Economic Studies in English

Lecture 1&2

1. Introduction and Basic Economic Concepts

Individuals in all societies are beset by fundamental problems of physical survival-Mere subsistence requires that they have minimal levels of food , clothing , and shelter .These necessities are extracted from the earth's environment by the application of human effort .

Economics has to do with understanding how men and women provide for their necessities, but it goes beyond concern for necessities even if all human necessities are provided, many human wants remain unsatisfied. If wants are unsatisfied ,we say that sacristy exists .***Sacristy*** means that wants exceeds the supply of goods available to satisfy them .If there are not enough goods to go around – not enough to satisfy everyone's wants – then some means must be found to allocate what goods there are among the various uses to which they cold be put . economic is thus concerned with the allocation of scare goods ,and with two questions :What is the best way to provide goods and services to the people, and who will receive this goods and services once they are provided?

Given unlimited wants, it is important that an economy makes the best use of its limited resources. That brings us to the critical notion of efficiency.

Efficiency denotes the most effective use of a society's resources in satisfying people's wants and needs. In economics, we say that economy is producing efficiently when it can not make anyone economically better off without making someone else worse off.

The ***allocation problem*** involves how to produce, what to produce, who is to produce and who is to received what is produced. A closely related yet separate problem is how much of these goods and services particular individuals should receive. This is the ***distribution problem***, and it involves the issue of equity or fairness.

The study of economics can get us started in solving allocation and distribution problems.

1.1.The important topics of economics:

Over the last half-century, the study of economics has expanded to include a vast range of topics. What are the major definitions of these growing subjects? The important ones are that economics:

- ***Analyzes*** how a society's institutions and technology affect prices and the allocation of resources among the different uses.

- ***Explores*** the behavior of the financial markets, including interest rates and stock prices.
- ***Examines*** the distribution of income and suggests the ways, which the poor can be helped without harming the performance of the economy.
- ***Studies*** the business cycle and examines how monetary policy can be used to moderate the swings in unemployment and inflation.
- ***Studies*** the patterns of trade among nations and analyzes the impact of trade barriers.
- ***Looks*** at growth in developing countries and purposes ways to encourage the efficient use of resources.
- ***Asks*** how government polices can be used to pursues important goals such as rapid economic growth, efficient use of the resources, full employment, price

stability, and a fair distribution of income.

From the previous topics we can say that:
Economics is the study of how societies use scarce resources to produce valuable commodities and distribute them among different people.

1.2.Microeconomics and Macroeconomics

Typically, in the study of economics, the subject is divided into two major sections. One section covers what is called microeconomics and the other is called macroeconomics.
Microeconomics is the study of small economic units such as the consumer, the firm, the industry and markets for individual goods or services. *Adam Smith* is usually considered the founder of the field of microeconomics. In *The Wealth Of Nations (1776),* Smith considered how individual prices are set, studied the

determination of prices of land, labor, and capital, and inquired into the strengths and weakness of the market mechanism.

Macroeconomics is the branch of economics, which concerns with the overall performance of the economy. It means that macroeconomics refers to the study of the aggregate economy. Macroeconomics divided the aggregate economy into four sectors, which are:

- The household sector.
- The business sector.
- The government sector.
- The foreign trade sector.

1.3.Factors of Production

Inputs, which are used in the production process in order to create output are called *factors of production*. They include land, labor, capital, and management.

- ***Land***

Land includes minerals, water, and other natural resources. Of themselves, such resources do not produce output without human's efforts.

- ***Labor***

Labor is a scare resource; that is, skilled labor. The labor supply consists of all those who are able to work and willing to do it. Labor is quite varied in its levels of skills and qualifications.

- ***Capital***

Capital refers to man-made units of production. These are the buildings, factories, machines, and tools, which produce goods and services. We do not mean capital in the sense of finances or money. Capital without labor can't possibly provide any output. And labor without capital is greatly impaired in its ability to provision society.

- ***Management***

Management is a special kind of labor. Managers are decision maker who coordinate the use of capital and labor to produce output.

2. MICROECONOMICS

2.1 DEMAND

The law of demand states that the quantity people are willing and able to buy is inversely related to the price of the good, ceteris paribus. *Ceteris paribus* means that other things remaining equal, and signifies that all other parameters are held constant when quantity and price of the good in question vary. Thus, if the price falls the quantity bought will increase.

While we assume that other things are held constant, we realize that the price is not the only variable affecting the quantity demanded of a commodity or service. Income, tastes, expectations, season, population size, transaction costs, and the prices of related goods also play a role in determining the quantity that people will buy.

In the shorthand of symbolic notation, the law of demand can be written as :

$$Qd = f\,(Po)\ldots\ldots\ldots\ldots(1)$$

The symbol Qd stands for quantity demanded per unit of the time and ***f*** is the symbol for "is the function of" . The letter **P**o is the symbol for the price of the particular good being studied. The price **P**o is the independent variable, and the quantity **Q**d is the dependent variable. The *Ceteris paribus* condition is always implied.

Illustration of demand

Demand (the relationship between price and quantity bought) can be illustrated by the ***demand schedule, demand curve*** and ***demand function.***

A. The Demand Schedule

The demand schedule is a table showing the quantities of a good demanded at different levels of price during a specific period of time assuming that other factors, which affect the quantity demanded, are held constant.

The following illustration shows the demand schedule for Cornflakes:

Table 1: The demand schedule relates quantity demanded to price.

Price (LE per box) **(P)**	Quantity demanded (millions of boxes per year) **(Q)**
5	**9**
4	**10**
3	**12**
2	**15**
1	**20**

B. The Demand Curve

The demand curve is the *graphical representation* of the demand schedule. The demand curve graphs the quantity of a good (Q) on the horizontal axis and the price of the good (P) on the vertical axis. Not that the quantity and price are inversely related ; that is, (Q) goes up when (P) goes down. The demand curve slopes downward, going from northwest to southeast. This important property is called the *Law of downward-sloping demand.*

Law of downward-sloping demand: When the price of a commodity is raised (and other factors affecting the demand are held constant), buyers tend to buy less of the commodity .Similarly, when the price is lowered , (and other factors affecting the demand are held constant),quantity demanded increases.

Quantity demanded tends to fall as price rises for two reasons:

First is the *substitution effect*. When the price of a good rises, the consumer will substitute other similar goods for it (as the price of meat rises, the consumer will eat more fish).

A second reason why a higher price reduces quantity demanded is the *income effect*. This occurs because when a price goes up, the consumer finds himself somewhat poorer than he was before, which means a decreasing in his real income.

The following graph shows- as example- the demand curve (Not that the demand curve has a negative slope).

C. The Demand Function

The demand function is an algebraic expression of the demand schedule. In its simple form, the demand function represents the relation between the quantity demanded of a good as dependent variable and its own price as independent variable, holding all other factors affecting demand constant. A general form of the demand function might be as equation (1) ,which is :

$Q_d = f(P_o)$

Where : Q_d is the quantity demanded per unit of the time.

P_o is the price of the particular good being studied.

For example, if the demand function is shown as the following specific form :

Q = 20 – 2 P,

Then the quantity demanded can be calculated for each price level as follows:

If P = 1 , then Q = 20 – 2 (1) = 18 units

If P = 2 , then Q = 20 – 2 (2) = 16 units

If P = 3 , then Q = 20 – 2 (3) = 14 units
If P = 4 , then Q = 20 – 2 (4) = 12 units
These values for (P) and (Q) can help to construct the demand schedule, which in turn, can help to draw the demand curve.

Market Demand

Market Demand represents the sum total of all individual demands.
The market demand curve is found by adding together the quantities demanded by all individuals at each price.
In this chapter we will always focus on the market demand

Movements along the demand curve

Consider the market demand curve for good X in fig.2. To start with, suppose that the price of X is 20 L.E. per unit and the quantity demanded is 500 units ; this combination is represented by point a on the curve . If price should fall to 20 LE per unit ,*ceteris paribus*, quantity demanded will rise to 600 unit . This fall in price means that we have simply *moved along* the demand curve from point A to point B . If price should rise to 30 LE per unit, quantity demanded will fall to 400 units. Again, we have simply moved along the demand curve . This time from point B to point C. Such movements along a demand curve are sometimes called *expansions* of demand (for an increase in quantity demanded following a price change) or I contraction of demand (for an decrease in quantity demanded following a price change).

Result: ***The effect of a change in the price of good X*** **, ceteris paribus,** ***can be traced by moving along the market demand curve for good X***

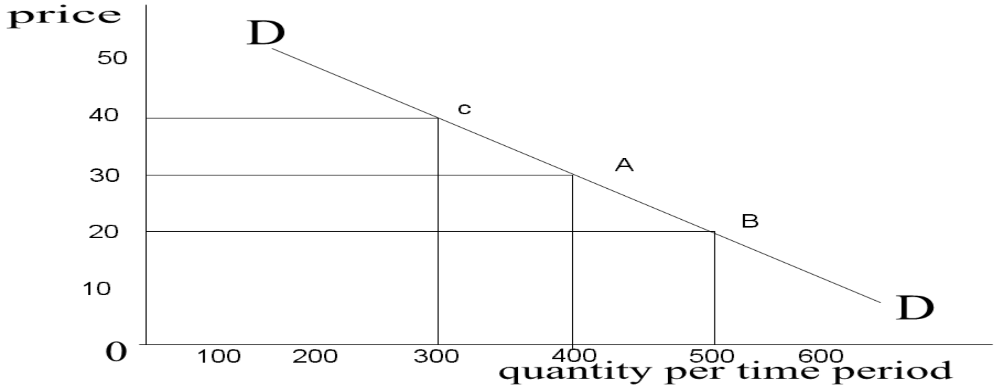

fig. 2 . Movement along a demand curve

Lecture 3&4

Shift of the demand curve

Starting once again at point A on the demand curve in fig.2. suppose now that one of the other influencing factors, such as the real national income, the price of substitute goods, price of complementing good, changes. Suppose in fact that real national income increase so that everyone has more to spend on all good s. the market demand for good X will now increase *at all prices*. In other words, we must draw a new demand curve to represent the new relationship between quantity demanded and prices. Figure 3 shows the original demand curve ,DD, together with the new one, D'D', which lies above and to the right of the original one .

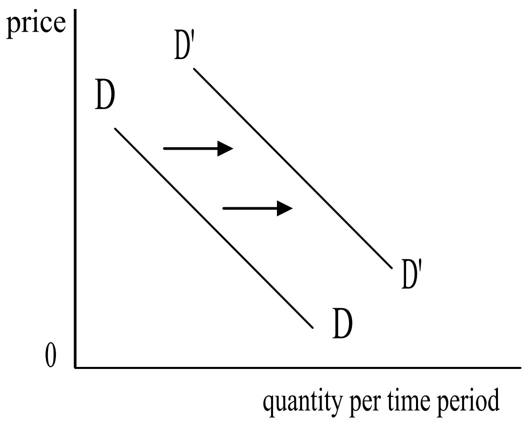

fig.3 . A shift in a demand curve

Result: A change in any of the affecting factors except the price o X causes a shift in the demand curve for X.

To illustrate this, consider the following likely causes of shifts in the demand curve for a particular good, say cod:

Cause	**Effect**
1.Increase in *national income*.	Increase in demand for cod at all prices. *Result: Demand curve shifts right*
2. Decrease in *national income*.	Decrease in demand for cod at all prices. *Result: Demand curve shifts left*

3.Rise in the *price of substitute goods* (such as fish or meat).	Increase in demand for cod at all prices. *Result: Demand curve shifts right*
4.Fall in the *price of substitute goods* (such as fish or meat).	Decrease in demand for cod at all prices. *Result: Demand curve shifts left*
5.Rise in *the price of complementary goods* (such as tea and sugar).	Decrease in demand for cod at all prices. *Result: Demand curve shifts left*
6.Fall in the *price of complementary goods* (such as tea and sugar).	Increase in demand for cod at all prices. *Result: Demand curve shifts right*
7. Positive *change in tastes* in favor of cod.	Increase in demand for cod at all prices. *Result: Demand curve shifts right*
8.*Change in tastes* against cod.	Decrease in demand for cod at all prices.

	Result: Demand curve shifts left
9. *Expectation of a rise in the future price* of cod.	Increase in demand for cod at all prices. *Result: Demand curve shifts right*
10. *Expectation of a fall in the future price* of cod.	Decrease in demand for cod at all prices. *Result: Demand curve shifts left*

ENGEL CURVE

***Def.* :** *Engel curve is the curve ,which represents the relationship between quantity demanded and income for the normal good and the inferior good.*

Likely demand curves, Engel curves can be drawn either for an individual or for the market as a whole. As an example, consider an individual consumer's Engel curve for good X. Table 2 shows different levels of income for the consumer together with his demand for good X on the assumption that the price of X and all other affecting factors (except, of course, the consumer's income) remain constant. Plotting this information on a graph with income on the vertical axis and quantity demanded on the horizontal axis. We obtain the consumer's Engel curve for good X. This is shown in Fig.4.

Note that Engel curve can also be drawn for the economy as a whole - in that case , thought, the vertical axis must be labeled "national income" and the horizontal axis "total quantity demanded in the market".

Table 2. : Consumer's income and demand for good X.

Consumer's income (LE per week)	Quantity demanded (Unit per week)
50	1
60	2
70	4
80	7

Lecture 5&6

Why are the Engel curves useful?

