HARAMAYA UNIVERSITY

COLLEGE OF BUSINESS AND ECONMICS
DEPARTMENT OF ECONMICS

MICROECONOMICS I

(Econ1021)

LECTURE NOTE

CHAPTER ONE

Theory of Consumer Behavior and Demand

Section 1: Consumer Preferences and Choices

1.1 Consumer Preference

Given any two consumption bundles, the consumer can either decide that one of consumption bundles is strictly better than the other, or decide that he is indifferent between the two bundles.

Strict preference

Given any two consumption bundles(X_1, X_2) and (Y_1, Y_2), if (X_1, X_2)> (Y_1, Y_2) or if he chooses (X_1, X_2) when (Y_1, Y_2) is available the consumer definitely wants the X-bundle than Y.

Weak preference

Given any two consumption bundles(X_1, X_2) and (Y_1, Y_2), if the consumer is indifferent between the two commodity bundles or if (X_1, X_2) $\geq$ (Y_1, Y_2), the consumer would be equally satisfied if he consumes (X_1, X_2) or (Y_1, Y_2).

Completeness

For any two commodity bundles X and Y, a consumer will prefer X to Y,Y to X or will be indifferent between the two.

Transitivity

It means that if a consumer prefers basket A to basket B and to basket C, then the consumer also prefers A to C.

More is better than less

Consumers always prefer more of any good to less and they are never satisfied or satiated. However, bad goods are not desirable and consumers will always prefer less of them.

1.2 Utility

Definition

Utility is the level of satisfaction that is obtained by consuming a commodity or undertaking an activity.

In defining strict preference, we said that given any two consumption bundles (X_1, X_2) and (Y_1, Y_2), the consumer definitely wants the X bundle than the Y bundle if (X_1, X_2) > (Y_1, Y_2).This means, the consumer preferred bundle (X_1, X_2) to bundle (Y_1, Y_2) if and only if the utility (X_1, X_2) is larger than the utility of (Y_1, Y_2).

The concept of utility is characterized with the following properties:

- 'Utility' and 'Usefulness" are not synonymous. For example, paintings by Picasso may be useless functionally but offer great utility to art lovers.
- Utility is subjective. The utility of a product will vary from person to person. That means, the utility that two individuals derive from consuming the same level of a product may not be the same. For example, no-smokers do not derive any utility from cigarettes.
- The utility of a product can be different at different places and time. For example, the utility that we get from meat during fasting is not the same as any time else.

A Consumer considers the following points to get maximum utility (satisfaction):

- How much satisfaction he gets from buying and then consuming an extra unit of a good or service.
- The price he pays to get the good.
- The satisfaction he gets from consuming alternative products.
- The prices of alternative goods and services.

Section 2: Approaches to measure Utility

There are two major approaches of measuring utility. These are Cardinal and ordinal approaches. This sub unit is divided into two Sections. In this Section will be discussed these two approaches.

2.1: The Cardinal Utility theory

Neo classical economists argued that utility is measurable like weight, height, temperature and they suggested a unit of measurement of satisfaction called utils. Autil is a cardinal number like 1, 2, 3 etc. simply attached to utility. Hence, utility can be quantitatively measured.

2.1.1 Assumptions of Cardinal Utility theory

1. **Rationality of Consumers**. The main objective of the consumer is to maximize his/her satisfaction given his/her limited budget or income. Thus, in order to maximize his/her satisfaction, the consumer has to be rational.
2. **Utility is Cardinally Measurable.** According to this approach, the utility or satisfaction of each commodity is measurable. Money is the most convenient measurement of utility. In other words, the monetary unit that the consumer is prepared to pay for another unit of commodity measures utility or satisfaction.
3. **Constant Marginal Utility of Money.** According to assumption number two, money is the most convenient measurement of utility. However, if the marginal utility of money changes with the level of income (wealth) of the consumer, then money can not be considered as a measurement of utility.
4. **Limited Money Income.** The consumer has limited money income to spend on the goods and services he/she chooses to consume.
5. **Diminishing Marginal Utility (DMU).**The utility derived from each from each successive units of a commodity diminishes. In other words, the marginal utility of a commodity diminishes as the consumer acquires larger quantities of it.
6. The total utility of a basket of goods depends on the quantities of the individual commodities.

If there are n commodities in the bundle with quantities, $X_1, X_2, ...X_n$ the total utility is given by:

$$TU=f(X_1, X_2.....X_n)$$

2.1.2 Total and Marginal Utility

Total Utility (TU): It refers to the total amount of satisfaction a consumer gets from consuming or possessing some specific quantities of a commodity at a particular time. As the consumer consumes more of a good per time period, his/her total utility increases. However, there is a saturation point for that commodity in which the consumer will not be capable of enjoying any greater satisfaction from it.

Marginal Utility (MU): It refers to the additional utility obtained from consuming an additional unit of a commodity. In other words, marginal utility is the change in total utility resulting from the consumption of one or more unit of a product per unit of time. Graphically, it is the slope of total utility.

Mathematically, the formula for marginal utility is:

$MU = \frac{\Delta TU}{\Delta Q}$ Where, ΔTU is the change in Total Utility, and,

ΔQ ischange in the amount of product consumed.

2.1.3 The Law of Diminishing Marginal Utility (LDMU)

The utility that a consumer gets by consuming a commodity for the first time is not the same as the consumption of the good for the second, third, fourth, etc.

Table1.1 Hypothetical table showing TU and MU of consuming Oranges (X)

Units of Quantity(x) consumed	**0 Unit**	**1st Unit**	**2nd unit**	**3rd unit**	**4th unit**	**5th Unit**	**6th Unit**
TU_X	0 util	10 utils	16 utils	20 utils	22 utils	22 utils	20 utils
MU_X	0	10	6	4	2	0	-2

The Law of Diminishing Marginal Utility States that as the quantity consumed of a commodity increases per unit of time, the utility derived from each successive unit decreases, consumption of all other commodities remaining constant. The LDMU is best explained by the MU curve that is derived from the relationship between the TU and total quantity consumed.

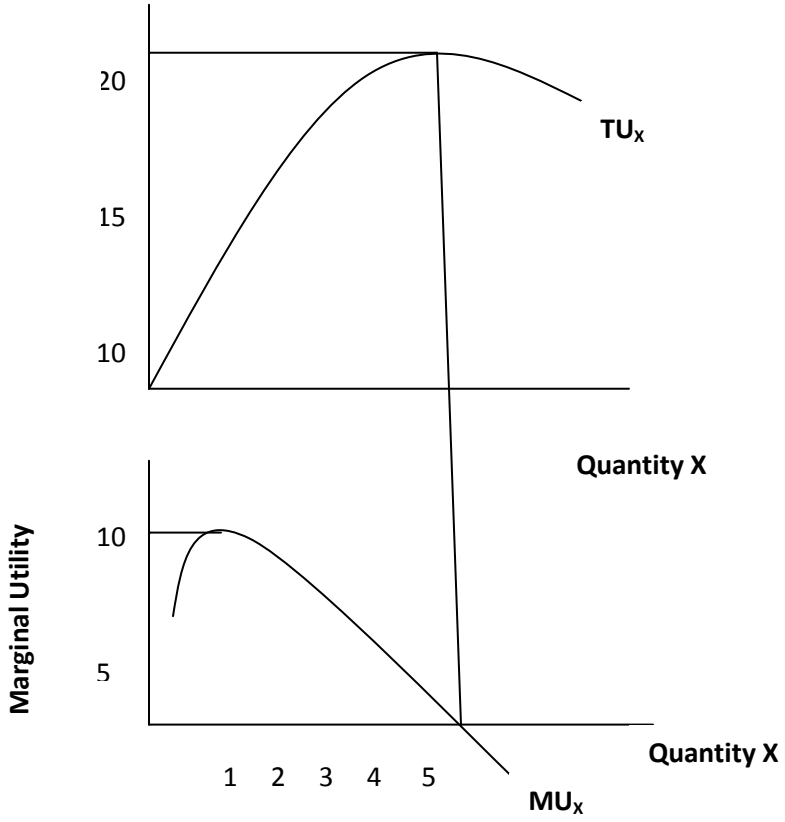


Fig.1.1Derivation of marginal utility from total utility

As the consumer consumes more of a good per time period, the total utility increases, at an increasing rate when the marginal utility is increasing and then increases at a decreasing rate when the marginal utility starts to decrease and reaches maximum when the marginal utility is Zero.

The total utility curve reaches its pick point (Saturation point) at point A. This Saturation point indicates that by consuming 5 oranges, the consumer attains its highest satisfaction of 11 utils. However, consumption beyond this point results in dissatisfaction, because consuming the 6th and more orange brings a lesser additional utility than the previous

orange. Point B where the MU curve reaches its maximum point is called an inflexion point or the point of Diminishing Marginal utility.

2.1.4 Equilibrium of a consumer

A consumer that maximizes utility reaches his/her equilibrium position when allocation of his/her expenditure is such that the last birr spent on each commodity yields the same utility.

For example, if the consumer consumes a bundle of n commodities i.e $X_1, X_2, \ldots, Xn$, he/she would be in equilibrium or utility is maximized if and only if:

$$\frac{MU_{X1}}{P_{X_1}} = \frac{MU_{X_2}}{P_{X_2}} = ... = \frac{MU_{X_n}}{P_{X_n}} = MU_m$$ Where: MUm –marginal utility of money

Table 1.2 Utility schedule for a single commodity

Quantity of Orange	Total utility	Marginal utility	Marginal utility per Birr(price=2 birr)	Marginal utility of money
0	0	-	-	1
1	6	6	3	1
2	10	4	2	1
3	12	2	1	1
4	13	1	0.5	1
5	13	0	0	1
6	11	-2	-1	1

For consumption level lower than three quantities of oranges, since the marginal utility of orange is higher than the price, the consumer can increase his/her utility by consuming more quantities of oranges. On the other hand, for quantities higher than three, since the marginal utility of orange is lower than the price, the consumer can increase his/her utility by reducing its consumption of oranges.

Mathematically, the equilibrium condition of a consumer that consumes a single good X occurs when the marginal utility of X is equal to its market price. $MU_X = P_X$

Proof

The utility function is:

$U = f(X)$

If the consumer buys commodity X, then his expenditure will be $Q_X P_X$ .Thus, the consumer wants to maximize the difference between his/her utility and expenditure

$Max(U - Q_X P_X)$

The necessary condition for maximization is equating the derivative of a function with zero. $\frac{dU}{dQ_X} - \frac{d(Q_X P_X)}{dQ_X} = 0$

$$\frac{dU}{dQ_X} - P_X = 0 \Rightarrow MU_X = P_X$$

Table 1.3 Utility schedule for two commodities

Orange, Price=2birr				***Banana, Price=4birr***			
Quantity	***TU***	***MU***	***MU/P***	***Quantity***	***TU***	***MU***	***MU/P***
0	***0***	***-***	***-***	***0***	***0***	***-***	***-***
1	***6***	***6***	***3***	***1***	***6***	***6***	***6***
2	***10***	***4***	***2***	***2***	***22***	***16***	***4***
3	***12***	***2***	***1***	***3***	***32***	***12***	***3***
4	***13***	***1***	***0.5***	***4***	***40***	***8***	***2***
5	***13***	***0***	***0***	***5***	***45***	***5***	***1.85***
6	***11***	***-2***	***-1***	***6***	***48***	***3***	***0.75***

Utility is maximized when the condition of marginal utility of one commodity divided by its market price is equal to the marginal utility of the other commodity divided by its marketprice **MU i.e.** $\frac{MU_1}{P_1} = \frac{MU_2}{P_2}$

Thus, the consumer will be at equilibrium when he consumes 2 quantities of Orange and 4 quantities of banana, because $\frac{MU_{orange}}{P_{orange}} = \frac{MU_{banana}}{P_{banana}} = \frac{4}{2} = \frac{8}{4} = 2$

2.1.5 Derivation of the Cardinalist Demand

The derivation of demand curve is based on the concept of diminishing marginal utility. If the marginal utility is measured using monetary units the demand curve for a commodity is the same as the positive segment of the marginal utility curve.

