theory Microeconomics,Department of economics , Faculty of social sciences, University of Kelaniya,
- 9.Paul Douglas was a twentieth-century economist at the University of Chicago who later became a U.S. senator. Charles Cobb was a mathematician at Amherst College. The Cobb-Douglas functional form was originally used to study production behavior.
- 10.SAMIRAN BANERJEE, Intermediate Microeconomics, A Tool-Building Approach, Routledge, London AND New York, 2015.
11. Debertin, David L., "Applied Microeconomics : Consumption, Production and Markets". University of Kentucky , Agricultural Economics Textbook Gallery. 3.2012.
12. Case, K., Fair, R. and Oster, S., Principles of Economics, Pearson Education, 10th Edition, 2014.