Engel curves are useful for differentiating between normal and inferior goods as follows:

- When income rises, the quantity demanded of a normal good increases (as in our simple example).This is indeed the result one would normally expect. In this case the slope of the Engel curve will be positive.
- When income rises, the quantity demanded of an inferior good falls. This is indeed the result one would normally expect. In this case the slope of the Engel curve will be negative.

To explain this, consider the market demand for black and white television sets.

PRICE ELASTICITY OF DEMAND

Price elasticity of demand is the coefficient, which measures the degree of responsiveness of the quantity bought to change in the price of a particular good.

Mathematically, the price elasticity of demand, hereafter referred to as elasticity of demand , is *defined* as the ratio of the percentage change in quantity demanded to the percentage change in price. Price elasticity is a measure of the sensitivity of quantity bought to change in price, or

$$E_d = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

Types of price elasticity of demand

To understand the types of elasticity of demand we will discuss the following examples :

- If the price of good X should rise by 10% and the quantity demanded should fall in consequence by less than 10% (say 5%) ,then , the price elasticity of demand would equal to 0.05/0.1 = 0.5.

In this case, since the elasticity is **less than one**, we say that the demand for X is ***inelastic***, which means that a given percentage change in price leads to a smaller percentage change in quantity demanded**.** This occurs with the necessary commodities , which have a little number of substitutions , such as meat, bread, fish, poultry, eggs, tea, coffee and other foods.

- If the price of good X should rise by 10% and the quantity demanded should fall in consequence by more than 10% (say 20%) ,then , the price elasticity of demand would equal to 0.2/0.1 = 2.0. In this case, since the elasticity is **more than one**, we say that the demand for X is ***elastic***, which means that a given percentage change in price leads to a smaller percentage change in quantity demanded**.** This occurs with the less necessary commodities such as new furniture , cars, Television sets, Mobil and so what.

- If the price of good X should rise by 10% and the quantity demanded should fall by exactly 10% , then , the price elasticity of demand would equal to 0.1/0.1 = 1. In this case, since the price elasticity would be **exactly equal to one**, we say that the demand for X is ***unitary elastic***, which means that a given percentage change in price leads to the same percentage change in quantity demanded**.** This case is theoretical case**.**

- If the price of good X is not changed and the quantity demanded decreased or increased by any percentage then , the price elasticity of demand would equal to infinity . In this case, we say that the demand for X is ***perfectly elastic***, which means that the quantity demanded could change without any change in price**.** This occurs with the luxury commodities such as very expensive furniture , new types of cars, new types of Television sets, new types of Mobil and so what.

- If the price of good X should rise by 10% and the quantity demanded held constant , then , the price elasticity of demand would equal to 0.1/zero = zero. In this case, since the price elasticity would be **equal to zero**, we say that the demand for X is ***perfectly inelastic***, which means that a given percentage change in price does not lead to any percentage change in quantity demanded**.** This occurs with the very necessary goods ,Which have not substitutions such as sold.

Formulas with inequality signs indicate these ranges of elasticity coefficient. Thus when :

Ed < 1   demand is inelastic.
Ed > 1   demand is elastic.
Ed = 1   demand is unitary elastic.

Ed = 0 demand is perfectly inelastic.
Ed = ∞ demand is perfectly elastic.

It is important to keep in mind that price elasticity are ratios of percentages; they are therefore pure numbers. You can always tell if a designated range over a curve is elastic or inelastic simply by looking at Fig. 5.

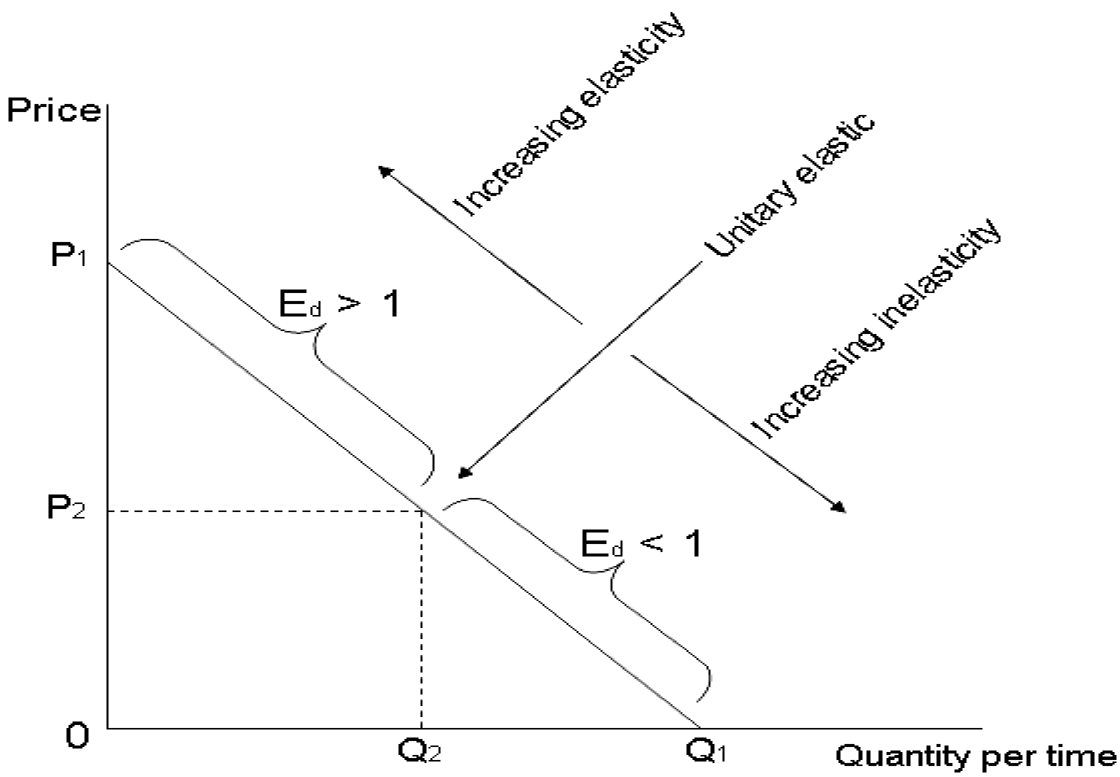

Fig.5: Price elasticity along a designated range over a curve

Fig.6. shows the graphic illustration of the different types of demand elasticity .

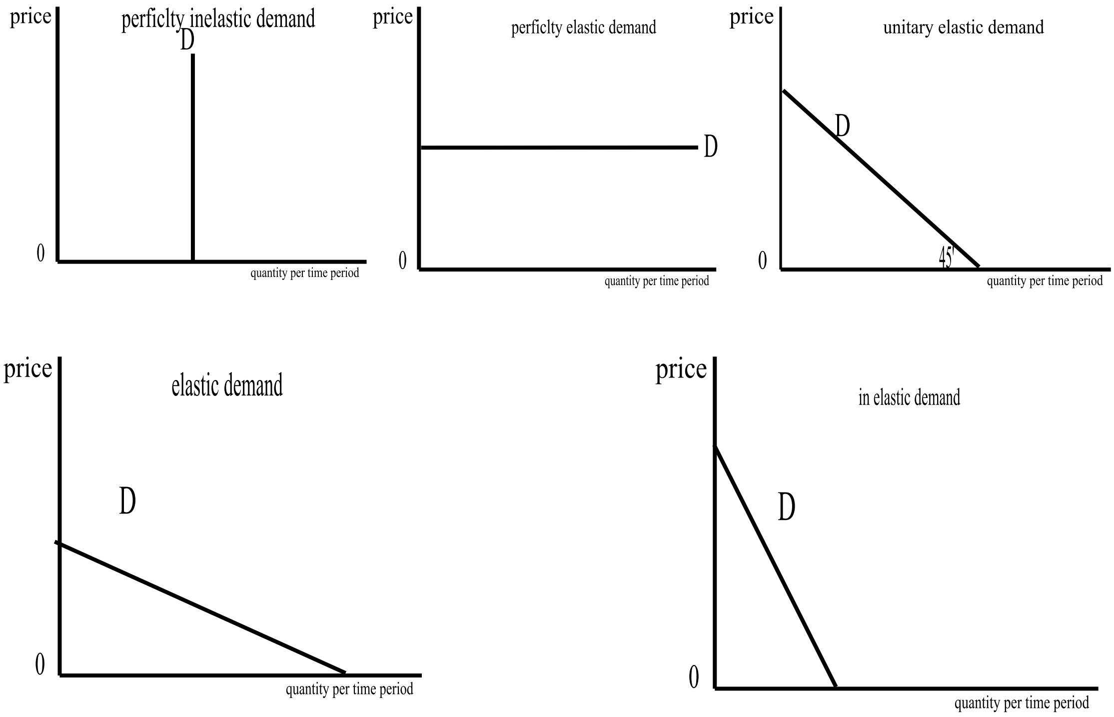

Fig.6.: The graphic illustration of the different types of demand elasticity.

<u>Methods for measuring of demand elasticity</u>

A. Measuring of *point elasticity* of demand

The *point elasticity* of demand calculates the price elasticity with complete *accuracy* at a point on a demand curve .It could be calculated for a straight line demand curve and non-linear demand curve .

- Point elasticity of demand for a straight line demand curve:

For a straight line demand curve, point elasticity can be found using the following formula :

$$\text{Point } E_d = -\frac{\triangle q / q}{\triangle p / p} = \frac{\triangle q}{\triangle p} \frac{p}{q}$$

Example : From table (3) find the price elasticity of demand when price = 6 LE.

Table (3):The quantity demanded at different prices of good X

Price of X	Quantity demanded
8	0

7	5
6	**10**
5	15
4	20
3	25
2	30
1	35
0	40

Solution : $\Delta q / \Delta p = 5 / -1 = -5$ & $P / q = 6 / 10 = 0.6$

Then : Point elasticity Ed = (-5) (0.6) =-3.

Note that $\Delta q / \Delta p$ is the reciprocal of the slope of the demand curve, which is straight line.

- Point elasticity of demand for non linear demand curve:

The same previous formula can be used to find the elasticity of demand at a point on a non-linear demand curve, but this time $\Delta q / \Delta p$ refers to the reciprocal of the slope of the tangent to the curve at the point. . This is illustrated in Fig.7, where the elasticity at point A is :

$$Ed = -(\Delta q / \Delta p) (p1 / q1)$$

Fig.7.: Point elasticity on a non-linear demand curve

Note that the slop of the tangent in the same as the slop of the curve at point A. This slop (written as dp / dq) can only be determined exactly using differential calculus.

B. Measuring of *arc elasticity* of demand

Arc elasticity is an estimate of the elasticity along a range of demand curve. It can be calculated for both linear and non-linear demand curves using the following formula :

$$\text{Arc Ed} = \frac{-\Delta q}{\Delta p} \cdot \frac{(p1 + p2)/2}{(q1 + q2)/2}$$

In this formula, p1 and q1 represent the initial price and quantity, and p2 and q2 represent the new price and quantity. This means that (p1 + p2) / 2 is a measure of the average price in the range along the demand curve and (q1 + q2)/2 is the average quantity in that range.

<u>Example</u> : From table 2, estimate the elasticity of demand curve <u>*in the price range*</u> from 5 LE to 6 LE. What is the type of the demand elasticity? To what does the elasticity coefficient refer?

Solution:

$$\text{Arc Ed} = \frac{-\Delta q}{\Delta p} \cdot \frac{(p1 + p2)/2}{(q1 + q2)/2}$$

= {- (15-10)/(5-6) } { (5+6) /2 ÷ (15+10/2)}
= { -(5) /(-1) } { 5.5 ÷ 12.5 }
= (5) (0.44) = 2.2

It means that the demand is elastic because the elasticity coefficient is more than one. In addition, the elasticity coefficient refers to that the commodity is not necessary for the consumer.

Lecture 7&8

Factors determining the price elasticity of demand

1. *Availability of substitutes:* When there are other choices , a rise in the price of one commodity finds consumers switching to the purchase of close substitutes . Food as a group is inelastic in demand over a large price range (we have to eat somethings).
2. *Degree of Necessity:* The less necessary items are the more demand elastic.
3. *Large Budget Item* : Items that are a relatively large part of one's budget tend to be more elastic in demand, for example , flat color television sets and stereo equipment.
4. *Time* : For longer time period demand for a commodity becomes more elastic over a price range.

CROSS ELASTICITY OF DEMAND

Cross elasticity of demand measures the effect of changing the price of one good related to the quantity demanded of another good . It may be defined as

Cross Ed = <u>percentage change in quantity bought of good "A"</u>
Percentage change in price of good "B"

Cross elasticity of demand will be positive if the related good is a substitute good (such as: Fish and meat) and negative if the related good is a complement (such as: Tea and Sugar) .

INCOME ELASTICITY OF DEMAND

Income elasticity of demand measures the effect of changing income related to the quantity demanded for a particular good .It may be defined as

$$\text{Income Ed} = \frac{\text{percentage change in quantity demanded}}{\text{Percentage change in income}}$$

An Income Elasticity Of demand greater than one means that a given percentage increase in national income will cause a bigger percentage increase in quantity demanded . it follows that producers of such goods may need to plane extra capacity in times of rising incomes .that is the necessity of studying income elasticity

2.2.Theory of Consumer Behavior

Theory of consumer behavior , focusing attention on the relationship between man and economic good, has played a central role in the neoclassical approach to economics, which explain market prices for commodities on the basis of the interaction of demand and supply curves. From studying the theory of consumer behavior we could derive the individual demand curve assuming the rationality of consumer behavior.