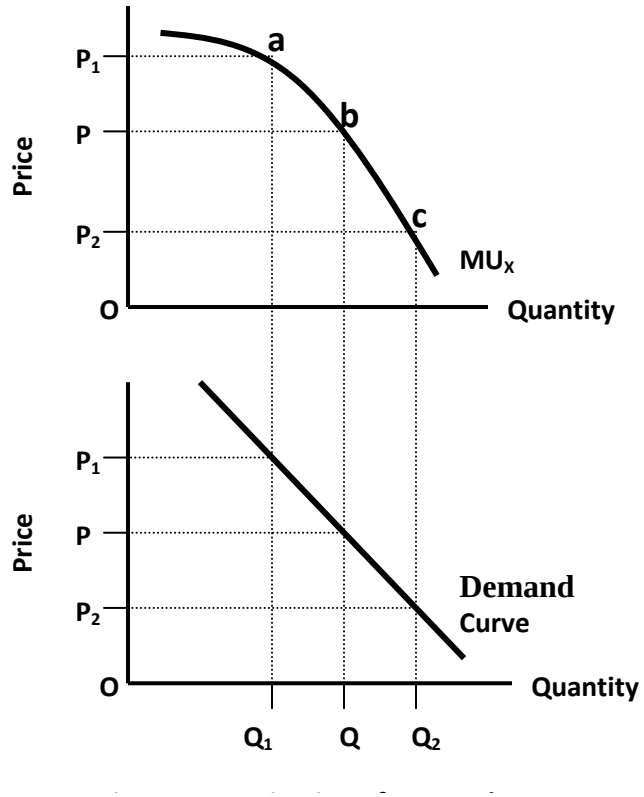


Fig.1.2 Derivation of Cardinalist Demand curve

Limitation of the Cardinalist approach

The Cardinalist approach involves the following three weaknesses:

1. The assumption of cardinal utility is doubtful because utility may not be quantified.
2. Utility can not be measured absolutely (objectively). The satisfaction obtained from different commodities can not be measured objectively.
3. The assumption of constant MU of money is unrealistic because as income increases, the marginal utility of money changes.

2.2 The Ordinal Utility Theory

In this approach, utility cannot be measured absolutely but different consumption bundles are ranked according to preferences. The concept is based on the fact that it may not be possible for consumers to express the utility of various commodities they consume in absolute terms, like, 1 util, 2 util, or 3 util, but it is always possible for the consumers to express the utility in relative terms. It is practically possible for the consumers to rank commodities in the order of their preference as $1^{st}2^{nd}3^{rd}$ and so on.

2.2.1 Assumptions of Ordinal Utility theory

1. The Consumers are rational-they aim at maximizing their satisfaction or utility given their income and market prices.
2. Utility is ordinal, i.e. utility is not absolutely (cardinally) measurable. Consumers are required only to order or rank their preference for various bundles of commodities.
3. Diminishing Marginal Rate of Substitution (MRS): The marginal rate of substitution is the rate at which a consumer is willing to substitute one commodity (x) for another commodity (y) so that his total satisfaction remains the same. When a consumer continues to substitute X for Y the rate goes decreasing and it is the slope of the Indifference curve.
4. The total utility of the consumer depends on the quantities of the commodities consumed, i.e., U=f (X_1, X_2, X_3, …)
5. Preferences are transitive or consistent:
    - It is transitive if the consumer prefers market basket X to market basket Y, and prefers Y to Z, and then the consumer also prefers X to Z.
    - When we said consistent it means that If market basket X is greater than market basket Y (X>Y) then Y not greater than X (Y not >Y).

The ordinal utility approach is expressed or explained with the help of indifference curves. An indifference curve is a concept used to represent an ordinal measure of the

tastes and preferences of the consumer and to show how he/she maximizes utility in spending income. Since it uses ICs to study the consumer's behavior, the ordinal utility theory is also known as the Indifference Curve Analysis.

2.2.2. Indifference Set, Curve and Map

Indifference Set/ Schedule: It is a combination of goods for which the consumer is indifferent, preferring none of any others. It shows the various combinations of goods from which the consumer derives the same level of utility.

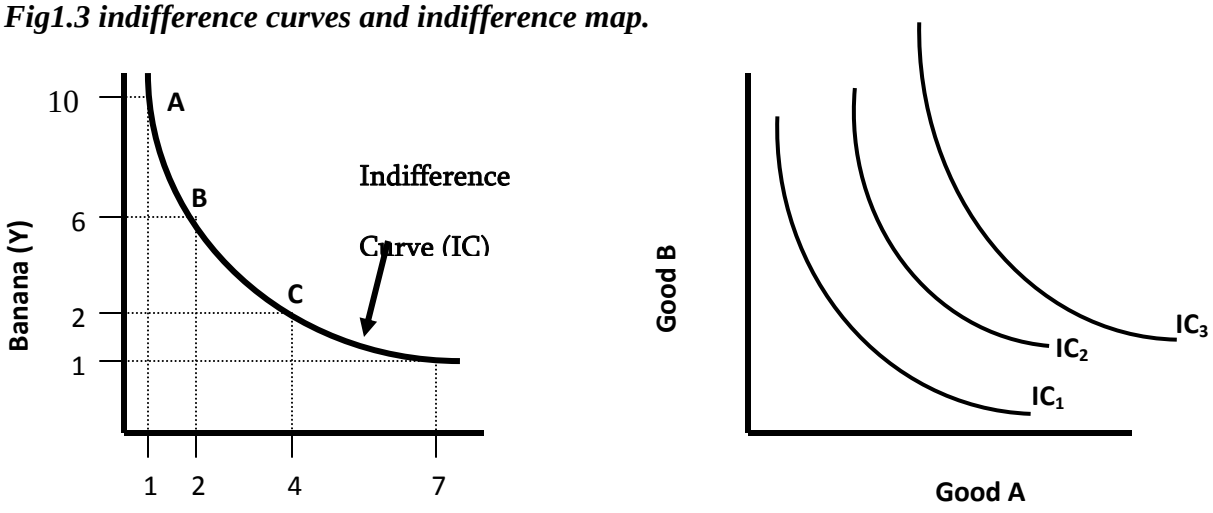
Table 1.4 Indifference Schedule

Bundle (Combination)	A	B	C	D
Orange(X)	1	2	4	7
Banana (Y)	10	6	3	1

Each combination of good X and Y gives the consumer equal level of total utility. Thus, the individual is indifferent whether he consumes combination A, B, C or D.

Indifference Curves: an indifference curve shows the various combinations of two goods that provide the consumer the same level of utility or satisfaction. It is the locus of points (particular combinations or bundles of good), which yield the same utility (level of satisfaction) to the consumer, so that the consumer is indifferent as to the particular combination he/she consumes.

Fig1.3 indifference curves and indifference map.



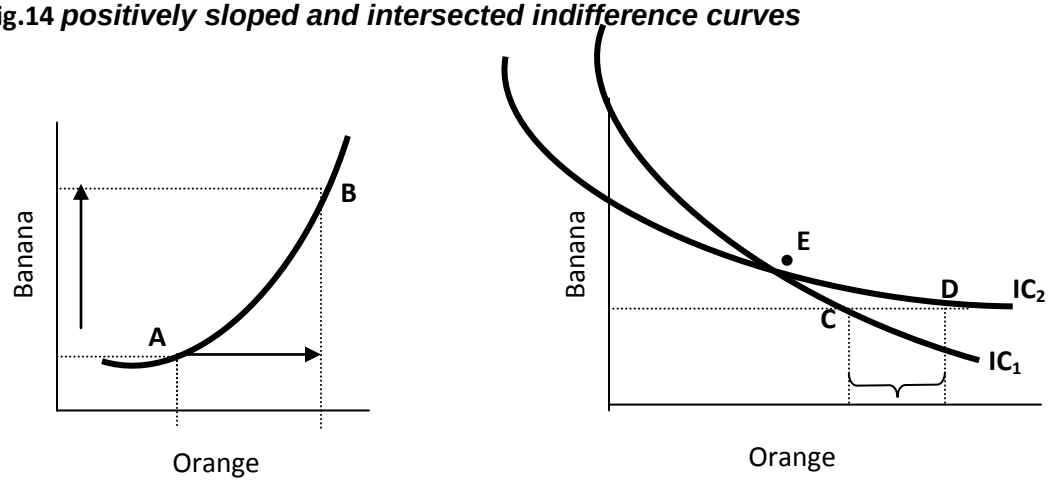
Indifference curve **Indifference map**

Indifference Map: To describe a person's preferences for all combinations potato and meat, we can graph a set of indifference curves called an indifference map. In other words it is the entire set of indifference curves is known as an indifference map, which reflects the entire set of tastes and preferences of the consumer. A higher indifference curve refers to a higher level of satisfaction and a lower indifference curve shows lesser satisfaction. IC2 reflects higher level of utility than that of IC1.Any consumer has lots of indifference curves, not just one.

2.2.3 Properties of Indifference Curves:

1. Indifference curves have negative slope (downward sloping to the right). It is because the consumption level of one commodity can be increased only by reducing the consumption level of the other commodity. That means, if the quantity of one commodity increases with the quantity of the other remaining constant, the total utility of the consumer increases. On the other hand, if the quantity of one commodity decreases with the quantity of the other remaining constant, the total utility of the consumer reduces. Hence, in order to keep the utility of the consumer constant, as the quantity of one commodity is increased, the quantity of the other must be decreased.
2. Indifference curves do not intersect each other. Intersection between two indifference curves is inconsistent with the reflection of indifference curves. If they did, the point of their intersection would mean two different levels of satisfaction, which is impossible.
3. A higher Indifference curve is always preferred to a lower one. The further away from the origin an indifferent curve lies, the higher the level of utility it denotes: baskets of goods on a higher indifference curve are preferred by the rational consumer, because they contain more of the two commodities than the lower ones.
4. Indifference curves are convex to the origin. This implies that the slope of an indifference curve decreases (in absolute terms) as we move along the curve from the left downwards to the right. This assumption implies that the commodities can substitute one another at any point on an indifference curve, but are not perfect substitutes.

Fig.14 ***positively sloped and intersected indifference curves***



As we discussed earlier, Indifference curves cannot intersect each other. If they did, the consumer would be indifferent between C and E, (Right panel of figure 2.6) since both are on indifference curve one (IC1). Similarly, the consumer would be indifferent between points D and E, since they are on the same indifference curve, IC2.By transitivity, the consumer must also be indifferent between C and D. However, a rational consumer would prefer D to C because he/she can have more Orange at point D (more Orange by an amount of X).