Utility

Utility denotes *satisfaction*. It refers to how consumers rank different goods and *services*. Often utility is *defined* as the subjective pleasure or usefulness, which a person derives from consuming a good or service. This means that, *the total utility* is the total satisfaction enjoyed from consuming a given quantity of commodity. Total utility is assumed to be a function of the quantities of goods consumed as follows:

TU = f (Q1, Q2 , Q3 ,---------- Qn)

Where : TU : Total utility

Q1, Q2 , Q3 ,---------- Qn : quantities consumed from different goods

In the theory of demand , we say that people maximize their utility, which means that they choose the bundle of consumption goods that the most prefer.

There are two approaches to comparison of utilities, which are *the cardinal utility* approach and *ordinal utility* approach .

- *The cardinal utility* approach assumes that utility can be measured in subjective units , called utils.
- *The ordinal utility* approach examines only the preference ranking of bundles of commodities. Ordinal utility asks, " Is **(A)** preferred to **(B)?** The economists today apply the Ordinal utility to establish firmly the general properties of market demand curve described in this chapter.

A. Consumer Equilibrium according to *the* cardinal utility approach

To understand , how does utility apply to the theory of demand, we suppose a consumer who consumes ice cream units. We say that consuming the first unit of ice cream gives him a certain level of satisfaction or utility. A consuming a second unit will give him some additional utility and his total utility goes up. The additional utility, which the consumer get from the consumption of an additional unit of a commodity, is defined as *marginal utility*.

Def. : ***Marginal utility*** is defined as the additional utility, which the consumer get from the consumption of an additional unit of a commodity**.**

Law of diminishing marginal utility

The law of diminishing marginal utility state that, as the amount of a good consumed increases, the marginal utility of that good tends to diminish.

Numerical example

Table (4) shows the quantity consumed of a good (column 1) and total utility(column 2) . We will note that the total utility (U) increases as consumption

(Q) grows, but it increase at a decreasing rate. Column 3 measures marginal utility as the extra utility gained when 1 extra unit of the good is consumed. Thus when the individual consumes 2 units, the marginal utility is 7-4=3 units of utility (call these units "utils".

Table (4) : Utility rises with consumption and marginal utility diminishes.

(1)	(2)	(3)
Quantity of a good consumed (Q)	Total utility (U)	Marginal utility (MU)
0	0	
1	4	4
2	7	3
3	9	2
4	10	1
5	10	0

From column 3, it is clear that the marginal utility declines with higher consumption , which illustrates the law of diminishing marginal utility.

Graphically illustration of law of diminishing marginal utility:

We can illustrate the law of diminishing marginal utility graphically by total utility curve and marginal utility curve, which are illustrated in Fig. 8. From this figure you must note that :

- The total utility curve must look concave, like a dome, and reaches to maximum when marginal utility equal to zero,
- The marginal utility curve (MU) must slope downward,
- The marginal utility equals to zero when the total utility reaches to maximum.

The previous notations imply the law of diminishing marginal utility.

Fig.8.:Law of diminishing marginal utility

Consumer Equilibrium

The fundamental condition of maximum satisfaction or utility is the *eqimarginal principle*. It state that a consumer having a fixed income, and facing given market prices of goods will achieve maximum utility when the marginal utility of the last pound spent on each good is exactly the same as the marginal utility of the last pound spent on any other good.

The fundamental condition of consumer equilibrium can be written in terms of marginal utilities (MUS) and prices (P**s**) of the different goods in the following way :

$$\frac{MU_{good\ 1}}{P1} = \frac{MU_{good\ 2}}{P2} = \frac{MU_{good\ 3}}{P3} = \ldots \text{ MU per pound of income.}$$

Where : **MU**good 1 is the _marginal utility of_ good 1 , P1 is the price of one unit of good 1.. and so what..

The mathematically derivation of this fundamental condition is outside the scope of this introductory course.

Numerical example

Determine the consumer equilibrium and the marginal utility for money given the following assumptions:

1- There are two commodities A and B

2- PA = 20 EL & PB = 10 EL , and the total income I= 160 EL,

3.Total utilities of the two commodities are in the following table:

Quantity	1	2	3	4	5	6	7	8	9	10
Com. A	60	115	166	212	255	295	330	362	389	411
Com. B	32	61	86	106	122	134	143	149	153	155

<u>Solution:</u>

- We have to calculate the marginal utility for each commodity , then calculate the marginal utility / price for each quantity for each commodity.
- We find the point in which marginal utility / price is equal

Quantity	1	2	3	4	5	6	7	8	9	10
Com. A	60	115	166	212	255	295	330	362	389	411
marginal		55	51	46	43	40	35	32	37	22

utility Ma										
MUa / Pa		3.75	2.55	2.30	2.15	**2.00**	1.75	1.60	1.35	1.10
Com. B	32	61	86	106	122	134	143	149	153	155
marginal utility Mb		29	25	20	16	12	9	6	4	2
MUb / Pb		2.90	2.50	**2.00**	1.60	1.20	0.90	0.60	0.40	0.20

Figures in the table indicate the following results :

1- The consumer equilibrium realizes when the consumer consumes 6 units of commodity A and 4 units of commodity B where the marginal utilities of money are equal.
2- Marginal utility for money at the point of consumer

equilibrium is equal to: marginal utility Ma = 2 marginal utility Mb

The consumer equilibrium should also satisfy the income constraint : P1Q1 + P2Q2 =Income

(20)(6) + (10) (4) = 160 , which satisfies the income constraint in our example.

We could also calculate the total utility associated with equilibrium quantities which equal : 295 + 106 = 401

This is the maximum total utility that can be obtained for quantities that satisfy both the equilibrium condition and the income constraint.

Lecture 9&10

Consumer Equilibrium according to *the* ordinal utility approach

This approach presents the modern theory of indifference analysis and derives the major conclusions of consumer behavior with that new tool. This approach is based on the idea of a preference ordering, or ranking rather than the concept of measurable utility. The important tools of this approach are the indifference curves and budget lines. The analysis of consumer equilibrium according to the ordinal utility approach will help us to derive the consumer demand curve. This approach assumes that the consumer has rational behavior.

The Indifference Curve

To understand the concept of indifference curves let us the following example .
Suppose that the consumer faces 10 market baskets as shown in table 4. The market baskets refer to all different combination of two commodities , which give the consumer a given level of satisfaction. It means that each market basket (combination) could give the consumer the same satisfaction . If we plot each of the market basket on a diagram , we obtain the indifference curve as shown in fig. (9).

Table 4: Alternative market baskets.

Market basket	Meat (kg.)	Potatoes (kg.)
1	1	4
2	2	3

3	3	2
4	4	1
5	5	0

Figure 9: The indifference curves for Meat and Potatoes

Def.: ***The indifference curve*** is a graphical illustration of different market baskets of two commodities ,which give the consumer a given level of satisfaction.

The characteristics of indifference curves

All indifference curves have certain characteristics that should be noted. They are :

1. Indifference curves have a negative slope because of the substitution possibilities between the two commodities to get a given level of satisfaction,
2. The indifference curves that are higher represent greater levels of satisfaction than indifference curves that are lower as shown in fig.8. ,
3. The indifference curves cannot intersect.

(To understand the reasons read : Edwin Mansfield, Microeconomics, Norton & Company, Inc., pp.27)

The Indifference Map

The Indifference Map refers to a set of difference curves, which denote different levels of satisfaction for a consumer as shown in fig.(10).Note that the satisfaction level A < the satisfaction level B < C < D.

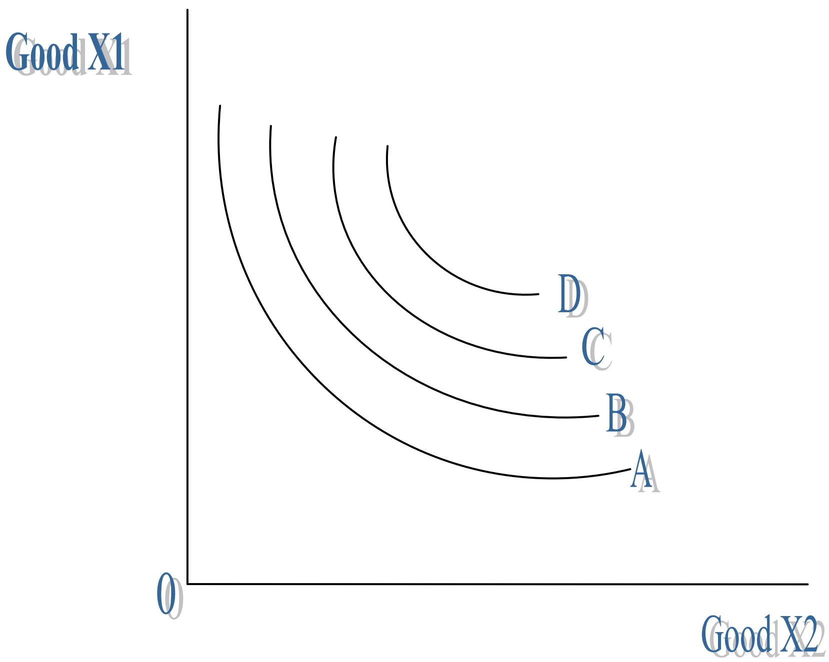

Fig. 10: Indifference map for two goods

The Marginal Rate of Substitution

The Marginal Rate of Substitution is defined as the number of units of good Y that must be given up if the consumer , after receiving an extra unit of good X, is to maintain a constant level of satisfaction. For example , in figure 11 , the consumer can give up (0Y2 – 0Y1) units of good Y to receive (0X2 – 0X1) extra units of good X, without any change in his level of satisfaction. Thus the ***Marginal Rate of Substitution*** **of** **good X for good Y (MRS X/Y)** is (0Y2 – 0Y1) / (0X2 – 0X1). This is the number of units of **good Y** that must be given up - per unit of **good X** received – to maintain a constant level of satisfaction. More precisely, the marginal rate of substitution is equal to minus one times the slope of the indifference curve as shown in the following equation:

MRS X/Y = **-** ($\Delta Y / \Delta X$),

Where ($\Delta Y / \Delta X$) = The slope of indifference curve.

Note that:

- **MU**y = **(ΔTU / ΔY)**

Then: **ΔY** = (**ΔTU** / **MU**y)

- **MU**x = **(ΔTU / ΔX)**

Then: **ΔX** = (**ΔTU** / **MU**x)

Then : The slope of indifference curve =

$$\left(\Delta Y / \Delta X \right) = \frac{(\Delta TU \, / \, MU_y)}{(\Delta TU \, / \, MU_x)}$$

Then: **(ΔY / ΔX) =** $\frac{MU_x}{}$ = **MRS X/Y** = slope of indifference curve

MUy

In general, the marginal rate of substitution will vary from point to point on a given indifference curve, since the indifference curve's slope will vary from point to point

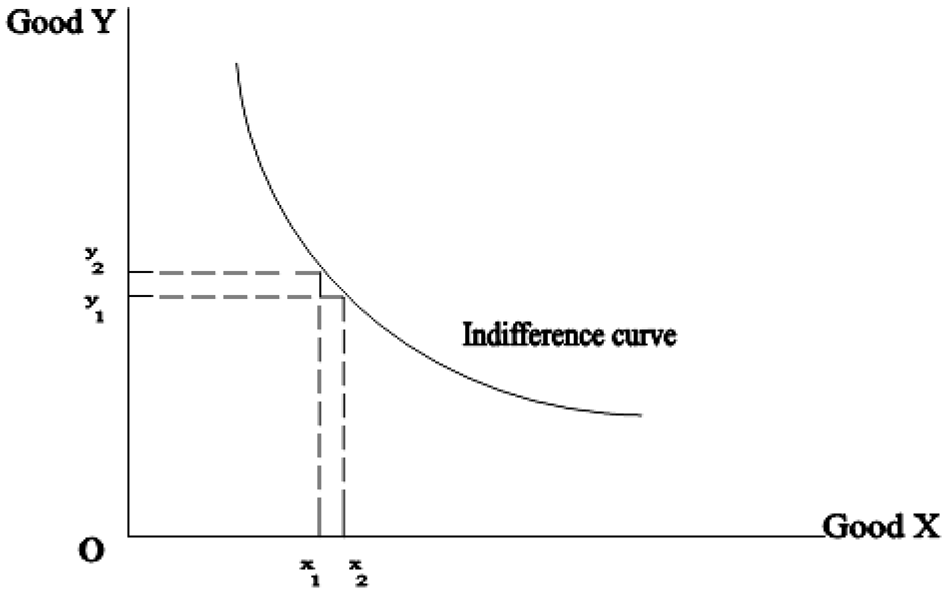

Fig.11. : The marginal rate of substitution

The Rational Consumer

Returning to our discussion of indifference curves, how can we use these curves to help predict the behavior of the consumer? Given the consumer's tastes, we assume that he is rational, in the sense that he tries to get on the highest possible indifference curve. In other words , he tries to maximize utility. To maximize utility, the consumer must take account of factors other than his own tastes. He must take account of the prices of various commodity and the level of his money income, since both of these factors limit, or constraint, the nature and size of the market basket that he can buy. The consumer's money income is the amount of money that he can spend per unit of time.

The Budget Line

To under stand the meaning of the budget line, we assume that there are only two commodities that the consumer can buy, good X and good Y. Since the consumer must spend all of his money income on one or the other of these two commodities, it is evident that

$$Q_xP_x + Q_yP_y = I \text{------------} \quad (1)$$

Where Q_x is the amount the consumer buys of good X , Q_y is the amount the consumer buys of good Y, P_x is the price of good X, P_y is the price of good Y and I is the consumer's money income. For example, if the price of good X is $1 a unit and the price of good Y is $2 a unit and the consumer's money income is $100, it must be true that $Q_x + 2 Q_y = 100$. Note that we assume that the consumer takes prices as given. This , of course, is generally quite realistic.

It is possible to plot the combinations of quantities of good X and Y that the consumer can buy on the same sort of graph as the indifference map. Solving Equation (1) for Q_y, we have :

$$Q_y = (1/P_y)(I) - (P_x / P_y)(Q_x) \qquad (2)$$

Equation (2) , which is a straight line, is plotted in Figure 12 .The first term on the right- hand side of Equation (2) is the intercept of the line on the vertical axis : it is he amount of good Y that could be bought by the consumer if he spent all of his income on good Y.

The slope of the budget line is equal to the negative of the price ratio, ***Px* / *Py*** .

The straight line in equation (2) is called the ***budget line*.** It is defined as the line, which shows all of the combinations of quantities of good X and good Y that the consumer can buy with a given amount of income. You have to note that any change in commodity's price will change the slope of budget line. In addition, the change in the consumer's income will move the budget line to the right (when it increases) and to the left (when it decreases).

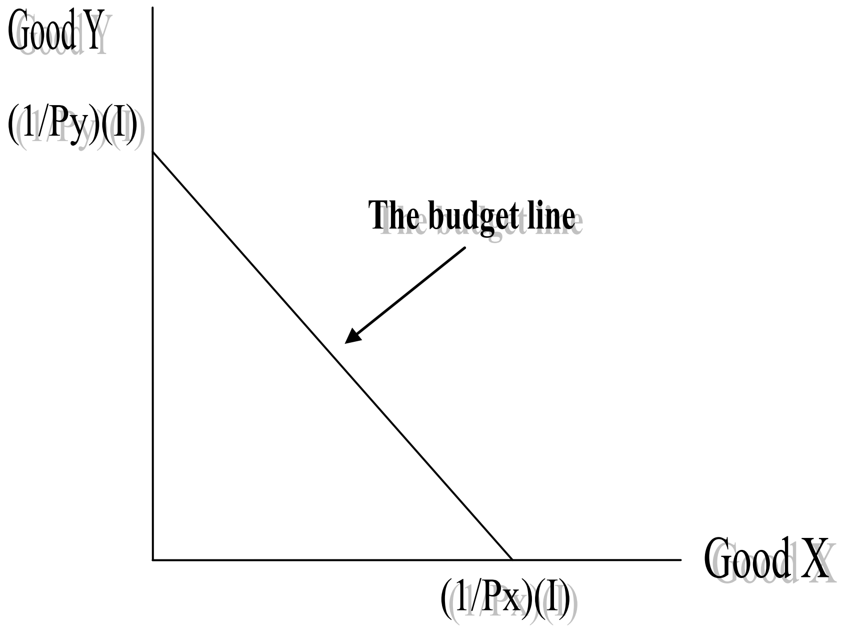

Figure 12 : The budget line

Consumer Equilibrium

The equilibrium behavior of the consumer could be understood as a course of action that will not be changed by him in favor of some other course of action, if his money income , his tastes, and the prices he faces remain the same. Then his equilibrium behavior will be to choose the market basket that maximizes his utility.

What market basket will maximize the consumer's utility?

To answer this question we will use Figure (13), which brings together the consumer's indifference map and his budget line. All of the relevant information needed to answer this question is contained in this Figure. The consumer's indifference map shows what the consumer's preferences are. For example, any market basket on indifference curve 1 is preferred to any on indifference curve 2 ; and any market basket on indifference curve 2 is preferred to any on indifference curve 3. The consumer would like to choose a market basket on the highest possible indifference curve. This is the way for him to maximize his utility.

But not all market baskets are available to him. The ***budget line shows what the consumer can do.*** He can choose any market basket such as U,V, or W on the budget line, but he cannot obtain a market basket like T which is above the budget line.

(Of course, he can also buy any market basket below the budget line, but any such market basket lies on a lower indifference curve than a market basket on the budget line .) Since this is the case , the market basket that will maximize the consumer's utility is the one on the budget line that is on his highest indifference curve , which is V in Figure (13).

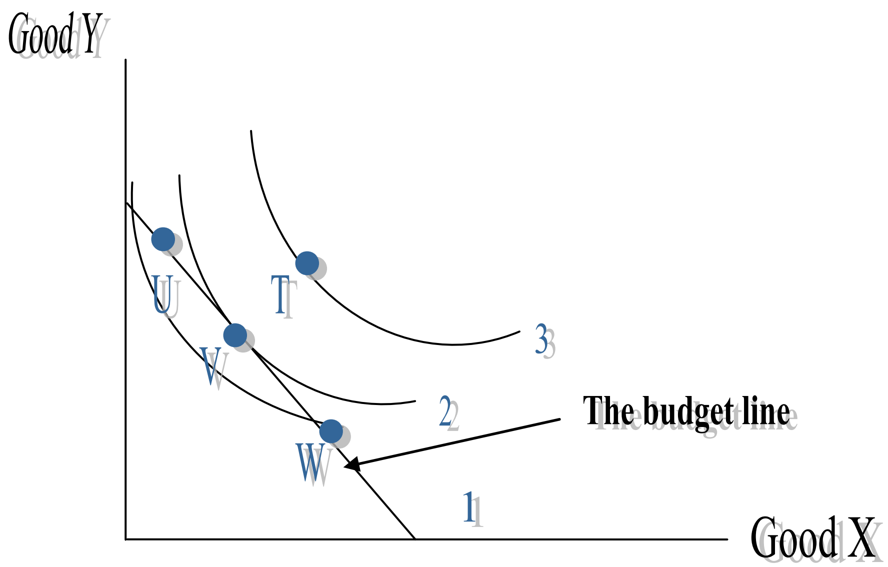

Fig.13.: Consumer Equilibrium

It can be seen that the equilibrium market basket is at a point where the budget line is tangent to an indifference curve. This market basket, V , is the one that the rational consumer would, according to our model, be predicated to buy in equilibrium.

At the point of the equilibrium market basket V, the slope of budget line is equal to the slope of the indifference curve as the following equation:

$$\frac{MU_x}{MU_y} = \frac{P_x}{P_y} = MRS\ X/Y$$

The previous equation could be written as :

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

This equation is known as the consumer equilibrium equation or condition for consumer equilibrium . For many commodities (n) this equation could be generalized as :

$$\frac{MU_1}{P_1} = \frac{MU_2}{P_2} = \frac{MU_3}{P_3} = \ldots\ldots \frac{MU_n}{P_n}$$

The relation just above provides an alternative view of the condition for consumer equilibrium. Dividing the marginal utility of a commodity by its price gives the marginal utility per dollar's worth of the commodity bought. In this light we can restate the condition for consumer equilibrium as the following :

Principle. To attain equilibrium**,** a consumer must allocate money income so that the marginal utility per dollar spent on each commodity is the same for all commodities purchased.

Lecture 11&12

Consumer Behavior and Individual Demand

Having developed the concept of consumer equilibrium , we are now prepared to analyze the effect of changes in two important determinants of the quantity demanded ,which are the price of the good and the consumer's income .
In this part we will examine these two types of changes . Through this analysis we could derive both the income demand curve and the price demand curve.
The basic concepts to be learned in this part are :

- How a demand curve is derived from indifference curves and budget lines.
- The definition of the price-consumption curve.

- How to derive the relation between income and quantity demanded from indifference curves and budget lines.

- The definition of the income-consumption curve.

1.**Derivation of an individual's price demand curve**

In order to derive a demand curve for a particular commodity, it is necessary to consider situations that differ only with respect to the **price** of that commodity. For example, suppose that Figure 12 shows the consumer's budget line ***F1G1*** , which is derived in the light of a given amount of money income ***(I)***, and the prices of the two commodities ***Px1*** & ***Py1*** . This Figure shows also the highest indifference curve , which the consumer could get it in the light of his money income and the prices of the two commodities .The consumer equilibrium point is the tangency point of budget line *F1G1* and indifference curve (point A). This point determines the equilibrium quantity demanded from both commodities X and Y (**0X1 & 0Y1**). Suppose that ***Py***1 decreased to ***Py***2 and let the income and the price of commodity X be constant. The budget line will shift to ***F1G2*** ,which will tangent a new indifference curve determining another consumer equilibrium point B. According to the new equilibrium point B, the consumer will increase the quantity demanded from commodity Y to become **0Y2** and does not change the quantity demanded from commodity X. If you suppose different levels of prices for commodity Y in a specific period you will get different levels of quantity demanded from commodity Y. Then you can derive the demand curve for commodity Y. Similarly, you can derive the demand curve for commodity X. The curve that connects the various equilibrium points is called ***the price- consumption curve,*** which is shown in Figure 14 .Table 5 shows the demand schedule for commodity Y that was derived as shown previously. From this demand schedule you can graph the demand curve for commodity Y and similarly for commodity X .

Def. : ***The price- consumption curve* is defined as the locus of consumer equilibrium points relating the quantity of a given good purchased to its price, money income and all other prices remaining constant.**

Figure 14 : The price consumption curve

Table 5 : The demand schedule for commodity Y

Price of Commodity Y	Quantity demanded from Commodity Y
***Py*1** ***Py*2** ***Py*3**	**0Y1** **0Y2** **0Y3**

2.**<u>Derivation of an individual's income demand curve</u>**

In order to derive an income demand curve for a particular commodity, it is necessary to consider situations that differ only with respect to the consumer **money income**. For example, suppose that Figure 15 shows the consumer's budget line ***F1G1*** , which is derived in the light of a given amount of money income ***(I)***, and the prices of the two commodities ***Px1*** &

Py1 . This Figure shows also the highest indifference curve , which the consumer could get it in the light of his money income and the prices of the two commodities .The consumer equilibrium point is the tangency point of budget line *F1G1* and indifference curve (point A). This point determines the equilibrium quantity demanded from both commodities X and Y (**0X1 & 0Y1**). Suppose that ***the consumer money income (I1)*** increased to

(I2) and let the prices of commodity X and Y be constant. The budget line will shift to ***F2G2*** ,which will tangent a new indifference curve determining another consumer equilibrium point B. According to the new equilibrium point B, the consumer will increase the quantity demanded from commodity Y and X to become **0Y2** and **0X2** . If you suppose different levels of consumer income in a specific period you will get different levels of equilibrium quantity demanded from both commodity Y and X. Then you can derive the income demand curve for commodity Y and X . The curve that connects the various equilibrium points is called ***- the income- consumption curve,*** which is shown in Figure 15 .As example, table 6 shows the income demand schedule for commodity Y that was derived as shown previously. From this income demand schedule you can graph the income demand curve for commodity Y and similarly for commodity X .

Figure 15: The income- consumption curve.

Table 6: The income demand schedule for commodity Y.

Money Income	**Quantity demanded from Commodity Y**
I1 **I2** **I3**	**OY1** **OY2** **OY3**

Def. : ***The income demand curve*** is a locus of points relating to equilibrium quantity of a given good to the level of money income. Such curves are readily derived from income- consumption curve,

Def. : ***The income- consumption curve*** is the locus of points showing consumer equilibrium at various levels of money income at constant prices .

Lecture 13&14

2.3.Theory of the Firm

A firm is a technical unit in which commodities are produced. Its entrepreneur (owner and manger) decides how much of and how one or more commodities will be produced, and gains the profits or bears the loss which results from his decision. An entrepreneur transforms inputs into outputs, subject to the technical rules specified by his production function. The different between his revenue from the sale of outputs and the cost of his inputs is his profit, if positive , or his loss , if negative.

The entrepreneur's production function gives the mathematical expression to the relationship between the quantities of inputs he employs and the quantities of outputs he produces.

An input is any good or service which contributes to the production of an output. An entrepreneur will usually use many different inputs for the production of a single output. Generally , some of his inputs are the outputs of other firms. For example, steel is an input for an automobile producer and an output for a steel producer. Other inputs – such as labor, land, and mineral resources – are not produced.

The formal analysis of the firm is similar to the formal analysis of the consumer in the following respects :

- The consumer purchases commodities with which he produces satisfaction ; the entrepreneur purchases inputs with which he produces commodities.
- The consumer possesses a utility function ; the firm possesses a production function.
- The consumer's budget equation is a linear function of the amount of commodities he purchases ; the

competitive firm's cost equation is a linear function of the amounts of inputs it purchases.

- The rational consumer maximizes utility for a given income ; the entrepreneur aims to maximize the quantity of his output and his profits for a given cost level.

2.3.1 Basic Concepts

- **Fixed and variable inputs**

For a given period of production, inputs are classified as either fixed or variable.

A fixed input is necessary for production, but its quantity is invariant with respect to the quantity of output produced. Its costs are incurred by the entrepreneur regardless of his short-run maximizing decisions.

A variable input is the input which its necessary quantity depends upon the quantity of output produced.