2.2.4 The Marginal rate of substitution (MRS).

Definition: Marginal rate of substitution of X for Y is defined as the number of units of commodity Y that must be given up in exchange for an extra unit of commodity of X so that the consumer maintains the same level of satisfaction.

$$MRS_{X,Y} = \frac{Number\ of\ units\ of\ Y\ given\ up}{Number\ of\ units\ of\ X\ gained}$$

It is the negative of the slope of an indifference curve at any point of any two commodities such as X and Y, and is given by the slope of the tangent at that point:

i.e., Slope of indifference curve, $\frac{\Delta y}{\Delta x} = MRS_{X,Y}$

In other words, MRS refers to the amount of one commodity that an individual is willing to give up to get an additional unit of another good while maintaining the same level of satisfaction or remaining on the same indifference curve. The diminishing slope of the

indifference curve means the willingness to substitute X for Y diminishes as one move down the curve.

$MRS_{X,Y}$ measures the downward vertical distance (the amount of y that the individual is willing to give up) per unit of horizontal distance (i.e. per additional unit of x required) to remain on the same indifference curve. That is, $MRS_{X,Y} = -\frac{\Delta Y}{\Delta X}$ because of the reduction in Y, MRS is negative. However, we multiply by negative one and express $MRS_{X,Y}$ as a positive value.

The rationale behind the convexity, that is, diminishing MRS, is that a consumer's subjective willingness to substitute A for B (or B for A) will depend on the amounts of B and **A** he/she possesses.

Table1.5 level of consumption of good X and Y

Bundle (Combination)	A	B	C	D
Orange(X)	1	2	4	7
Banana (Y)	10	6	3	1

$MRS_{X,Y}(between\ points\ A\ and\ B = \frac{\Delta Y}{\Delta X} = \frac{4}{1} = 4$

It means the consumer is willing to forgo 4 units of Banana to obtain 1 more unit of Orange. If the consumer moves from point B to point C, he is willing to give up only 2 units of Banana(Y) to obtain 1 unit of Orange (X), so the MRS is 2($\Delta Y/\Delta X$ =4/2). Having still less of Banana and more of Orange at point D, the consumer is willing to give up only 1 unit of Banana so as to obtain 3 units of Orange. In this case, the MRS falls to ⅓. In general, as the amount of Y increases, the marginal utility of additional units of Y decreases. Similarly, as the quantity of X decreases, its marginal utility increases. In addition, the MRS decreases as one move downwards to the right.

Marginal Utility and Marginal rate of Substitution

It is also possible to show the derivation of the MRS using MU concepts as follow.

Suppose the utility function for two commodities X and Y is defined as:

$U = f(X,Y)$

Since utility is constant on the same indifference curve:

$U = f(X,Y) = C$

The total differential of the utility function is:

$$dU = \frac{\partial U}{\partial X}dX + \frac{\partial U}{\partial Y}dY = 0$$

$$MU_X dX + MU_Y dY = 0$$

$$\frac{MU_X}{MU_Y} = -\frac{dY}{dX} = MRS_{X,Y}$$

Or, $$\frac{MU_Y}{MU_X} = -\frac{dX}{dY} = MRS_{Y,X}$$

Example

Suppose a consumer's utility function is given by $U = 5\frac{X^4}{Y^{-2}}$. Compute the $MRSX,Y.$

$$MRS_{X,Y} = \frac{MU_X}{MU_Y} \; MU_X = \frac{dU}{dX} \quad and \; MU_Y = \frac{dU}{dY}$$

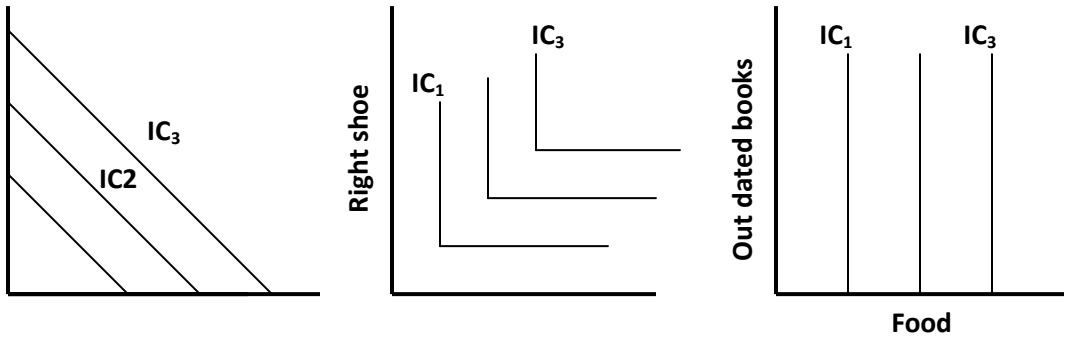
$$MU_X = 4(X^{4-1}Y^2) = 4(X^3Y^2) \quad and \quad MU_Y = 2(X^4Y^{2-1}) = 2X^4Y$$

$$MRS_{X,Y} = \frac{MU_X}{MU_Y} = \frac{4X^3Y^2}{2X^4Y} = 2\frac{Y}{X}$$

2.2.5 Special Indifference Curves

I. Perfect substitutes: If two commodities are perfect substitutes (if they are essentially the same), the indifference curve becomes a straight line with a negative slope. MRS for perfect substitutes is constant. (Panel a)

Fig.1.5 Special cases of indifference curves



Panel a Panel b Panel c

II. Perfect complements: If two commodities are perfect complements the indifference curve takes the shape of a right angle. Suppose that an individual prefers to consume left shoes (on the horizontal axis) and right shoes on the vertical axis in pairs. For example, if an individual has two pairs of shoes, additional right or left shoes provide no more utility for him/her. MRS for perfect complements is zero (both MRS_{XY} and MRS_{XY} is the same, i.e. zero).

III.A useless good: Panel C in the above figure shows an individual's indifference curve for food (on the horizontal axis) and an out-dated book, a useless good, (on the vertical axis). Since they are totally useless, increasing purchases of out-dated books does not increase utility. This person enjoys a higher level of utility only by getting additional food consumption. For example, the vertical indifference curve IC_2 shows that utility will be IC_2 as long as this person has some units of food no matter how many out dated books he/she has.

2.3 The Budget Line or the Price line

Anindifference curves only tell us about the consumer's preferences for any two goods but they can not tell us which combinations of the two goods will be chosen or bought. In reality, the consumer is constrained by his/her money income and prices of the two commodities. Therefore, in addition to consumer preferences, we need to know the consumer's income and prices of the goods. In other words, individual choices are also affected by budget constraints that limit people's ability to consume in light of prices they

must pay for various goods and services. Whether or not a particular indifference curve is attainable depends on the consumer's money income and on commodity prices. A consumer while maximizing utility is constrained by the amount of income and prices of goods that must be paid. This constraint is often presented with the help of the budget line constructing by alternative purchase possibilities of two goods.

The budget line is a line or graph indicating different combinations of two goods that a consumer can buy with a given income at a given prices. In other words, the budget line shows the market basket that the consumer can purchase, given the consumer's income and prevailing market prices.

2.3.1 Assumptions for the use of the budget line

In order to draw the budget line facing the consumer, we consider the following assumptions:

1. there are only two goods, X and Y, bought in quantities X and Y;
2. each consumer is confronted with market determined prices, Px and Py, of good X and good Y respectivley; and
3. the consumer has a known and fixed money income (M).

By assuming that the consumer spends all his/her income on two goods (X and Y), we can express the budget constraint as:

$M = P_X X + P_Y Y$ Where, P_X=price of good X

P_Y=price of good Y

X=quantity of good X

Y=quantity of good Y

M=consumer's money income

This means that the amount of money spent on X plus the amount spent on Y equals the consumer's money income.

Suppose for example a household with 30 Birr per day to spend on banana(X) at 5 Birr each and Orange(Y) at 2 Birr each. That is, $P_X = 5, P_Y = 2, M = 30 birr$.

Therefore, our budget line equation will be: $5X + 2Y = 30$

Table 1.6 Alternative purchase possibilities of the two goods

Consumption Alternatives	**A**	**B**	**C**	**D**	**E**	**F**
Kgs of banana (X)	0	1	2	3	4	6
Kgs of Orange(Y)	15	12.5	10	7.5	5	0
Total Expenditure	30	30	30	30	30	30

At alternative A, the consumer is using all of his /her income for good Y. Mathematically it is the y-intercept (0, 15). And at alternative F, the consumer is spending all his income for good X. mathematically; it is the x-intercept (6, 0). We may present the income constraint graphically by the budget line whose equation is derived from the budget equation.

$$M = P_X X + P_Y Y$$
$$M - XP_X = YP_Y$$

By rearranging the above equation we can derive the general equation of a budget line,

$$Y = \frac{M}{P_Y} - \frac{P_X}{P_Y} X$$

$\frac{M}{P_Y}$ = Vertical Intercept (Y-intercept), when X=0.

$-\frac{P_X}{P_Y}$ = slope of the budget line (the ratio of the prices of the two goods)

The horizontal intercept (i.e., the maximum amount of X the individual can consume or purchase given his income) is given by:

$$\frac{M}{P_Y} - \frac{P_X}{P_Y} X = 0$$
$$\frac{M}{P_Y} = \frac{P_X}{P_Y} X$$

$$X = \frac{M}{P_X}$$

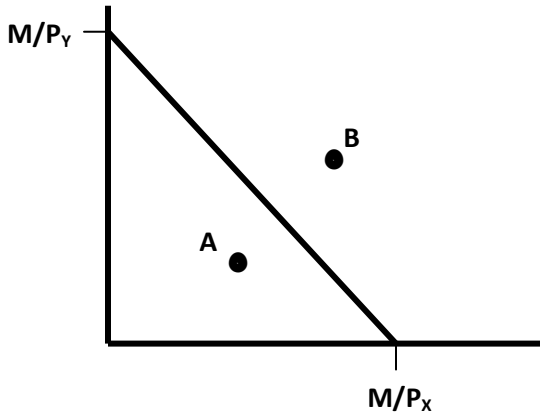


Fig.1.6 Derivation of the Budget Line

Therefore, the budget line is the locus of combinations or bundle of goods that can be purchased if the entire money income is spent.

2.3.2 Factors Affecting the Budget Line

2.3.2.1 Effects of changes in income

If the income of the consumer changes (keeping the prices of the commodities unchanged) the budget line also shifts (changes).

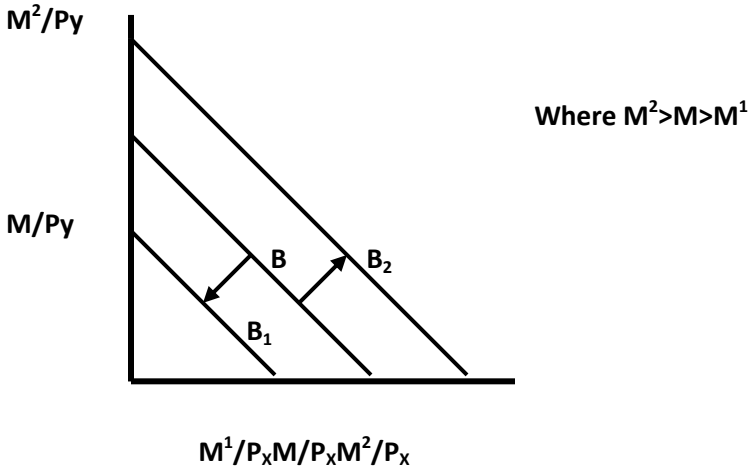


Fig.1.7 Effects of change in income

Increase in income causes an upward shift of the budget line that allows the consumer to buy more goods and services and decreases in income causes a downward shift of the budget line that leads the consumer to buy less quantity of the two goods. It is important

to note that the slope of the budget line (the ratio of the two prices) does not change when income rises or falls. The budget line shifts from B to B1 when income decreases and to B2 when income rises.