- **The Production Function**

Def.: **A production function** is a schedule or mathematical equation showing the maximum amount of output that can be produced from any specific set of inputs, giving the existing technology.

Consider a simple production process in which an entrepreneur utilizes two variable inputs (X1 and X2) and one or more fixed inputs in order to produce a single output (Q). The production function states the quantity of output (q) as a function of the quantities of the variables inputs (x1 and x2) :

$$q = f(x1\ ,\ x2)\ldots\ldots\ldots\ldots \quad (2\text{-}1)$$

- **Short and long runs**

Def.:

The short run refers to that period of time in which the input of one or more productive agents is fixed. For example , in the short run a producer may be able to expand output only by operating for more hours per day without expanding his existing plant.

.

The long run refers to that period of time in which all inputs are variable. For example, in the long run a producer may be able to expand output by expanding his existing plant.

2.3.2 PRODUCTION WITH ONE VAR1ABLE INPUT

To clarify analysis we first introduce some simplifying assumption in order to cut through the complexities of dealing with hundreds of different inputs, Thus our attention is focused upon the essential principles of production. More specifically, we assume that there is only variable input. which can be combined in different proportions with fixed inputs to produce various quantities of output. Note that these assumptions also imply the assumption that inputs may be combined in various proportions to produce the commodity in question.

- **Total, average, and marginal product:**

1.**Arithmetic approach**

Assume that a firm with a fixed plant can apply different numbers of workers to get output according to columns 1 and 2 of Table 7. Columns one and two define a production function over a specific range.

Table 7 : Total ,Average and marginal products of Labor

Number of workers (x)	Total output per unit of time (Q)	Average product	Marginal product
1	10	10.0	-
2	25	12.5	15
3	45	15.0	20
4	60	15.0	15
5	70	14.0	10
6	78	13.0	8
7	84	12.0	6
8	88	11.0	4
9	90	10.0	2
10	88	8.8	-2

They specify the product per unit of time for different numbers of workers in that period. The total output rises up to a point (nine workers),then declines. The total output is the maximum output obtainable from each number of workers with the given plant.

Average and marginal product are obtained from the production function. The average product of labor is the total product

divided by the number of workers (here it rises, readies a maximum at 15, then declines thereafter). Marginal product is the additional output resulting from using one additional worker with a fixed plant (or with the use of all other inputs fixed). It first rises, then falls, becoming negative when an additional worker reduces total product.

Note that we speak of the marginal product of labor, not of the marginal product of a particular laborer. We assume all workers are the same in the sense that if we reduce the number of workers from eight to seven, total product falls from 88 to S4 regardless of which of the eight workers is released. Thus, the order of hiring makes no difference; the third worker adds 20 units no matter who is hired.

Note also from the Table that when average product is rising (falling) marginal product is greater (less) than average product. When average product reaches its maximum, average product equals marginal (at 15). This result is not a peculiarity of this particular table; it occurs for any production function in which the average product peaks. An example should illustrate this point. If you have taken two tests on which you have grades of 70 and 8, your average grade is 75. If your third test grade is higher than 75, say 90, your average rises, to 80 in the example. The 90 is the marginal addition to your total grade. If your third grade is less than 75, the marginal addition is below average and the average falls. This is the relation

between all marginal and average schedules. In production theory, if each additional worker adds more than the preceding worker, average product rises; if each additional worker adds less than the preceding worker, average product falls.
The short-run production function set in Table 7 specifies a very common assumption in production theory. <u>Marginal and average products first increase then decrease . Marginal reaches a peak before the peak of average is attained. At the peak of average, marginal equals average .These relation mean that total product at first increases at an increasing rate , then increases at a decreasing rate, and finally decreases</u>. The graphical exposition in the next sub-section will illustrate these points.

However, while this shape is frequently assumed for a short-run (one variable input) production function, it is not the only shape assumed. We summarize in the following:

Definition.

- **The average product** of an input is total product divided by the amount of the input used. Thus, average product is the output-input ratio for each level of output and the corresponding volume of input.
- **The marginal product** of an input is the addition to total product resulting from the addition of one unit of the variable input to the production process, the fixed inputs remaining constant.

2.Graphical approach

The short-run production function in Figure 16 shows the output per unit of time obtainable from different amounts of the variable input (labor), given a specified amount of the fixed input and the required amounts of the ingredient inputs. In Figure 16 and thereafter this section, we assume that both the output and variable input are continuously divisible.

In the Figure, Ox_o is the maximum amount of output obtainable when OL_o workers are combined with the fixed and ingredient inputs. Likewise, OL_1 workers can produce a maximum of Ox_1, and so forth. Certainly the specified numbers of inputs could produce less than the amount indicated by the total product curve but not more than that amount.

Figure 16 : Derivation of average product from total product

First, total output increases with increases in the variable input up to a point, in this case OL_2 workers. After that so many workers are combined with the fixed inputs that output diminishes when additional workers are employed. Second, production at first increases at an increasing rate, then increases at a decreasing rate until the maximum is reached.

The average product of OL_0, workers is Ox_0/OL_0, the slope of the ray from the origin, OL'. In like manner, the average product of any number of workers can be determined by the slope of a ray from the origin to the relevant point on the total product curve; the steeper the slope, the larger the average product. It is easy to see that the slopes of rays from the origin to the total product curve in Figure 16 increase with additional labor until OL" becomes tangent at OL_1 workers and Ox_1 output ,then decrease thereafter (say, to

OL''' at OL2 workers). Hence typical average product curves associated with this total product curve first increase and then decrease thereafter.

As with average product, we can derive a marginal product curve from a total product curve. In Figure 17, Ol_o workers can produce Ox_o units of output and OL1 can produce Ox_1 . L_oL_1 additional workers increase total product by x_0x_1. Marginal product is therefore x_0x_1/L_0L_1 or $\Delta x/\Delta L$, where the symbol Δ denotes "the change in." Let L_1 become very close to L0 ; hence X1 very close to X0 ; $\Delta X/\Delta L$ approaches the slope
of the tangent T to the total product curve. Therefore, at any point on the total product curve, marginal product, which is the rate of change of total product, can be estimated by the slope of the tangent at that point.

On inspection we see that marginal product first increases; note that T' is stepper than T. It then decreases, OL'' at point M being less steep than T'. Marginal product becomes zero when OL2 workers are employed(the slope of T'' is zero) and then becomes negative. At point M the slope of the tangent OL'' is also the slope of the ray from the origin to that point. As noted above, average product attains a maximum when a ray from the origin is tangent to the total product curve. Therefore, marginal product equals average product at the latter's maximum point.

To repeat, so long as marginal product exceeds average product, the latter must rise; when marginal product is less than average product, the latter must fall. Thus, average product must attain its maximum when it is equal to marginal product.

Figure 17 illustrates all these relations . In this graph one can see not only the relation between marginal and average products but also the relation of these two curves to total products .

Consider first the total product curve. For very small amounts of the variable inputs, total products rises gradually. But even at a low level of input it begins to rise quite rapidly ,reaching its maximum slope(or rate of increase) at point 1 . Since the slope

Figure 17: Drivation of marginal product from total product

of the total product curve equals marginal product, the maximum slope (point 1) must correspond to the maximum point on the marginal product curve (point 4) .

After attaining its maximum slope at point 1 , the total product curve continues to rise but output increases at a decreasing rate , so the slope is less steep . moving outward along the curve from point 1, the point is soon reached at which a ray from the origin is just tangent to the curve (point 2).since tangent of the ray to the curve defines the condition for maximum average product point to lies directly above point 5.
As the quantity of variable input is expanded from its value at point 2, total product continues to increase. But its rate of increase is progressively slower until point 3 is finally reached . at this position total product is at a maximum ; thereafter it declines . Over a tiny range around point 3, additional input does not change total output. The slope of the total product curve is zero; thus marginal product must also be zero. This is shown by the fact that

point 3 and 6 occur at precisely the same input value. And since total product declines beyond point 3, marginal product becomes negative.

Most of the important relations have so far been discussed with reference to the total product curve. To emphasize certain relations, however consider the marginal and average product curve. Marginal product at first increases, reaches a maximum at point 4 (the point of diminishing marginal physical returns) and declines thereafter. It eventually becomes negative beyond point 6. where total product attains its maximum.

Average product also rises 5 at first until it reaches its maximum at point 5, where marginal and average products are equal. It subsequently declines, conceivably becoming zero if total product itself becomes zero. Finally, one may observe that marginal product exceeds average product when the latter is increasing and is less than average product when the latter is decreasing.

Lecture 15&16

- **Law of diminishing marginal physical returns**

The slope of the marginal product curve in Figure 18 illustrates an important principle, which is the law of diminishing marginal physical returns. As the number of units of the variable input increases, other inputs held constant, after a point the marginal product of the variable input declines. When the amount of the variable input is small relative to the fixed inputs (the fixed inputs are plentiful relative to the variable input), more intensive utilization of fixed input by variable inputs may increase the marginal output of the variable input. Nonetheless a point is reached beyond which an increase in the use of the variable input yields progressively less additional returns. Each additional unit has, on average, fewer units of the fixed inputs with which to work.

Three stages of production

Economists use the relations among total, average, and marginal products to define three stages of production, illustrated in Figure 19.

Stage I covers that range of variable input use over which average product increases. In other words, stage I corresponds to increasing *average returns* to the variable inputs.

Stage II includes the range over which marginal product is positive and less than average product.

Stage III is defined as the range of negative marginal product or declining total product. Additional units of variable input during this stage of production actually cause a decrease in total output. Even if units of the variable input were free, a rational producer would not employ them beyond the point of zero marginal product because their use entails a reduction in total output.

Figure 19**: Stages of production**

The concept of a single variable input is quite important in developing the more advanced theory of production and particularly in deriving demands for factors of production. It is not a really important real-world concept since it would be difficult to visualize a firm using only one variable input. Thus we shall postpone our examples and applications until the theory has been extended a little further.

2.3.3 PRODUCTION WITH TWO OR MORE VARIABLE INPUTS

Here we consider the more general case of several variable inputs. For graphical purposes we concentrate upon only two inputs; but all of the results hold for more than two. One may assume either that these two inputs are the only variable inputs or that one of the inputs represents some combination of all variable inputs other than one.

- **Production isoquants**

When analyzing production with several variable inputs we cannot simply use several sets of average and marginal product curves such as those discussed above. Recall that these curves were derived holding the use of all other inputs constant and letting the use of only one input vary. Thus when the amount of one variable input changes, the total, average, and marginal product curves of other variable inputs shift.

In the case of two variable inputs, increasing the use of one input would probably cause a shift in the marginal and average product curves of the other input. For example, an increase in capital would quite possibly result in an increase in the marginal product of labor over a wide range of labor use.

If both labor and capital are variable, each factor has an infinite set of product curves. Another tool of analysis is necessary when there is more than one variable factor. This tool is the ***production isoquant.***

Df.: **An isoquant** is a curve or locus of points showing all possible combinations of two inputs physically which produce a given level of output. An isoquant that lies above another represents a higher level of output.

Figure 20 illustrates two isoquauts of the shape typically assumed in economic theory. Capital use is plotted on vertical axis and labor use on the horizontal. Isoquant I shows the locus of combinations of capital and labor yielding 100 units of output. The producer can produce 100 units of output by using 10 units of capital and 75 of labor, or 50 units of capital and 15 of labor, or by using any other combination of inputs on I.

Similarly, isoquant II shows; the various combinations of capital and labor that can produce 200 units of output.
Isoquants I and II are only two of an infinite number of isoquants that are possible. In fact there are an infinite

number of isoquants between I and II because there are an infinite number of possible production levels between 100 and 200 units , provided, as we have assumed, that the product is continuously divisible.

Figure 20: Production Isoquants

Properties of isoquants

Isoquants have the following important properties.

- Isoquants slope downward over the relevant range of production. This negative slope indicates that if the producer decreases the amount of capital employed, more labor must be added in order to keep the rate of output constant. Or if labor use is decreased, capital must be increased to keep output constant. Thus the two inputs can be substituted for one another to maintain a constant level of output.
- Isoquants cannot intercept one another. This property follows logically from the assumptions made

Marginal Rate of Technical Substitution

Great theoretical and practical importance is attached to the rate at which one input must be substituted for another in order to keep output constant. This rate at which one input is substituted for another along an isoquant is called the ***Marginal Rate of Technical Substitution (MRTS)***

Def.: Marginal Rate of Technical Substitution (MRTS) is defined as the rate at which one input must be substituted for another in order to keep output constant. Mathematically, it is defined as

$$MRTS = -\ \Delta C\ /\ \Delta L$$

where **C** is the amount of the input measured along the vertical axis, **capital**, and **L** is the amount measured along the horizontal, **labor**.

The minus sign is added in order to make **MRTS** a positive number, since $\Delta C/\Delta L$, the slope of the isoquant, is negative.

Over the relevant range of production the marginal rate of technical substitution diminishes; that is, as more and more labor is used relative to capital, the absolute value of **$\Delta C/\Delta L$** decreases along an isoquant. This can be seen in Figure 20. If capital is decreased by 10 units from 50 to 40, labor must be increased by only 5 units, from 15 to 20, in order to keep the level of output at 100 units. But if capital is decreased by 10 units from 20 to 10, labor must increase by 35 units, from 40 to 75, to keep output at 100 units.

The fact that the marginal rate of technical substitution diminishes means that isoquants must be concave from above .