2.3.2.2Effects of Changes in Price of the commodities

Disproportional changes in the prices of the commodities change the position and the slope of the budget line, but proportional increases or decreases in the price of the two commodities (keeping income unchanged) do not change the slope of the budget line if it is in the same direction.

A. Price of x falls, while price of good Y & money incme remaining constant

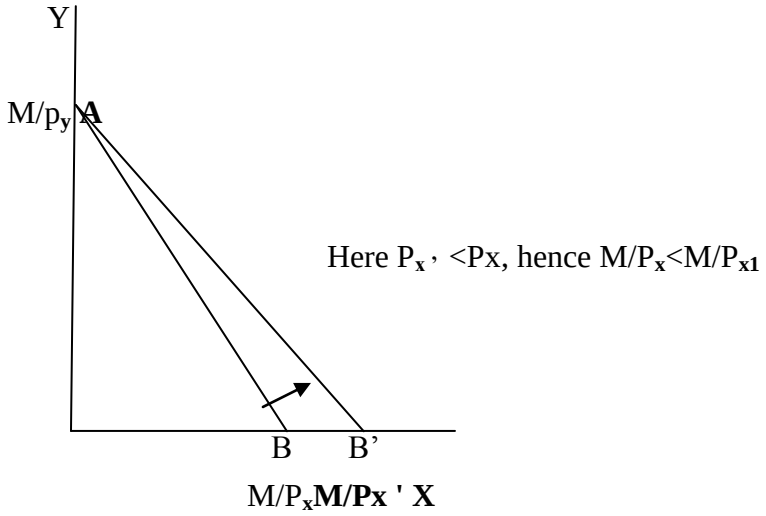


Fig. 1.8 Effect of a decrease in price of x on the budget line

Since the Y-intercept (M/Py) is constant, the consumer can purchase the same amount of Y by spending the entire money income on Y regardless of the price of X. We can see from the above figure that a decrease in the price of X, money income and price of Y held constant, pivots the budget line out-ward, as from AB to AB'.

B. Price of x rises, while price of good Y & money incme remaining constant

Since the Y-intercept (M/Py) is constant, the consumer can purchase the same amount of Y by spending the entire money income on Y regardless of the price of X. We can see from the figure below that an increase in the price of X, money income and price of Y held constant, pivots the budget line in-ward, as from AB to AB'.

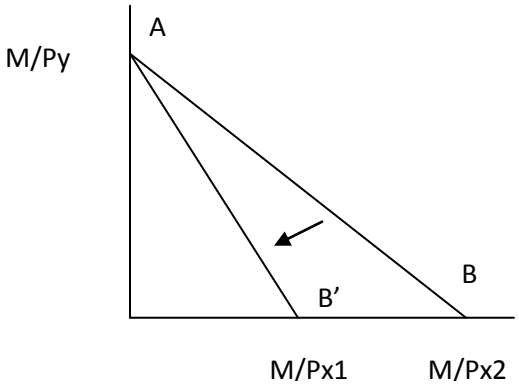


Fig. 1.9 Effect of an increase in price of x on the budget line

C. Price of Y rises, while price of good X & money incme remaining constant

Since the X-intercept (M/Py) is constant, the consumer can purchase the same amount of X by spending the entire money income on X regardless of the price of Y. We can see from the above figure that an increase in the price of Y, money income and price of X held constant, pivots the budget line in-ward, as from AB to A'B.

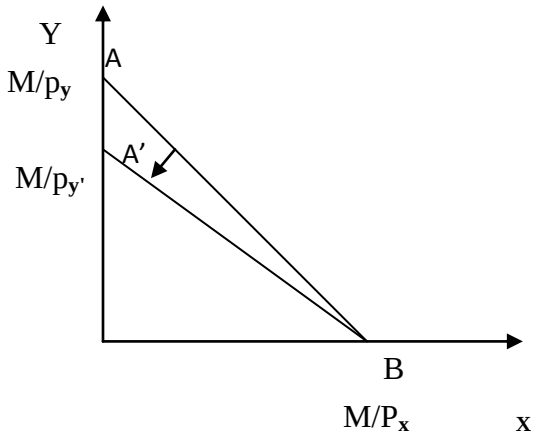


Fig.1.10 Effect of a raise in price of Y on the budget line

D. Price of Y falls, while price of good Y & money incme remaining constant

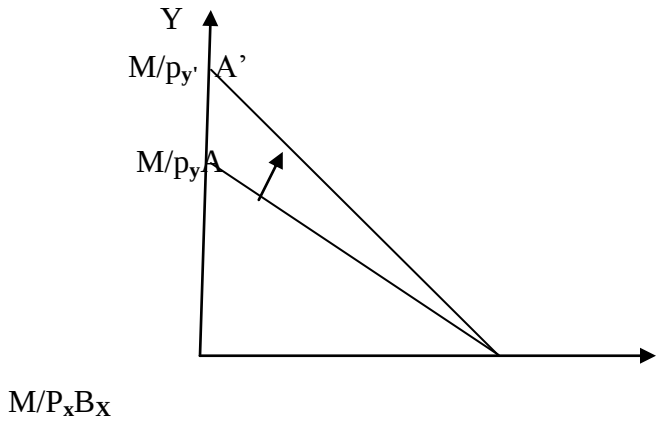


Fig.1.11 Effect of a fall in price of Y on the budget line

The above figure shows what happens to the budget line when the price of Y decreases while the price of good X and money income held constant. Since P_y decreases, M/P_y increases thereby the budget line shifts outward.

Numerical Example

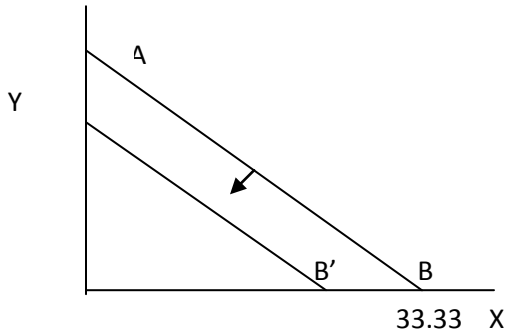
A person has $ 100 to spend on two goods(X,Y) whose respective prices are $3 and $5.

a) Draw the budget line.
b) What happens to the original budget line if the budget falls by 25%?
c) What happens to the original budget line if the price of X doubles?
d) What happens to the original budget line if the price of Y falls to 4?

The budget line for two commodities expressed as: $P_X X + P_Y Y = M$

$$3X + 5Y = 100$$
$$5Y = 100 - 3X$$
$$Y = \frac{100}{5} - \frac{3}{5}X$$
$$Y = 20 - \frac{3}{5}X$$

When the person spends all of his income only on the consumption of good Y, we can get the Y intercept that is(0,20).However, when the consumer spends all of his income on the consumption of only good X, then we get the X intercept that is (33.33,0). Using these two points we can draw the budget line. Thus, the budget line will be:



If the budget decreases by 25%, then the budget will be reduced to 75.As a result the budget line will be shifted in-ward that is indicated by (A'B').This forces the person to buy less quantity of the two goods. The equation for the new budget line solved as:

$$3X + 5Y = 75$$
$$5Y = 75 - 3X$$
$$Y = \frac{75}{5} - \frac{3}{5}X$$
$$Y = 15 - \frac{3}{5}X$$

Therefore, the Y-intercept is 15 while the X-intercept is 25.However, since the ratio of the prices does not change the slope of the budget line remains constant.

If the price of good X doubles the equation of the budget line will be $6X + 5Y = 100$ and if the price of good Y falls to 4, the equation for the new budget line will be $6X + 4Y = 100$.

2.4 Optimum of the Consumer

Rational consumer seeks to maximize his utility or satisfaction by spending his or her income. It maximizes the utility by trying to attain the highest possible indifference curve, given the budget line. This occurs where an indifference curve is tangent to the budget line so that the slope of the indifference curve (MRS_{XY}) is equal to the slope of the budget line (P_X / P_Y).

Thus, the condition for utility maximization, consumer optimization, or consumer equilibrium occurs where the consumer spends all income (i.e. he/she is on the budget line) and the slope of the indifference curve equals to the slope of the budget line $MRS_{XY} = P_X / P_Y$.

The preferences of the consumer (what he/she wishes) are indicated by the indifference curve and the budget line specifies the different combinations of X and Y the consumer can purchase with the limited income. Therefore, the consumer tries to obtain the highest possible satisfaction with in his budget line. However, the consumer cannot purchase any bundle lying above and to the right of the budget line. Because Indifference curves above the region of the budget line are beyond the reach of the consumer and are irrelevant for equilibrium consideration. The question then arises as to which combinations of X and Y the rational consumer will purchase.

Graphically, the consumer optimum or equilibrium is depicted as follows:

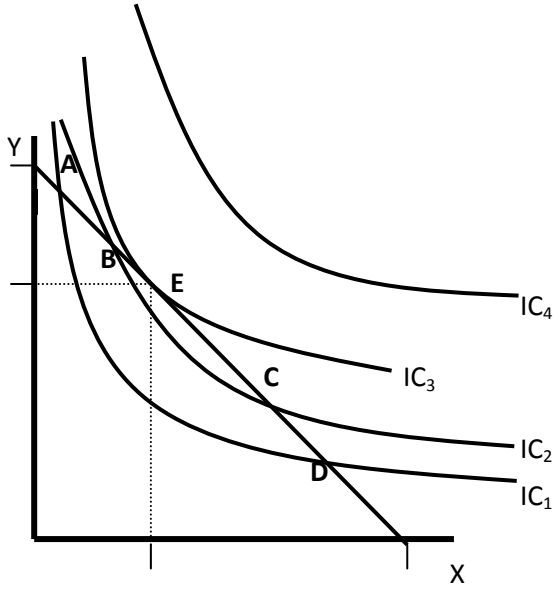


Figure1.12 Consumer equilibrium

At point 'A' on the budget line, the consumer gets IC_1 level of satisfaction. When he/she moves down to point 'B' by reallocating his total income in favor of X he/she derives greater level of satisfaction that is indicated by IC_2. Thus, point 'B' is preferred to point 'A'. Moving further down to point 'E', the consumer obtains the greatest level of satisfaction (IC3) relative to other indifference curves.

Therefore, point 'E' (which represents combination X and Y) is the most preferred position by the consumer since he/she attains the highest level of satisfaction within his/her reach and point 'E' is known as the point of consumer equilibrium (or consumer optimum). This equilibrium occurs at the point of tangency between the highest possible indifference curve and the budget line. Put differently, equilibrium is established at the point where the slope of the budget line is equal to the slope of the indifference curve.

Mathematical derivation of equilibrium

Suppose that the consumer consumes two commodities X and Y given their prices by spending level of money income M. Thus, the objective of the consumer is maximizing his utility function subject to his limited income and market prices. In utility maximization, the function that represents the objective that the consumer tries too achieve is called the objective function and the constraint that the consumer faces is represented by the constraint function.

The maximization problem will be formulated as follows:

$$Maximize U = f(X,Y)$$

$$Subject\ to\ P_X X + P_Y Y = M$$

We can rewrite the constraint as follows:

$$M - P_X X + P_Y Y = 0 \quad or \quad P_X X + P_Y Y - M = 0$$

Multiplying the constraint by Lagrange multiplier λ

$$\lambda(M - P_X X + P_Y Y) = 0$$

Forming a composite function gives as the Lagrange function:

$$\lambda = U(X,Y) + \lambda(M - P_X X + P_Y Y)$$

Or, $$\lambda = U(X,Y) - \lambda(P_X X + P_Y Y - M)$$

The first order condition requires that the partial derivatives of the Lagrange function with respect to the two goods and the langrage multiplier be zero.

$$\frac{\partial \lambda}{\partial X} = \frac{\partial U}{\partial X} - \lambda P_X = 0 \; ; \frac{\partial \lambda}{\partial Y} = \frac{\partial U}{\partial Y} - \lambda P_Y = 0 \; and \; \frac{\partial \lambda}{\partial \lambda} = -(P_X X + P_Y Y - M) = 0$$

From the above equations we obtain:

$$\frac{\partial U}{\partial X} = \lambda P_X \quad and \quad \frac{\partial U}{\partial Y} = \lambda P_Y$$

$$\frac{\partial U}{\partial X} = MU_X \quad and \frac{\partial U}{\partial Y} = MU_Y$$

Therefore, substituting and solving for λ we get the equilibrium condition:

$$\lambda = \frac{MU_X}{P_X} = \frac{MU_Y}{P_Y}$$

By rearranging we get:

$$\frac{MU_X}{MU_Y} = \frac{P_X}{P_Y}$$

The second order condition for maximum requires that the second order partial derivatives of the Lagrange function with respect to the two goods must be negative.

$$\frac{\partial \lambda^2}{\partial X^2} = \frac{\partial U^2}{\partial X^2} < 0 \quad and \quad \frac{\partial \lambda^2}{\partial Y^2} = \frac{\partial U^2}{\partial Y^2} < 0$$

Example

A consumer consuming two commodities X and Y has the following utility function $U = XY + 2X$ .If the price of the two commodities are 4 and 2 respectively and his/her budget is birr 60.

a) Find the quantities of good X and Y which will maximize utility.
b) Find the $MRS_{X,Y}$ at optimum.

Solution

The Lagrange equation will be written as follows:

$$\lambda = XY + 2X + \lambda(60 - 4X - 2Y)$$

$$\frac{\partial \lambda}{\partial X} = Y + 2 - \lambda 4 = 0 \; \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (1)$$

$$\frac{\partial \lambda}{\partial Y} = X - \lambda 2 = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\frac{\partial \lambda}{\partial \lambda} = 60 - 4X - 2Y = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

From equation (1) we get $Y + 2 = 4\lambda$ and from equation (2) we get $X = 2\lambda$.Thus, we can get that $X = \frac{Y+2}{2}$ and equation (2) gives as $\lambda = \frac{1}{2}X$.

By substituting $X = \frac{Y+2}{2}$ in to equation (2) we get $Y = 14$ *and* $X = 8.$

B. $MRS_{X,Y} = \frac{MU_X}{MU_Y} = \frac{Y+2}{X}$

After inserting the optimum value of Y=14 and X=8 we get 2 which equals to the price ratio of the two goods $(\frac{P_X}{P_Y} = \frac{4}{2} = 2)$.

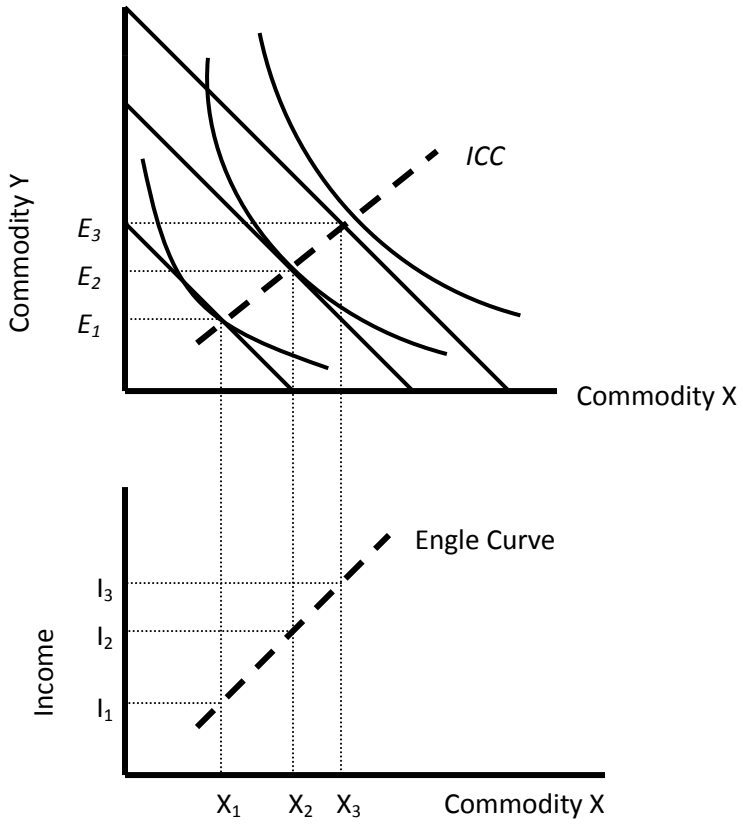
2.4 Optimum of the Consumer

2.4.1 Effects of Changes in Income and Prices on Consumer

2.4.1.1 Changes in Income: Income Consumption Curve and the Engel Curve

In our previous discussion, we noted that an increase in the consumer's income (all other things held constant) results in an upward parallel shift of the budget line. This allows the consumer to buy more of the two goods. And when the consumer's income falls, ceteris paribus, the budget line shifts downward, remaining parallel to the original one.

If we connect all of the points representing equilibrium market baskets corresponding to all possible levels of money income, the resulting curve is called the ***Income consumption curve (ICC)*** or ***Income expansion curve (IEC)***. The Income Consumption Curve is a curve joining the points of consumer optimum (equilibrium) as income changes (ceteris paribus). Or, it is the locus of consumer equilibrium points resulting when only the consumer's income varies.



From the Income Consumption Curve we can derive the Engle Curve. The Engle curve is named after Ernest Engel, the German Statistician who pioneered studies of family budgets and expenditure positions

The Engle Curve is the relationship between the equilibrium quantity purchased of a good and the level of income. It shows the equilibrium (utility maximizing) quantities of a commodity, which a consumer will purchase at various levels of income; (celeries paribus) per unit of time.

In relation to the shape of the income-consumption and Engle curves goods can be categorized as normal (superior) and inferior goods. Thus, commodities are said to be normal, when the income consumption curve and its Engle curve are positively sloped; meaning that more of the goods are purchased at higher levels of income. On the other

hand, commodities are said to be inferior when the income consumption curve and Engle curve is negatively sloped, i.e. their purchase decreases when income increases.

For example, in the figure below good Y is a normal good while good X is a normal good until the person's level of income reaches M_2 .Thus, when income increases beyond M_2, the person will buy less of good X as his income increases. Therefore, good X is a normal good Up to point A and becomes an inferior good as the income consumption curve bends backward.

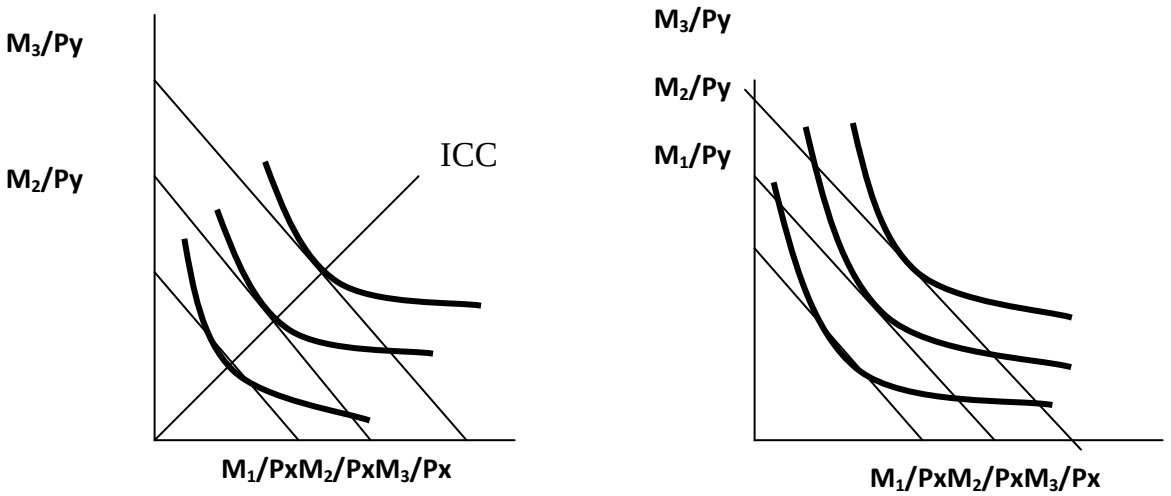


Figure 1.14 income consumption curves

2.4.1.2 Changes in Price: Price Consumption Curve and Individual Demand Curve

We now look at the second factor that affects the equilibrium of the consumer that is price of the goods. The effect of price on the consumption of good is even more important to economists than the effect of changes in income. Here, we hold money income constant and let price change to analyze the effect on consumer behavior.

In our earlier previous discussion, we have seen that an increase in the price of good X, for example, increases the absolute value of the slope of the budget line, but it does not affect the vertical (Y) intercept of the line. Thus, the change in the price of x will result in out ward shift of the budget line that makes the consumer to buy more of good x.If we connect all the points representing equilibrium market baskets corresponding to each price of good X we get a curve called ***price-consumption curve***.

The price-consumption curve is the locus of the utility-maximizing combinations of products that result from variations in the price of one commodity when other product prices, the money income and other factors are held constant.

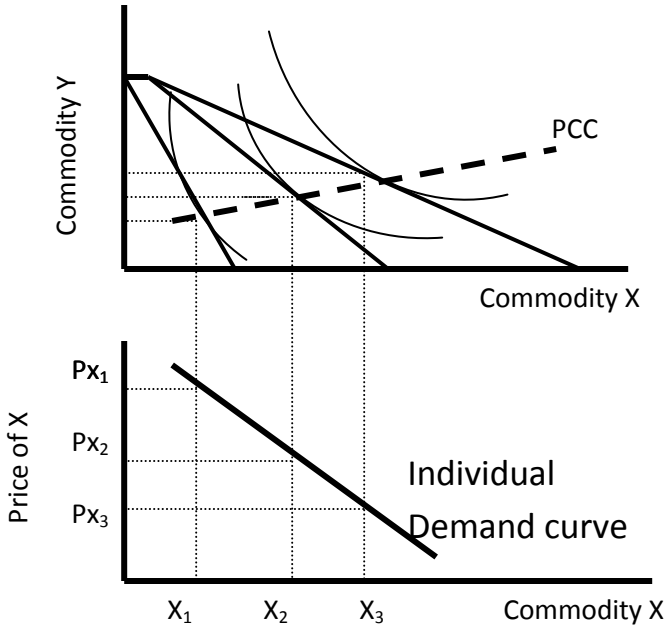


Figure1.15 the PPC and derivation of the demand curve

2.4.2 Decomposition of Income and Substitution Effects (Normal, inferior and giffen goods)

We have noted that there are two effects of a price change. If price falls (rises), the good becomes cheaper (more expensive) relative to other goods; and consumers substitute toward (away from) the good. This is the substitution effect. Also, as price falls (rises), the consumer's purchasing power increases (decreases). Since the set of consumption opportunities increases (decreases) as price changes, the consumer changes the mix of his or her consumption bundle. This effect is called the income effect. Let us analyze each effect in turn, and then combine the two in order to see why demand is assumed to be downward sloping.