This relation is seen at point P in Figure 20. The slope of the tangent T shows the rate at which labor can be substituted for capital in the neighborhood of point P, maintaining an output of 100 units. For very small movements along an isoquant, the negative of the slope of the tangent is the marginal rate of technical substitution. It is easy to see that the slope of the tangent becomes less and less steep as the input combination moves downward along the isoquant.

The concept of diminishing **MRTS** is stressed again in Figure 21. Q, R, S, and T are four input combinations lying on the isoquant I. Q has the combination OK1 units of capital and one unit of labor; R has OK2 units of capital and two units of labor; and so on. For the movement from Q to R, the marginal rate of technical substitution of capital for labor is, by the formula,

$$- \text{OK1} - \text{OK2} = \frac{\text{OK1} - \text{OK2}}{1 - 2}$$

Similarly, for the movements from R to S and S to T, the marginal rates of technical substitution are OK2- OK3 and OK3- OK4, respectively.

Since the marginal rate of technical substitution of capital for labor diminishes as labor is substituted for capital, it is necessary that OK1- OK2 > (OK2- OK3)> (OK3- OK4). Visually, the amount of capital replaced by successive units of labor will decline if, and only if, the isoquant is concave from above. Since the amount must decline, the isoquant must be concave from above-.

Figure 21: Diminishing marginal rate of technical substitution

Relation of **MRTS** to marginal products

For very slight movements along an isoquant the marginal rate of technical substitution equals the ratio of marginal products of the two inputs. The proof is quite straightforward.

Let the level of output, Q, depends upon the use of two inputs, L and K. Assume that L and K. are both allowed to vary slightly, and consider Q must vary. As an example, suppose the use of L increases by 3 units and that of K by 5. If, in this range, the marginal product of L is 4 units of Q per unit of L and that of K is 2 units of Q per unit of K, the change in Q is

$$\Delta Q = (4 \times 3) + (2 \times 5) = 22.$$

In other words, when L and K are allowed to vary slightly, the change in Q resulting from the change in the two inputs is the marginal product of L times the amount of change in L plus the marginal product of K times its changed . Put in equation form

$$\mathbf{\Delta Q = MPL\ \Delta L + MPk\ \Delta K\ .}$$

Along an isoquant Q is constant; therefore **ΔQ** equals zero. Setting **ΔQ** equal to zero and solving for the slope of the isoquant, $\Delta Q / \Delta L$, we have

$$-\frac{\Delta K}{\Delta L} = \frac{MPL}{MPk} = MRTS.$$

Since, as noted, along an isoquant K and L must vary inversely, **ΔK / ΔL** is negative.

Using the relations developed here the reason for diminishing is easily explained. As additional units of labor are added to a fixed amount of capital the marginal product of labor diminishes.

2.3.4 OPTIMAL COMBINATION OF RESOURCES (Producer Equilibrium)

So far the theory of production has been analyzed from the standpoint of individual producers. However, nothing has been said about the optimal way in which they should combine resources. Any desired level of output can normally be produced by a number or different combinations of inputs. Our task now is to determine the specific combination a producer should select. We shall see in this section that a firm attains the highest possible level of output for any given level of cost or the lowest possible cost for any given level of output when the marginal rate of technical substitution for any two inputs equals the ratio of input prices.

Input prices and isocosts

Inputs, as well as outputs, bear specific market prices. In determining the optimal input combination producers must pay heed to relative input prices if they are to minimize the cost of producing a given output or maximize output for a given level of cost.

Input prices are determined, as are the prices of goods, by supply and demand in the market.

Let us continue to assume that the two inputs are labor and capital, although the analysis applies equally well to any two productive agents. Denote the quantity of capital and labor by K and L, respectively, and their unit prices by r and w. The total cost, C, of using any volume of K and L is

C = rK + wL

To take a more specific example, suppose capital costs $1,000 per unit (r =- $1,000) and labor receives a wage of $2,500 per man-year (w =$2,500). If a total of 815,000 is to be spent for inputs, the equation above shows that the following combinations are possible:

$15,000 = $1,000 K + $2,500 L,

or K = 15 - 2.5 L.

Similarly, if $20,000 is to be spent on inputs, one can purchase the following combinations :

K = 20 - 2.5 L.

More generally, if the fixed amount C is to be spent, the producer can choose among the combinations given by:

K= (C/r) - (w/r) (L)

This equation is illustrated in Figure 22. If $15,000 is spent for inputs and no labor is purchased, 15 units of capital may be bought. More generally, if C is to be spent and r is the unit cost, C/r units of capital may be purchased. This is the vertical axis intercept of the line.

Figure 22: Isocost curves for r = \$1,000 and w = \$2,500

If one unit of labor is purchased at \$2,500, two and five tenths units of capital must be sacrificed; if two units of labor arc bought, five units of capital must be sacrificed; and so on.

Thus, as the purchase of labor is increased, the purchase of capital must decrease if cost is held constant. For each additional unit of labor, w/r units of capital must be foregone. In Figure 22, w/r = 2.5, Attaching a negative sign, this is the slope of the line.

The solid lines in Figure 22 are called **isocost curves** because they show the various combinations of two inputs that may be purchased for a given amount of expenditure. It is definition of **isocost curves**

In summary:

Relation. At fixed input prices, r and w for capital and labor, a fixed outlay C will purchase any combination of capital and labor given by the following linear equation:

K= (C/r) - (w/r) (L)

This is the equation for an isocost curve, whose intercept (C/r) is the amount of capital that may be purchased if no labor is bought and whose slope is the negative of the input price ratio (w/r).

Lecture 17&18

Production of a given output at minimum cost

Output producers aim at producing a maximum production with a given amount of cost ,or they aim at minimizing the cost for a given amount of output. To accomplish this task, production must be organized in the most efficient way. The basic principles can be shown with the following problem:

Problem.

Suppose that Transport Service must produce a certain output of cargo and passenger service per year. The Service is confronted with the following combinations of aircraft and mechanics that can be used to yield this required output over its route pattern.

Combination No.	Number of aircraft	Number of mechanics
1	60	1,000
2	61	920
3	62	850
4	63	800
5	64	760
6	65	730
7	66	710

If the annual cost resulting from the operation of another aircraft is $ 250,000 ,and if mechanics cost them $6,000 each annually, which combination of aircraft and mechanics should Transport Service use to minimize its cost?

By trial and error a solution of combination No. 4 is obtained. Or, we could use the following method. Begin at combination 1.

An additional airplane would cost $250,000, but 80 mechanics could be released at a saving of $480,000. A move to 2 would be beneficial. By moving to 3, the firm would save $420,000 in mechanics' salaries and add $ 250,000 in aircraft expenses. Following the same line of reasoning, the firm could save cost by moving to combination 4. It would not move to 5 since the $240,000 saved is less than the $250,000 added.

Figure 23: Optimal input combination to minimize a given level of output

Let us analyze the problem graphically. Suppose at given input prices r and w and entrepreneur wishes to produce the output indicated by isoquant I in Figure 23 .

Isucost curves KL, K'L', K"L" represent the infinite number of isocost curves from which the producer can choose at the given input prices. Obviously he chooses the lowest one that enables him to attain output level I. That is, he produces at the cost represented by isocost curve K'L'. Any resource expenditure below that, for example, that represented by KL, is not feasible since it is impossible to produce output I with these resource combinations. Any resource combinations above that represented by K'L' are rejected because the entrepreneur wishes to produce the desired output at least cost. If combinations A or B are chosen, at the cost represented by K"L", the producer can reduce costs by moving along I to point E. Point E shows the optimal resource combination, using OK0 units of capital and OL0 units of labor.

Equilibrium is reached <u>when the isoquant representing the chosen output is just tangent to an isocost curve</u>.

Since tangency means that the two slopes are equal, least cost production requires that the marginal rate of technical substitution of capital for labor be equal to the ratio of the price of labor to the price of capital. The market input-price ratio tells the producer the rate at which one input can be substituted for another in purchasing.. **The marginal rate of technical substitution shows the rate at which the producer can substitute m production**. So long as the two are not equal, a producer can achieve a lower cost by moving in the direction of equality.

Principle.

To minimize cost subject to a given level of output and given input prices, the producer must purchase inputs in quantities such that the marginal rate of technical substitution of capital for labor is equal to the input-price ratio (the price of labor to the price of capital), Thus

$$\mathbf{MRTS = (MPL / MPk) = (w/r)}$$

We can analyze the equilibrium condition in another way. Assume the equilibrium condition did not hold, or specifically that

$$\mathbf{(MPL / MPk) < (w/r)}$$

In other words, $\mathbf{(MPL / w) < (MPk /r)}$

In this case the marginal product of an additional dollar's worth of labor is less thin the marginal product of an additional dollar's worth of capital. The firm could reduce its use of labor by one dollar, expand its use of capital by less than one dollar, and remain at the same level of output but with a reduced cost. It could continue to do this so long as the above inequality holds. Eventually **MPL / w** would become equal to **MPk /r** since **MPL** rises with decreased use of labor and increased use of capital, and MPk falls with increased capital and decreased labor. By the same reasoning it is easy to see that firms substitute labor for capital until the equality holds if the inequality is reversed.

Production of maximum output with a given level of cost

The most realistic way of examining the problem is to assume that the entrepreneur chooses a level of output and then chooses the input combination that permits production of that output at least cost. As an alternative we could assume that the entrepreneur can spend only a fixed amount on production and wishes to attain the highest level of production consistent with that amount of expenditure. Not too surprisingly, the results turn out the same as before.

Figure 24: Output maximization for a given level of cost

This situation is shown in Figure 24. The isocost line KL shows every possible combination at the two inputs at the given level of cost and input prices. Four isoquauts are shown. Clearly at the given level of cost, output level IV is unattainable. Neither level I nor level II would be chosen since higher levels are possible. Thus the highest level of output attainable with a given level of cost is produced by using OL0 labor and OK0 capital. At point A the highest possible isoquant, III, is just tangent to the given isocost. Thus in the case of output maximization the marginal rate of technical substitution of capital for labor equals the input- price ratio (the price of labor to the price of capital).

Principle:
In order either to maximize output subject to a given cost or to minimize cost subject to a given output, the producer must employ inputs in such amounts as to equate the marginal rate of technical substitution and the input-price ratio.

Expansion path

The expansion path in production theory shows the way in which factor proportions change when output changes, the factor-price ratio held constant. In Figure 25 the curves I, II, III are isoquants depicting a representative production function; KL, K'L', and K"L" represent the least cost of producing the three output levels. Since the factor-price ratio does not change, they are parallel.

To summarize:

- First, factor prices remain constant.
- Second, each equilibrium point is defined by equality between the marginal rate of technical substitution and the factor-price ratio.
- Since the latter remains constant, so does the former. Therefore, OS is a locus of points along which the marginal rate of technical substitution is constant. But it is a curve with a special feature. Specifically, it is the locus along which output will expand when factor prices are constant. We may accordingly formulate this result as the following definition:

Definition.

The expansion path is the curve along which output expands when factor prices remain constant. The expansion

path thus shows how factor proportions change when output or expenditure changes, input prices remaining constant throughout. The marginal rate of technical substitution remains constant also since the factor-price ratio is constant .The expansion path gives the firm its cost structure. That is, the expansion path shows the optimal input combination for each level of output at the given set of input prices. Thus it gives the minimum cost of producing each level of output from the cost associated with each tangent isocost curve.

In Figure 25 the two inputs, capital and labor, are called normal inputs because as higher levels of output are produced, more of each input is used. In other words, the expansion path is positively sloped.

SUMMARY

- This chapter has set forth the basic theory of production and the optimal combination of inputs under a given set of input prices. The basic-concepts upon which production theory is based are given in the following definitions:

Definition 1.
A production function is a schedule, table, or equation showing the maximum output that can be obtained from any given combination of inputs.

Definition 2.
An isoquant is the locus of points showing combinations of inputs physically capable of producing a given level of output. An isocost line shows all combinations of inputs that can be purchased at some given level of expenditure. The slope of the isoquant, the marginal rate of technical substitution, shows the rate at which one input can be substituted for another while maintaining the same level of output.

The slope of the isocost line, the ratio of input prices, shows the rate at which the market allows inputs to be substituted.

- The optimal combination of inputs is determined by the following relations:

Relation 1.
The firm minimizes the cost of producing any given level of output or maximizes the output that can be produced at any given level of cost when the marginal rate of technical substitution equals the ratio of input prices.

Relation 2.
Two circumstances can change the input ratio used to produce a given output, relative input prices can change and technology can change. It is frequently difficult to separate the two effects.

We have briefly mentioned in this chapter the relation between production theory and cost. We will in the next chapter develop this relation further.

2.3.5 Cost of Production

It is important to note that economists base their estimate of production costs of the concept of the opportunity cost which is measured in terms of forgone alternatives. In this context, the opportunity cost to a firm of using resources in the productions of a good is the revenue forgone by not using those resources in their next best alternative use.

In estimating opportunity costs, economists take a wider view of costs than accountants .In the economist's view; there is no necessary connection between the price originally paid for a factor of production and the cost of using that factor in production. Consider an extreme case of a firm that owns a specialized piece of machinery which can only be used in one production process, has no alternative use and no scrape value. The opportunity cost of using this machine in production is zero, whatever price was originally paid for the machine. If a firm buys a factor of production and uses it up entirely within the relevant production period, then the price actually paid is normally a good estimate of the opportunity cost. If, fir example, a firm buys some fuel-oil for £1,000, the outlay of £1,000 represents the alternative resources that the firm has given up by spending that sum on fuel oil. Similarly, if a firm hires the services of a factor (for example, labor) ,then the money cost of hiring that factor , is a good estimate of opportunity cost .

In the case of factors owned outright by firm, it is necessary to estimate the opportunity cost. In this case, the estimate of opportunity cost is normally based on the amount for which the firm could hire out the services of the factor. If, for example, firm uses money which is already owns, the cost is the interest given up by not lending that money to someone else at the market rate of interest. Analogously, an entrepreneur has the alternative of hiring out his labor services and working for another employer, who might pay him, say £10,000 per annum. Thus, in estimating production costs when the entrepreneur is in business on his own, he should include the sum of £10,000 per annum to reflect his own efforts.

Lecture 19&20

Short–run production costs

When we discussed production previously, we distinguished between two production periods: that short–and long run. Recall that the short-run was defined as that period of time over which the input of at least one factor of production cannot be increased. If the quantity of a factor cannot be increased in the short-run, it is called a ***fixed factor***. A factor whose quantity can be increased in the short-run is known as a ***variable factor***.
Corresponding to this division, total costs can be broken down into *fixed costs* and *variable costs.* As the firm has to pay the costs associated with the fixed factors whether or not the firm produces, these costs are called ***fixed costs***. Examples are rents and rates on buildings, interest payments on loans, and license fees

contracted for manufacture under license from a patent holder. It must be noted that fixed costs do not vary as the level of output varies. The costs that change as the level of output varies are known as ***variable costs***. Examples include the cost of raw materials, components, labor and power. Total variable costs increase as the level of output increases.

To summarize we have:

Total costs = total fixed costs + total variable costs

Or in symbols:

TC = TFC + TVC

Now consider the costs of production of a hypothetical firm producing good X, shown in Table 2.3.5.1. Suppose that labor is the only variable factor. Recall that, with a fixed capital stock, this firm will eventually encounter the law of diminishing returns and the average productivity of labor will begin to fall. Assuming that the firm buys its factors of production in perfectly competitive factor markets, factor prices will be constant however much the firm buys. This implies that the eventual decline in the average productivity of labor must push up the average variable cost of production, as average variable cost and average labor productivity are opposite sides of the same coin.

Table 2.3.5.1: The costs of production of a hypothetical firm in the short-run.

(1) Output (units)	(2) Total fixed costs (TFC) (£)	(3) Total variable costs (TVC) (£)	(4) Total costs (TC) (£)	(5) Average fixed cost (AFC) (£)	(6) Average variable cost (AVC) (£)	(7) Average total cost (ATC) (£)	(8) Marginal cost (MC) (£)
0	5	0	5	∞	-----	∞	-----
1	5	4	9	5	4	9	4

2	5	7.5	12.5	2.5	3.75	6.25	3.5
3	5	10.8	15.8	1.67	3.60	5.27	3.3
4	5	13.8	18.8	1.25	3.45	4.70	3.0
5	5	17.0	22.0	1.00	3.40	4.40	3.2
6	5	20.5	25.5	0.83	3.42	4.25	3.5
7	5	24.3	29.3	0.71	3.47	4.18	3.8
8	5	28.6	33.6	0.63	3.57	4.20	4.3
9	5	33.5	38.5	0.56	3.72	4.28	4.9
10	5	39.0	44.0	0.50	3.90	4.40	5.5

In Table 2.3.5.1, column (6) is headed *average variable cost* (AVC). This is obtained by dividing Total variable costs by the quantity produced, or in symbols:

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

From Table 2.3.5.1 we see that AVC reaches a minimum when output is 5 units per production period. This is the level of output at which average productivity of labor is at a maximum. In other words, at this level of output, the proportion between the fixed factor and the variable factor are at an optimum.

At levels of output above 5 units, the variable factor has progressively less of the fixed factor to work with and its average productivity declines. This results in higher AVC as output increases. Conversely, AVC falls until output reaches 5 units because at low levels of output the variable factor has too much of the fixed factor to work with. Thus, if we plot AVC on a graph against output we obtain a U-shaped curve (see Fig. 2.3.5.1). Not that if a firm encountered diminishing returns as soon as it started production, it would have an upward-sloping AVC curve.

Column (5) is headed *average fixed cost* (AFC). This is obtained by dividing total fixed costs by the quantity produced, or in symbols:

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

Clearly, AFC must decline continuously as output increases because the given level of fixed costs will be spread over a bigger level of output. The "tooling-up" costs of establishing a car assembly line are an example. The tooling-up costs per car decline as the volume of output increases. This is sometimes described as "spreading the overheads".

Column (7) is headed *average total cost* (ATC). This is obtained by adding together average fixed costs and average variable cost,, or in symbols:

$$ATC = AFC + AVC$$

Alternatively, ATC can be obtained by dividing total costs by the level of output, or in symbols:

$$ATC = \frac{TC}{Q}$$

In table 2.3.5.1, ATC declines until output reaches 7 units as the fixed costs are spread over a larger output and initially the firm benefits from increasing returns to the variable factors. Above the level of output of 7 units, ATC increases as the influence of diminishing returns which is pushing up AVC , outweighs the decline in AFC . Thus if we plot ATC on a graph against output, we obtain another U- shaped curve (see figure 2.3.5.1)

Column (8) in headed marginal cost (MC) .this is defined as the change in total costs resulting from changing the level of output by one unit, or in symbols:

$$MC = \frac{\Delta TC}{\Delta Q}$$

From table 2.3.5.1, we see that producing 3 units of X costs £ 15.80, and producing 4 units costs £18.80. To work out the MC of producing the fourth unit, we have

$$MC = \frac{18.80-15.80}{1} = £\ 3$$

The shape of the MC curve is related to the behavior of the marginal product curve. If at low levels of output a firm benefits from increasing marginal returns to the variable factor (that is increasing MP), MC will be declining. MC reaches a minimum at the level of output at which MP is at a maximum. When the firm encounters diminishing marginal returns, so that MP is falling, MC begins to rise.

Whenever there is a fixed factor, so that the law of diminishing returns comes into operation, the MC curve will eventually start to rise. If we plot the MC curve on a graph against output, we see that it is a U-shaped curve (see Fig.2.3.5.1). Note that in this Fig., the MC is plotted at the mid-point of the class interval.

Fig.2.3.5.1 Short-run cost curves plotted from Table 2.3.5.1

The MC curve cuts the AVC and ATC curves at their minimum points for arithmetical reasons similar to those which meant that the MP curve cut the AP curve at its maximum. In Table 2.3.5.1, MC does not exactly equal ATC when ATC is at a maximum because of the discrete nature of the data. It is also for this reason that MC does not exactly equal AVC when AVC is at a minimum. If we had continuous data, we would obtain smooth cost curves as drawn in Fig. 2.3.5.2.

Fig.2.3.5.2 : Short-run cost curves for continuous data.

Long–run production costs

We already defined the long-run as that period of time over which the input of all factors of production can be varied. Thus, all factors are variable factors in long-run. Recall also that profit-maximizing firms will wish to minimize their costs of production.

Traditionally, when deriving the long-run average cost (LRAC) curve, elementary economic theory has assumed that a firm can build an infinite number of plants of different capacities. In some industries, this is clearly an unrealistic assumption; if only a limited number of plants of different capacities can be constructed, the firm's LRAC curve will not be continuously smooth.

Definition: The LRAC curve shows the lowest possible cost of producing different levels of output given the production function and factors prices, as reflected in the firm's isocost curves.

Not that a cost-minimizing firm will only produce at points along its expansion path as explained previously.

An LRAC curve is illustrated in Fig.2.3.5.3. It indicates the minimum possible average cost of producing any level of output on the assumption that all factors are variable. Thus, the LRAC curve in figure 2.3.5.3 indicates the minimum average cist of production for each level of output, given that the plant of the appropriate capacity has been constructed. the minimum average cost of producing output Oq1 in shown to be Oc1.

Figure 2.3.5.3: long-run average cost curve

The LRAC curve reaches a minimum when Oq2 units of output are produced. Up to this level of output, the LRAC curve is declining; the firm is experiencing economies of scale. Assuming fixed factor prices, this must be because the firm has increasing returns to scale. As output is increased above Oq2, the LRAC curve rises, indicating that the firm is facing diseconomies of scale. With fixed factor prices, this is because at these levels of output the firm has decreasing returns to scale. If factor prices are constant and long-run average cost is also constant, the firm is said to have constant returns to scale.

Note that if, having built a plant appropriate to minimum long-run average cost at a given level of output the firms varies its output, it will move along a short-run average cost (SRAC) curve .In Figure 2.3.5.3 as the firm changes its level of output with the plant appropriate for minimum long-run average cost of production at output Oq1, it moves along SRAC1. There is an SRAC curve at a tangent at every point along the LRAC curve. Each SRAC curve lies above the LRAC curve except at the point at which it is at a tangent. For this reason, the LRAC curve is sometimes known as an envelop curve.

Profit maximization

Definition: ***Profits*** are defined as the difference between total revenue and total costs, or in symbols:

$$\Pi = TR - TC$$

where Π represents profits, TR total revenue and TC total costs. As total revenue is the income to the firm from the sales of its output, it is calculated by multiplying price (or average revenue) by the number of units sold (or quantity). Thus we have

$$TR = P \times q$$

Where P is price and q quantity.

Recall that we assume that firms attempt to maximize their profits. How does a firm achieve profit maximization? We can answer this question by utilizing the concepts of ***marginal cost*** and ***marginal revenue.***

Definition: ***marginal revenue*** is defined as the change in total revenue resulting from altering the level of output by one unit. The marginal revenue curve (MR) facing the firm is derived from the average revenue (or demand) curve.

Assume for the moment that the firm faces a downward – sloping demand curve which, means that the firm also faces a downward – sloping MR curve, as in Fig.2.3.5.4.

Consider whether the firm is maximizing profits if it produces quantity Oq1 .It clearly is not, as at this level of output MR equals q1A and MC is q1B. As MR is greater than MC, by producing an additional unit of output, the firm will add more to revenue than to costs, and profit will increase. In general, we can state that if, for a profit-maximizing firm, MR is greater than MC, the firm should increase output.

Fig.2.3.5.4: Profit maximization

Now consider whether the firm is maximizing profits if it produces output Oq3. At this level of output, MC equals q1C and MR is q3D. As MC is greater than MR, by producing the last unit the firm has actually reduced profits. As long as MC is greater than MR, by producing less the firm can reduce costs more than revenue. Thus, in general, we can state that if MC is greater than MR, a profit-maximizing firm should reduce output.

Taken together our two general statements imply that ***in order to maximize profits, a***

firm should produce that quantity at which MC and MR are equal.

Referring back to Fig.2.3.5.4, in order to maximize profits, the firm should produce quantity Oq2, at which point both MC and MR equal q2E.

If we use the simple MC = MR rule for profit maximization, what is the profit-maximizing level of output in Fig.2.3.5.5 where the MC curve cuts the MR curve twice at point A and B? The simple MC = MR rule does not enable us to determine whether output Oq1 or output Oq2 is the profit-maximizing level of output.

Fig.2.3.5.5: Profit maximization where MC cuts MR twice

Consider output Oq1: if the firm increased output to Oq3, say, profit would increase as the MR of the additional units is greater than MC. Thus, output Oq1 is clearly not the profit-maximizing level.
Now consider output Oq2 : if the firm increased output to Oq4, say, profit would fall as MR is greater than MC. Conversely, if the firm increased output above Oq1, profit would also fall as MC is greater than MR. Output q2, therefore, is the profit-maximizing level of output. At this level of output the MC curve is rising and cuts the MR curve from below. At output Oq2, on the other hand, the MC curve is falling and cuts the MR curve from above. Thus, the profit maximization rule requires some refinement. It now states that to ***maximize profits, a firm should produce that quantity at which MC = MR, provided the***

MC curve is rising so that it cuts the MR curve from the below at this point.

Lecture 21&22

2.4. SUPPLY

The supply of a given commodity is defined as the quantity of this commodity that will be sold at each price level of this commodity. Therefore, the supply schedule relates the quantity supplied of a good to its market price, assuming that other factors affecting supply (such as costs of production, prices of related goods, and government policies) are constant.

The supply schedule (or supply curve) for a given commodity shows the relationship between its market price and the amount of that commodity, which the producer are willing to produce and sell, assuming that other factors affecting supply (such as costs of production, prices of related goods, and government policies) are constant.

The supply Curve

Definition: The supply curve for good X is defined as a graphical representation of the relationship between the prices of X and the quantities that firms are willing and able to sell at those prices, *ceteris paribus*.

To illustrate the apple supply curve (as example); consider a hypothetical supply of apple in a given market in a specific month. All apples are assumed to be identical from the point of view of the sellers. The total stock of apples available to potential sellers in that month is assumed to be fixed. The supply schedule for apple can be illustrated in Table 2.4.1.

Table 2.4.1 Supply of apples

Price in specific month $ /Kg	Quantity supplied in specific month('000kg/month)

0.89	430
0.79	400
0.69	380
0.59	360
0.49	345
0.39	310
0.29	270
0.19	220

The supply schedule for apples in Table 2.4.1 can be represented by a supply curve, as in Figure 2.4.1.