A. Let us Consider the case of a price-decline:

First a decrease in price increases the consumer's real income (purchasing power), thus enhancing the ability to buy more goods and services to some extent. Second, a decrease in the price of a commodity induces some consumers (the consumer) to substitute it for others, which are now relatively expensive (higher price) commodities.The 1st effect is known as the income effect, and the 2nd effect is known as the substitution effect. The combined effect of the two is known as the total effect (net effect).

A. Case of Normal Good

Suppose initially the income of the consumer is I_1, price of goodY is Py_1, and Price of good X is Px_1, we have the budget line with y-intercept $\frac{I}{Py_1}$ and X-intercept $\frac{I}{Px_1}$. The consumer's equilibrium is point **A** that indicates the point of tangency between the budget line and indifference curve IC_1.

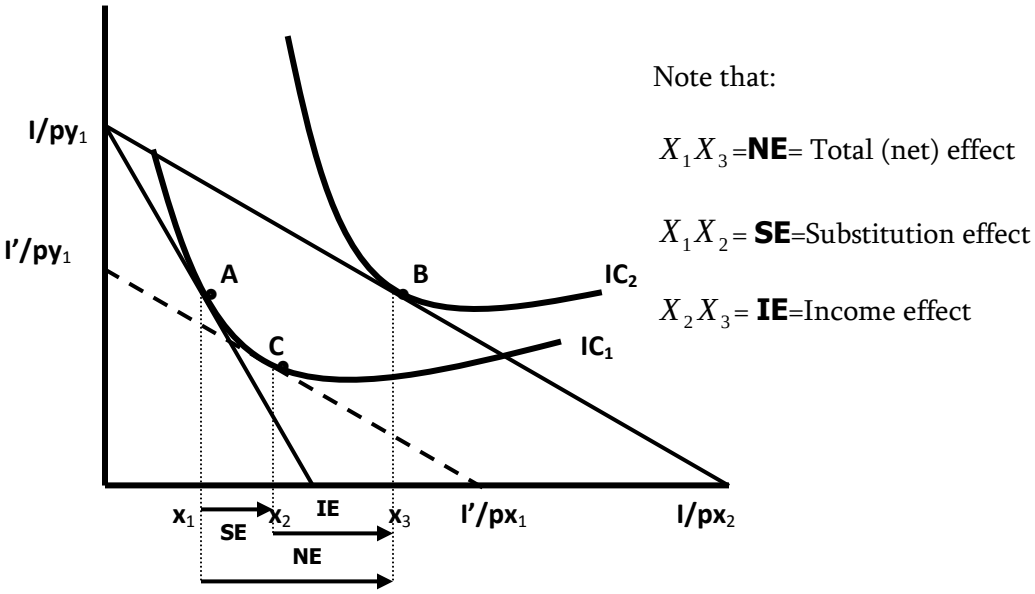


Figure1.16 Income and Substitution effect for a normal good

As a result of a decrease in the price of X from Px_1 to Px_2 the budget line shifts outward with Y-intercept $\frac{I}{Py_1}$ & X-Intercept $\frac{I}{Px_2}$. The consumer's new equilibrium will be on point B.

The total change in the quantity purchased of commodity X from the 1st equilibrium point at A to the second equilibrium point at B shows the Net effect or total effect of the price decline (change).

The total effect of the price change can be conceptually decomposed into the substitution effect and income effect.

The Substitution Effect

The substitution effect refers to the change in the quantity demanded of a Commodity resulting exclusively from a change in its price when the consumer's real income is held constant; thereby restricting the consumer's reaction to the price change to a movement along the original indifference curve. The decline in the price of X results in an increase in the consumer's real income, as evidenced by the movement to a higher indifference curve even though money income remains fixed.

Now, imagine that we decrease the consumer's income by an amount just sufficient to return to the same level of satisfaction enjoyed before the price decline. Graphically, this is accomplished by drawing a fictitious (imaginary) line of attainable combinations with a slope corresponding to new ratio of the product price $\frac{Px_2}{Py_1}$ so that it is just tangent to the original indifference curve IC_1.

The point of tangency is the imaginary point **C** (imaginary equilibrium). The movement from point **A** to the imaginary intermediate equilibrium at point **C**, which shows increase in consumption of X from X_1 to X_2 is the substitution effect.In other words, the effect of a decrease in price encourages the consumer to increase consumption of X than Y.

The Income Effect

The income effect may be defined as the change in the quantity demanded of a commodity exclusively associated with a change in real income. The income effect is

determined by observing the change in the quantity demanded of a commodity that is associated solely with the change in the consumer's real income.

In figure 1.16, letting the consumer's real income rise from its imaginary level (defined by the line of attainable combinations tangent to point **C**) back to its true level (defined by the line of attainable combinations tangent to point **B**) gives the income effect. Thus, the income effect is indicated by the movement from the imaginary equilibrium at point **C** to the actual new equilibrium at point **B**, the increase in the quantity of X purchased from X_2 to X_3 is the income effect.

The income effect of a change in the price of good shows the change in quantity demanded via change in real income, while the relative price ratio remains constant. This movement does not involve any change in prices; the price ratio is the same in budget line 1 as in budget line 2. It is due to a change in total satisfaction and such a change is a movement from one indifference curve to another.

When we look at both the substitution and income effects, the magnitude of the substitution effect is greater than that of the income effect. The reason is that:

- Most goods have suitable substitutes and when the price of good falls, the quantity of the good purchased is likely to increase very much as consumers substitute the now cheaper good for others.
- Spending only a small fraction of his /her income, i.e. with the consumers purchasing many goods and spending only a small fraction of their income on any one good, the income effect of a price change of any one good is likely to be small.

Usually, the income and substitution effects reinforce one another i.e. they operate in the same direction. The substitution effect is always negative. i.e. if the price of a good X increases and real income is held constant, there will always be a decrease in the consumption of good X, and vise versa. This result follows from the fact that indifference

curves have negative slopes. However, the income effect is not predictable from the theory alone. In most cases, one would expect that increases in real income would result in increases in consumption of a good. This is the case for so called Normal goods.

In short in the case of normal goods, the income effect and the substitution effect operate in the same direction –they reinforce each other. But not all goods are normal. Some goods are called inferior goods because the income effect is the opposite (of that of a normal good) for them-they operate in opposite direction.

B. Case of Inferior Goods

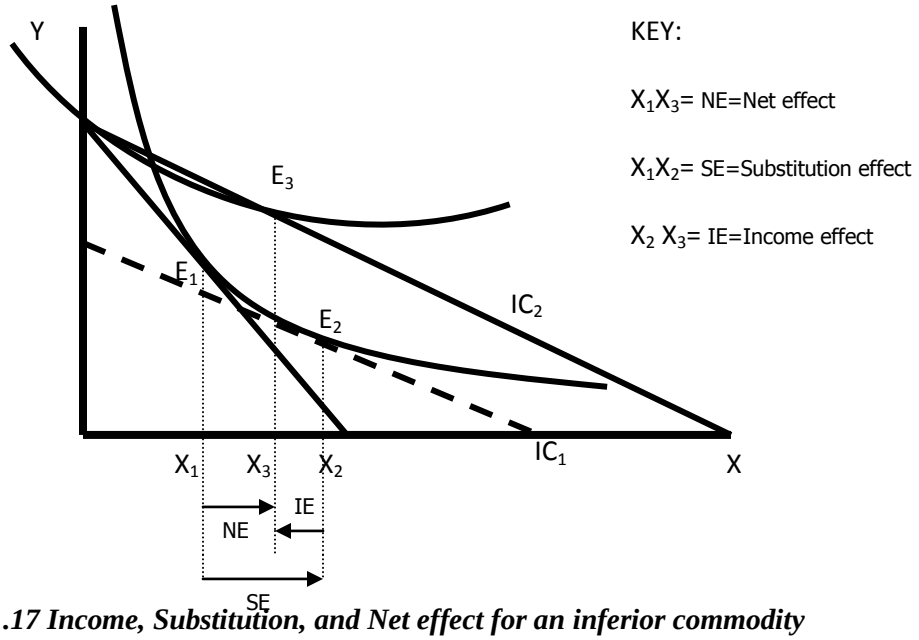


Figure 1.17 Income, Substitution, and Net effect for an inferior commodity

For an inferior good, a decrease in the price of the commodity causes the consumer to buy more of it (the substitution effect), but at the same time the higher real income of the consumer tends to cause him to reduce consumption of the commodity (the income effect). We usually observe that the substitution effect still is the more powerful of the two; even though the income effect works counter to the substitution effect, it does not override it. Hence, the demand curve for inferior goods is still negatively sloped. The above diagram that shows the income, substitution and net effect for an **inferior commodity** in the case of a decline in the price of good X.

In very rare occasions, a good may be so strongly inferior that the income effect actually overrides the substitute effect. Such an occurrence means that a decline in the price of a good would lead to a decline in the quantity demanded and that a rise in price will induce an increase in quantity demanded. In other words, price and quantity move in the same direction. The name given to such a unique situation is Giffen paradox; and it constitutes an exception to the Law of demand. That is for Giffen goods the income effect (which decreases the quantity demanded) is so strong that it offsets the substitution effect (which increases the quantity demanded), with the result that the quantity demanded is directly related to the price, at least over some range of variation of price.

C. Case of Giffen Goods

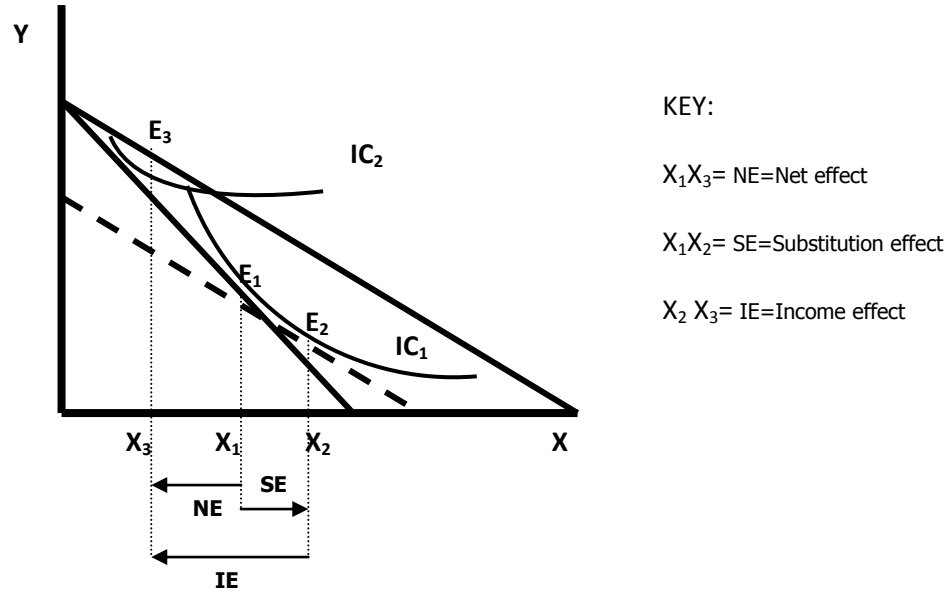


Figure 1.18 Income, Substitution and net effects for a Giffen good, When there is a price decline.