Figure 2.4.1: Supply curve of apples

Factors affecting the supply curve

The position and shape of the supply curve are affected by the following factors:

1. The stocks of the goods available to potential sellers in the market in the specific time period.
2. The expected prices for the goods in this and other markets in future periods.
3. Costs of storage and transportation.
4. Expected prices for the good in this specified period in other areas to which the good from a given market could be shipped, or from which the good could be shipped to this market.
5. Expectations held in the past concerning prices for the good in the present.

6. The total production cost of the commodity in the recent past.

Price elasticity of supply

Concept and definition of Price elasticity of supply

A supply curve contains information about the responsiveness of quantity supplied to differences in price; it is based on a functional relationship between these two variables (price and quantity supplied). A measure of the degree of this responsiveness at various points on the curve can be provided by the price elasticity of supply **(ηs)**. The price elasticity of supply is equal to the percentage change in quantity supplied devided by the corresponding percentage change in price. Its sign depends on the sign of the slope of the supply curve, and it is therefore positive for upward-sloping curves.

Definition: *Price elasticity of supply* is a measure of the extent to which the quantity supplied of a good responds to changes in the good's own price, ceteris paribus. It can be calculated by using the following formula:

Price elasticity of supply **(ηs)** =

$$\frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$$

Geometrically estimation of the elasticity of supply curve

The elasticity of supply curve at a particular point can be estimated geometrically. The method used is demonstrated for the linear supply curve PS in Figure 2.4.2

Figure 2.4.2 Quantity supplied of commodity X in a particular market in a specific period

The point on the curve at which the elasticity of supply is to be estimated is H. The price at this point is OP1 and the quantity is Q Q1. If the price were slightly higher, at OP2, the corresponding point on the curve would be K, and the quantity would be QQ2. From its definition we know that the elasticity of supply **(ηs)** is equal to $\Delta Q / Q \div \Delta P/P$. The values for point H are used to form the price and quantity relatives. From figure 2.4.2 we see that $\Delta Q = Q1Q2$, which can be written as HJ, while $\Delta P = P1P2$, which can be written as JK . When these terms are substituted in the equation for the *price* elasticity of supply , we have:

$$\eta s = \frac{HJ}{OQ1} \div \frac{JK}{OP1} = \frac{HJ}{JK} \cdot \frac{OP1}{OQ1}$$

Not that triangles HKJ and BHG are similar and OQ1= BG, BP1 = GH , which gives:

$$\frac{HJ}{JK} = \frac{BG}{GH} = \frac{OQ1}{BP1}$$

Then: ηs at point H $= \frac{OQ1}{BP1} \cdot \frac{OP1}{OQ1} = \frac{OP1}{BP1}$

That is, the elasticity of supply at a particular point on a linear supply curve is equal to the ratio of the price at that point divided by the difference between the price and the value of the intercept of this linear supply curve and the ordinate. In general, the value for the price elasticity of a supply curve will differ for different points on the curve. However, there are certain regularities for linear supply curve. If, as in Figure 2.4.1, the linear supply curve cuts the ordinate at a positive value, the elasticity of supply at all points on the curve has a value greater than one. If the linear supply curve (when extended, if necessary) cuts the ordinate below the origin, then the value for the elasticity of supply at all points on the curve has a value less than one. Finally, if the curve cuts the ordinate at the origin, the elasticity of supply at all points on the curve has a value equal to one.

These relationships are illustrated in Figure 2.4.3. The linear supply curve labeled S1 has unit elasticity at all points because when it is extended it goes through the origin. The price elasticity for all points on the curve S2 is greater than one. All points on S3 have elasticity values of less than one.

If a supply curve is parallel to the horizontal axis, it has an elasticity value of infinity at all points; if it is perpendicular to the horizontal axis, it has a value of zero at all points.

A geometrical estimate of the price elasticity at a particular point for a non-linear supply curve is readily obtained by finding the elasticity for the tangent to that curve at this point. For example, in figure 2.4.2 the elasticity of the supply curve Sc at point H is equal to the elasticity at that point of the tangent to the curve BS the price elasticity of the supply is equal to the product of the slope of a curve and the corresponding ratio of price to quantity point H is common to both curves and both have the same slope at the point

When the differences in the price being compare is not small, and then an arc elasticity of supply is a more appropriate estimate of the responsiveness of quantity to price than is a point elasticity estimate. The considerations and procedures here are similar to those dealt with in the discussion of the elasticity of demand. The value for the arc elasticity of supply is obtained by using the average of the quantities supplied and the averages of the prices as the bases for the quantity and price relatives.

Figure 2.4.3: Supply curves for a particular commodity in a specific period.

Determinants of the elasticity of supply

The main determinants of the elasticity of supply are the following three factors:

1.Time.

Since it takes time for firms to adjust the quantities they produce, the supply of a good is likely to be more elastic the longer the period of time under consideration.

2. *Excess capacity and unsold stocks*.

In the short – run, it may be possible to increase supplies considerably if there is a pool of unemployed labor and unused machinery (known as *excess capacity*) in the industry. Similarly, if the industry has accumulated a large stock of unsold goods, supplies can quickly be increased. It follows that supply will be more elastic the greater the excess capacity in the industry and the higher the level of unsold stocks.

3. *The ease with which resources can shift from one industry to another*.

In both the short – and long – run, in the absence of excess capacity and unsold stocks, an increase in supply requires the shifting of factors of production from one use to another. This may be costly because the price of the factors may have to be raised to attract them to move. There are, however, other problems which may limit the *mobility* of factors between industries. Labor may be reluctant to move away from family and friends and may need retraining before it is suitable for the new occupation. Similarly, capital equipment which is suitable for one use may be totally unsuitable for another. It is this heterogeneity of labor and capital which can severally restrict their mobility. In certain industries this is not such a serious problem and, given sufficient time, supply can be very elastic. In agriculture, for example, it is quite possible for both labor and capital to shift from barley production to wheat production in response to a rise in wheat prices, though in this particularly example time must be allowed for reaping the old crop and sowing the new one. In many other industries, however, labor may have to be completely retrained and new capital equipment may have to be acquired. In such cases, supply will be inelastic except over a very long time period.

Lecture 23&24

2.5 PERFECT COMPETITION

Perfect competition is a theoretical market structure based on a number of assumptions. Some real world markets contain a number of features of the perfectly competitive model as, for example, some agricultural markets.
The assumptions of the perfect competition model can be summarized as follows:

1.Many buyers and sellers

It means that there are a large enough number of potential buyers and sellers that no single buyer or seller can buy or produce enough output to affect the market price. Participants in the market are price takers. In this case the demand curve faced by a competitive producer for his product is perfectly elastic (Ed = ∞). No matter how much he brings to the market he receives the same price per unit. The firm or individual has no price policy.

2.Freedom of entry and exit to the market

It means that there are no barriers to new firms entering the industry or to existing firms leaving the industry.

3.Perfect mobility of factors of production

It means that there are no barriers to resources moving either in or out of the industry. There is perfect mobility for inputs to seek their best use. There is no discrimination of any kind that sets up arbitrary conditions for entry; initiation fees, licenses, patents and/or copyright are not required.

4.Perfect knowledge (information)

It means that all participants in the market are perfectly well informed about prices, quality, output levels and all other market conditions.

5.Homogeneous product

It means that each unit produced is identical, so that buyers and can have no preferences between different units. Perfect knowledge and a homogeneous product together imply that there must be a single market price for all units of output.

Prices and output determination in the short-run

- **Market equilibrium price and output**

The equilibrium price is determined in the **market** for a given good (say a good X) by the interaction of supply and demand. **Fig.2.5.1 (a)** shows the market demand curve (DD) and the market supply curve (SS) which intersect to give an **equilibrium price** Op1 and an **equilibrium industry output** OQ1.

- **The price that the firm receives per unit**

Fig.2.5.1 (b), drawn on a much bigger scale, illustrates the cost and revenues of a typical firm earning above-normal profit. The firm faces a perfectly elastic demand curve (dd), indicating that it can sell all that it produces at the ruling market price Op1. The price that the firm receives per unit is given by total revenue divided by the number of units produced, and is, therefore, the same as average revenue (AR). In symbols, we have:

$$P = TR / q = AR$$

In words we have:

Output price per unit

= Total Revenue / Quantity of output = Average revenue

- **The demand curve facing the firm**

As the firm receives a constant price Op1 its AR is also constant. In addition, since an extra unit of output can always be sold without reducing price, MR must also be equal to price. Thus in **Fig.2.5.1 (b)** the demand curve facing the firm is labeled **dd = AR = MR.**

Fig.2.5.1: Market (Industry) and firm in perfect competition earning above-normal profits.

- **The firm equilibrium**

To find the equilibrium quantity that the firm will produce, we apply the **MR = MC rule.** The **MR and MC curve**s in the diagram intersect at the point where MC cuts MR from below. The profit-maximizing level of output, therefore, is Oq1. Not that the equilibrium price Op1 is equal to MC at the equilibrium level of output Oq1. Since in perfect competition price and MR and MC will also necessarily equate price and MC. **The equality of price and MC is the most significant feature of perfect competition** and its welfare implications are discussed below.

<u>Rule:</u> The important condition of firm equilibrium in perfect competition is the following equality:

MR = MC = P

- **When does the firm realize normal profits?**

The firm realizes normal profits when the unit price of output is equal to the minimum value of average total cost.

In Fig.2.5.1 (b), when the unit price of output is equal to OC(which is equal to the minimum value of ATC) , average total cost at output level Oq1 (equilibrium level of output) is q1B. The total costs which are given by average total cost multiplied by quantity are thus represented by the rectangle Oq1OC. In this case, the total revenue is equal to total cost and then the firm realizes **normal profit,** which is the rate of return necessary to keep the factors of production in their present use.

- **When does the firm realize above-normal profits?**

The firm realizes above-normal profits when the unit price of output is more than (above) the minimum value of average total cost.
In Fig.2.5.1 (b), when the unit price of output is equal to Op1(which is above the minimum value of ATC) , at the equilibrium level of output Oq1 , **total revenue** is represented the area of

rectangle Oq1OP1. In this case the average total cost at output level Oq1 is q1B. **The total costs** which are given by average total cost multiplied by quantity are thus represented by the rectangle Oq1BC. In this case, the total revenue is more than the total cost and then the firm realizes **above-normal profit.**

- **When does the firm realize a loss?**

To understand this case, we consider now another perfectly competitive firm whose situation is illustrated in Fig. 2.5.2.

Fig. 2.5.2.(a) illustrate the determination of the equilibrium price (Op1) in the market. The cost and revenue curves of a typical firm are illustrated in Fig. 2.5.2.(b).Note that the ATC lies completely above the AR curve, indicating that this firm cannot cover its full opportunity costs. The intersection of the MR and MC curves at point A now indicates that the loss-minimizing level of output is Oq1. At this output ,

ATC equals Bq1, which is greater than AR (= output price) or Aq1. The loss per unit of output is equal to BA so that the total loss is represented by the area of rectangle p1DBA.

At the price is above average variable cost (AVC) at output Oq1, the firm will continue to produce in the short-run , as it minimizes its losses. If the firm shut down production entirely, its loss would be equal to its total fixed costs. By producing and selling output Oq1 at price Op1, the firm more than covers its variable costs and can pay for part of its fixed costs.

Fig. 2.5.2 : Industry (market) and firm in perfect competition making a loss.

Lecture 25&26

The firm's short-run supply curve

We can note from foregoing analysis that the perfectly competitive firm which aims to maximize profits produces at the intersection of its horizontal MR curve with the MC curve provided this is above the shut- down point. This is illustrated for different prices in Fig. 2.5.3. For example, the firm offers for sale quantity Oq2 at price Op2. If price rises to Op3, the quantity supplied by the firm increases to Oq3. We can see that the short-run supply curve of the perfectly competitive firm is its MC curve above the intersection with the AVC curve.

The short-run industry supply curve is obtained by the horizontal summation of the MC curves of the firms comprising the industry. This is illustrated in Fig.2.5.4 for an industry containing only two firms.

Fig. 2.5.4: The derivation of the industry supply curve.

The two left-hand diagrams illustrate the MC curves of firms A and B respectively. At a price of £ 10, firm A produces 25 units and firm B 35 units of output per time period. Industry output at this price, therefore, is 60 units and A is one point on the industry supply curve. Summing the firm's outputs at other prices enables the industry short-run supply curve, SS, to be derived. This is the supply curve which (together with the market demand curve for the good) determines the market price which all the individual firms have to take as given.

The long-run equilibrium of perfectly competitive firm

Fig. 2.5.4 illustrates a perfectly competitive firm's long-run average cost (LRAC) curve. It was noted that that if above-normal profits can be earned, in the long-run new firms are attracted into the industry, so that the above-normal profits are eventually competed away. Conversely, if the typical firm is making losses, firms will begin to leave the industry in the long-run, with the result that price rises until normal profits are restored. In the long-run equilibrium position, the perfectly competitive firm earns only normal profits. In Fig. 2.5.4, the equilibrium price is Op1 and the equilibrium output is Oq1. Note that in this situation, production is carried on at the lowest point on the LRAC curve. Price equals both marginal cost and average cost. The firm is earning sufficient revenue to cover its full opportunity costs. There exists no incentive for firms to enter or to leave the industry.

Fig. 2.5.4: The long-run equilibrium of perfectly competitive firm.