2.4.3 Derivation of market demand curve

The market demand curves can be derived as the sum of the individual demand curves of allconsumers in a particular market.

To keep things simple, let's assume that only three consumers **(A, *B,* and *C)*** are in the market for coffee. The following table tabulates several points on each of theseconsumers' demand curves.

(1)price per kg Birr	(2) individual A (utils)	(3) individual B (utils)	(4) individual C (utils)	(5) Market (utils)
10	6	10	16	32
20	4	8	13	25
30	2	6	10	18
40	0	4	7	11
50	0	2	4	6

The market demand column **(5),** is found byadding columns (2), (3), and (4) to determine the total quantity demanded at every price. For example, when the price is $3, the total quantity demanded is 2 + 6 + 10, or 18.

We sum horizontally to find the total amount that the three consumers will demand at any given price. For example, when the price is $40, the quantity demanded by the market (11 units) is the sum of the quantity demanded by **A** (no units), by B (4 units), and by ***C*** (7 units). Because all the individual demand curves slope downward, the market demand curve will also slope downward. However, the market demand curve need not be a straight line, even though each of the individual demand curves is so.

The aggregation of individual demands into market demands is not just a theoretical exercise. It becomes important in practice when market demandsare built up *from* the demands of different demographic groups or from consumers located in different areas.

For example, we might obtain information about the demand for home computers by adding independently obtained information about the demands of (i) households with children, (ii) households without children, and (iii) single individuals. Or we might determine the Ethiopia demand for natural gas by aggregating -the demands for natural gas of the major regions (Oromiya, Amara, SNNP, Tigray, and West, for example).

2.5 Elasticity of demand

Law of demand indicates only the direction of change in quantity demanded in response to a change in price. This does not tell us by how much or to what extent the quantity demanded of a good will change in response to change in its price. This information as to how much or to what extent the quantity demanded of a good will change as a result of a change in its price is provided by the concept of elasticity of demand. The concept of elasticity of demand refers to the degree of responsiveness of quantity demanded of a good to a change in its price, consumer's income and prices of related goods. Accordingly, there are three concepts of demand elasticity:

- Price elasticity
- Income elasticity
- Cross elasticity

I. Price elasticity of Demand

It indicates the degree of responsiveness of quantity demanded of a good to the change in its price, other factors such as income, price of related commodities that determine demand are held constant. And mathematically can be calculated as:

Price elasticity of demand (e_p) $= \frac{percenatage\ change\ in\ quantity\ demanded}{percentage\ chnage\ in\ price}$

$E_p = \%\Delta Q_d / \%\Delta P$

$$\frac{\%\Delta Qd}{\%\Delta P} = \frac{(Q1-Qo)/Qo*100}{(P1-Po)/Po*100} = \frac{(Q1-Qo)*Po}{(P1-Po)*Qo} = \frac{(Q1-Qo)}{(P1-Po)}*\frac{Po}{Qo}$$

where, Ep = price elasticity of demand

ΔQd = change in quantity demanded

ΔP = change in price

$NB: -Ep = Ed$

$Ep = \Delta Qd/\Delta P * Po/Qo$ It is known as point price elasticity of demand

We also use another formula to determine price elasticity of demand if the change in price is substantiallylarge. This is called Arc price elasticity of demand or mid-point

elasticity of demand. And measures the average responsiveness of quantity demanded between two points on the demand curve to change in price other things remaining constant. Mathematically,

$E_p = \frac{\%\Delta Qd}{\%\Delta P}$

$= \left(\frac{Q1-Q0}{Q1+Q0}\right) * 100\% \ \left(\frac{P1-P0}{P1+P0}\right) * 100\%$

$= \left(\frac{Q1-Q0}{Q1+Q0}\right) * \left(\frac{P1+P0}{P1-P0}\right) = \left(\frac{Q1-Q0}{P1-P0}\right) * \left(\frac{P1+P0}{Q1+Q0}\right)$

$E_p = \left(\frac{\Delta Qd}{\Delta P}\right) *) * \left(\frac{P1+P0}{Q1+Q0}\right)$

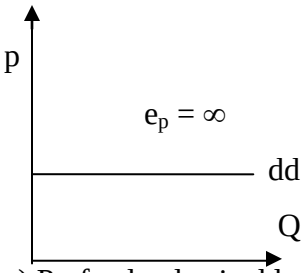
NB: - when the change in price is quite large, say more than 5 percent, and also when we want to measure elasticity between two points then accurate measure of price elasticity of demand can be obtained by taking the average of original price and subsequent price as well as average of the original quantity and subsequent quantity as the basis of measurement of percentage changes in price and quantity. Moreover

- ✓ E_p is unit free because it is a ratio of percentage change
- ✓ E_p is usually a negative number because of the law of demand i.e. negative relationship between price and quantity demand. So we can take the absolute value of /Ep/.

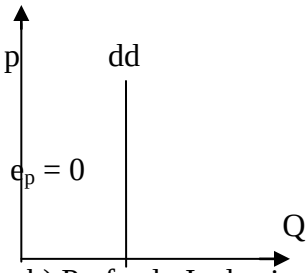
The main reason for differences in elasticity of demand is the possibility of substitution i.e. the presence or absence of competing substitutes. The greater the ease with which substitutes can be found for a commodity or with which it can be substituted for other commodities, the greater will be the price elasticity of demand of that commodity. The demand for salt is inelastic since it satisfies a basic human want and no substitutes for it are available. People would consume almost the quantity of salt whether it become slightly cheaper or dearer than before.

Perfectly elastic and perfectly inelastic: in perfectly inelastic whatever the price, quantity demanded of the commodity remains unchanged. An approximate example of perfectly inelastic demand is the demand of acute diabetic patient for insulin. Because he/she has to get the prescribed doze of insulin per week whatever its price. In perfectly elastic

demand the horizontal demand curve for a product implies that a small reduction in price would cause the buyers to increase the quantity demanded from zero to all they could obtain. On the other hand, a small rise in price of the product will cause the buyers to switch completely away from the product so that its quantity demanded falls to zero. The perfectly elastic demand curve found for the product of an individual firm working under perfect competition. Products of different firms working under perfect competition are completely identical. If any perfectly competitive firm raises the price of its product, it would lose all its customers who would switch over to other firms and if it reduces its price somewhat it would get all the customers to buy the product from it.



a) Perfectly elastic dd curve



b) Perfectly Inelastic dd curve

II. Cross elasticity of demand

Degree of responsiveness of demand for one good in response to the change in prices of another good represents the cross elasticity of demand of one good for the other.

We can measure the responsiveness or sensitivity in the quantity purchased of commodity X as a result of a change in the price of commodity Y by the cross elasticity of demand (E_{xy}). This is given by:

Coefficient of cross elasticity = $\frac{percentage\ change\ in\ the\ quantity\ demanded\ of\ X}{percentage\ change\ in\ the\ price\ of\ good\ Y}$

Exy = $\frac{\Delta Qx}{\Delta P_Y} . \frac{P_{Y_0}}{Qx_0}$ ---------- point formula

Exy = $\frac{\Delta Q_x}{\Delta P_Y} . \left(\frac{Py_1 + Py_2}{Qx_1 + Q_2} \right)$ ---------- Arc Formula

- ✓ Substitute goods, Exy>0.
- ✓ Complement goods, Exy< 0
- ✓ Unrelated goods ,Exy = 0,

III. **Income Elasticity (E1**)

Income elasticity of demand shows the degree of responsiveness of quantity demanded of a good to a small change in the income of consumers. And this is measured by:

Income elasticity = $\frac{percentage\ change\ in\ the\ quantity\ demanded}{percentage\ change\ in\ income}$

$E_I = \frac{\%\Delta Qd}{\%\Delta I} = \left(\frac{Q_1 - Q_0}{I_1 - I_0}\right)\left(\frac{I_0}{Q_0}\right) = \frac{\Delta Qd}{\Delta I} * \frac{I_0}{Q_0}$ …….. Point income elasticity of demand

$\overline{E}_I \left(\frac{Q_1 - Q_0}{I_1 - I_0}\right)\left(\frac{I_1 + I_0}{Q_1 + Q_0}\right)$ ……Arc income elasticity of demand formula

The result for income elasticity can be:

a) Positive ($E_I > 0$): if it is Normal Goods that Consumption of the goods varies directly (positively) with income i.e. when income increases consumption of these goods also increases& vice Versa.
   - ✓ A good having income elasticity more than one and which therefore bulks larger in consumer's budget as he becomes richer is called a luxury.
   - ✓ A good with an income elasticity less than one and which claims declining proportion of consumer's income as he becomes richer is called a necessity.
   - ✓ When income elasticity of demand for a good is equal to one, then proportion of income spent on the good remains the same as consumer's income increases.

b) Negative ($E_I < 0$): if it is inferior goods in such increase in income will lead to the fall in quantity demanded of the goods.

c) $E_I = 0$, means consumption of the good does not vary with income, e.g. salt

CHAPTER TWO
CHOICE –INVOLVING RISK AND UNCERTAINTY

2.1. Introduction

So far we have assumed that prices, incomes, and other variables are known with certainty. However, many of the choices that people make involve considerable uncertainty. For example, most people borrow to finance large purchases, such as a house or a college education, and plan to pay for the purchase out of future income. But for most of us, future incomes are uncertain. Our earnings can go up or down; we can be promoted, demoted, or even lose our jobs. Or if we delay buying a house or investing in a college education, we risk having its price rise in real terms, making it less affordable. How should we take these uncertainties into account when making major consumption or investment decisions?

Sometimes we must choose how much risk to bear. What, for example, should you do with your savings? Should you invest your money in something safe such as a savings account or something riskier but potentially more lucrative such as the stock market? Another example is the choice of a job or even a career. Is it better to work for a large, stable company where job security is good but the chances for advancement are limited, or to join (or form) a new venture, which offers less job security but more opportunity for advancement?

To answer questions such as these, we must be able to quantify risk so we can compare the riskiness of alternative choices. We therefore begin this chapter by discussing measures of risk. Afterwards, we will examine people's preferences toward risk. (Most people find risk undesirable, but some people find it more undesirable than others.) Next, we will see how people can deal with risk. Sometimes risk can be reduced-by diversification, by buying insurance or by investing in additional information. In other situations (e.g., when investing in stocks or bonds), people must choose the amount of risk they wish to bear.

To describe risk quantitatively, we need to know all the possible outcomes of a particular action and the likelihood that each outcome will occur.' Suppose, for example, that you are considering investing in a company that is exploring for offshore oil. If the exploration effort is successful, the company's stock will increase from $30 to $40 a share; if not, it will fall to $20 a share. Thus, there are two possible future outcomes, a $40 per share price and a $20 per share price.

Probability refers to the likelihood that an outcome will occur. In our example, the probability that the oil exploration project is successful might be 1/4, and the probability that it is unsuccessful ***3/4.*** Probability is a difficult concept to formalize because its interpretation can depend on the nature of the uncertain events and on the beliefs of the people involved. One *objective* interpretation of probability relies on the frequency with which certain events tend to occur. Suppose we know that of the last 100 offshore oil explorations 25 have succeeded and 75 have failed. Then the probability of success of1/4 is objective because it is based directly on the frequency of similar experiences. But what if there are no similar past experiences to help measure probability? In these cases objective measures of probability cannot be deduced, and a more *subjective* measure is needed.

Subjective probability is the perception that an outcome will occur. This perception may be based on a person's judgment or experience, but not necessarily on the frequency with which a particular outcome has actually occurred in the past. When probabilities are subjectively determined, different people may attach different probabilities to different outcomes and thereby-make different choices. For example, if the search for oil were to take place in an area where no previous searches had ever occurred, I might attach a higher subjective probability than you to the chance that the project will succeed because I know more about the project, or because I have a better understanding of the oil business and can therefore make better use of our common information. Either different information or different abilities to process the same information can explain why subjective probabilities vary among individuals.

Whatever the interpretation of probability, it is used in calculating two important measures that help us describe and compare risky choices. One measure tells us the *expected value* and the other the *variability* of the possible outcomes.

2.2. Expected utility

To simplify things, we'll consider the consumption of a single commodity-the consumer's income, or more appropriately, the market basket that the income can buy. We assume that consumers know all probabilities, and (for much of this section) that payoffs are now measured in terms of utility.

Table 2.1a shows how we can describe a woman's preferences toward risk. The level of utility increases from 10 to 16 to 18, as income increases from $10,000 to $20,000 to $30,000. But marginal utility is diminishing, falling from 10 when income increases from 0 to $10,000, to 6 when income increases from $10,000 to $20,000, and "to 2 when income increases from $20,000 to $30,000.

Now suppose she has an income of $15,000 and is considering a new but risky sales job that will either double her income to $30,000 or cause it to fall to $10,000. Each possibility has a probability of .5. As table 2.1a shows, the utility level associated with an income of $10,000 is 10 (at point A), and the utility associated with a level of income of $30,000 is 18 (at E). The risky job must be compared with the current job, for which the utility is 13 (at B).

To evaluate the new job, she can calculate the expected value of the resulting income. Because we are measuring value in terms of the woman's utility, we must calculate the *expected utility E(u)* she can obtain. The expected utility is the sum of the utilities associated with all possible outcomes,weighted by the probability that each outcome will occur. In this case, expected utility is

$E(u) = (1/2)u(\$10{,}000) + (1/2)u(\$30{,}000=) \; 0.5(10) + 0.5(18) = 14$

The new risky job is thus preferred to the original job because the expectedutility of 14 is greater than the original utility of 13. The old job involved no risk-it guaranteed an-income of $15,000 and a utility level of 13. The new job is risky, but it offers both a higher expected income ($20,000) and, more important, a higher expected utility. If the woman wished to increase her expected utility, she would take the risky job.

Table 2.1 Differ in preferences toward risk

combination	A	B	C	D	E
Income	10000	15000	16000	20000	30000
Utility	10	13	14	16	16

(a)

Combination	A	C	E
Income	10000	20000	30000
Utility	3	8	16

(b)

Combination	A	C	E
Income	10000	20000	30000
Utility	6	12	16

(c)

In (a)consumer's marginal utility diminishes as income increases. The consumer is risk averse because she would prefer a certain income of $30000 (with a utility of 16) to a gamble with a .5 probability of $10,00O'and a 5 probability of $301000 (and expected utility of 14). In (b) the consumer is risk loving, because she would prefer the same gamble (with expected utility of 105) to the certain income (with a utility of 8). Finally, in (c) the consumer is risk neutral and is indifferent between certain events and uncertain events withthe same expected income.

2.3. Risk Choice

People differ in their willingness to bear risk. Some are risk averse, some riskloving, and some risk neutral. A person who prefers a certain given income to a risky job with the same expected income is described as being risk averse.(Such a person has a diminishing marginal utility of income.) Risk aversion is the most common attitude toward risk. To see that most people are risk averse most of the time, note the vast number of risks that

people insure against.Most people not only buy life insurance, health insurance, and car insurance, but also seek occupations with relatively stable wages.

Table 2.1a applies to a woman who is risk averse. Suppose she can have a certain income of $20,000, or a job yielding an income of $30,000 with probability .5 and an income of $10,000 with probability .5 (so that the expected income is $20,000). As we saw, the expected utility of the uncertain income is 14, an average of the utility at point A (10) and the utility at E **(18),** and is shown by ***C.*** Now we can compare the expected utility associated with the risky job to the utility generated if $20,000 were earned without risk. This utility level, 16, is given by D in table 2.1a. It is clearly greater than the expected utility associated with the risky job.

A person who is risk neutral is indifferent between a certain income and an uncertain income with the same expected value. In table 2.1c the utility associated with a job generating an income of either $10,000 or $30,000 wit$ equal probability is 12, as is the utility of receiving a certain income of $20,000.

Table 2.1b shows the third possibility-risk loving. In this case the expected utility of an uncertain income that will be either $10,000 with probability .5 or $30,000 with probability .5 is higher than the utility associated with a certain income of $20,000. Numerically,

E(u) = *.5u($10,000) + .5u($30,000) = .5(3) + .5(18) = 10.5* >u($20,000) = *8*

The primary evidence for risk loving is that many people enjoy gambling.

Some criminologists might describe criminals as risk lovers, especially when a robbery is committed that has a high prospect of apprehension and punishment.These special cases aside, few people are risk loving, at least with respect to major purchases or large amounts of income or wealth.'

2.4. Risk Diversification

Suppose that you plan to take a part-time job selling appliances on a commissionbasis. You can decide to sell only air conditioners or only heaters, or you can spend half your time selling each. Of course, you can't be sure how hot or cold the weather will be next year. How should you apportion your time to minimize the risk involved in the sales job? The answer is that riskcan be minimized by diversification-by allocating your time toward selling two or more products (whose sales are not closely related),rather than a single product. Suppose that there is a fifty-fifty chance that it will be a relatively hot year, and a fifty-fifty chance that it will be cold.

Table 2.2 Income from Sales of Equipment

	Hot weather	Cool weather
Air conditioner sales	30000	12000
Heater sales	12000	30000

The above table gives the earnings that you can make selling air conditioners and heaters. If you sell only air conditioners or only heaters, your actual income will be either $12,000 or $30,000 but your expected income will be $21,000 [.5($30,000) +. .5($12000)]. But suppose you diversify by dividing your time evenly between the two products. Then your income will certainly be $21,000, whatever the weather. If the weather is hot, you will earn $15,000 from air conditioner sales and $6000 from heater sales; if it is cold, you will earn $6000 from air conditioner sales and $151000 from heater sales. Hence, by diversifying you eliminate all risk.

Diversification is not always this easy. In our example heater and air conditioner sales were inversely related-whenever the sales of one were strong, the sales of the other were weak. But the principle of diversification is a general one. As long as you can allocate your effort or your investment funds toward a variety of activities whose outcomes are not closely related, you can eliminate some risk

2.5. Risk spreading

Consider thesituation of an individual who had $35,000 and faced a .01 probability of a $10,000 loss. Suppose that there were 1000 such individuals. Then, on average, there would be 10 losses incurred, and thus $100,000 lost each year. Each of the 1000 people would face an *expected loss* of .01 times $10,000, or $100 a year. Let us suppose that the probability that any person incurs a loss doesn't affect the probability that any of the others incur losses. That is, let us suppose that the risks are *independent.*

Then each individual will have an expected wealth of .99 × $35, 000 +.01×$25, 000 = $34, 900. But each individual also bears a large amount of risk: each person has a 1 percent probability of losing $10,000. Suppose that each consumer decides to *diversify* the risk that he or she faces. How can they do this? Answer: by selling some of their risk to other individuals. Suppose that the 1000 consumers decide to insure one another. If anybody incurs the $10,000 loss, each of the 1000 consumers will contribute $10 to that person. This way, the poor person whose house burns down is compensated for his loss, and the other consumers have the peace of mind that they will be compensated if that poor soul happens to be themselves! This is an example of **risk spreading**: each consumer spreads his risk over all of the other consumers and thereby reduces the amount of risk he bears.

Now on the average, 10 houses will burn down a year, so on the average, each of the 1000 individuals will be paying out $100 a year. But this is just on the average. Some years there might be 12 losses, and other years there might be 8 losses. The probability is very small that an individual would actually have to pay out more than $200, say, in any one year, but even so, the risk is there.

But there is even a way to diversify this risk. Suppose that the homeowners agree to pay $100 a year for certain, whether or not there are any losses. Then they can build up a cash reserve fund that can be used in those years when there are multiple fires. They are paying $100 a year for certain, and on average that money will be sufficient to compensate homeowners for fires.

Chapter Three

Theory of Production

3.1 Production Function

To an economist production means creation of utility for sales. Alternatively, production may be defined as the act of creating those goods/services which have exchange value for sale (not for personal consumption).Raw materials yield less satisfaction to the consumer by themselves. In order to get utility from raw materials, first they must be transformed into output. However, transforming raw materials into final products require factor inputs such as land, labor, and capital and entrepreneurial ability. Thus, no production (transforming raw material into output) can take place without the use of inputs.

Fixed Vs variable inputs

In economics, inputs can be classified as fixed & variable. ***Fixed inputs*** are those inputs whose quantity cannot readily be changed when market conditions indicate that an immediate change in output is required. In fact no input is ever absolutely fixed, but may be fixed during an immediate requirement. For example, if the demand for Beer shoots up suddenly in a week, the brewery factories cannot plant additional machinery over a night to respond to the increased demand. It takes long time to buy new machineries, to plant them and use for production. Thus, the quantity of machinery is fixed for some times such as a weak. Buildings, machineries and managerial personnel are examples of fixed inputs because their quantity cannot be manipulated easily in short time periods.

Variable inputs, on the other hand, are those inputs whose quantity can be changed almost instantaneously in response to desired changes in output. That is, their quantity can easily be diminished when the market demand for the product decreases and vise versa. The best example of variable input is unskilled labor.

In our previous example, if the brewery factory had idle machinery before the market demand shot up, the factory can easily and immediately respond to the market condition by hiring laborers.

Short run Vs. long run

In economics, ***short run*** refers to that period of time in which the quantity of at least one input is fixed. For example, if it requires a firm one year to change the quantities of all the inputs, those time periods below one year are considered as short run. Thus, short run is that time period which is not sufficient to change the quantities of all inputs, so that at least one input remains fixed. One thing to be noted here is that short run periods of different firms have different duration. Some firms can change the quantity of all their inputs with in a month while it takes more than a year to change the quantity of all inputs for another type of firms. For example, the time required to change the quantities of inputs in an automobile factory is not equal with that of flour factory. The later takes relatively shorter time. ***Long run*** is that time period (planning horizon) which is sufficient to change the quantities of all inputs. Thus there is no fixed input in the long - run.

3.2 Production in the short run: Production with one variable input

Production with one variable input (while the others are fixed) is obviously a short run phenomenon because there is no fixed input in the long run.

Assumption of short run production analysis

1. ***Perfect divisibility of inputs and outputs***

   This assumption implies that factor inputs and outputs are so divisible that one can hire, for example a fraction of labor, a fraction of manager and we can produce a fraction of output, such as a fraction of automobile.

2. ***Limited substitution between inputs***

   Factor inputs can substitute each other up to a certain point, beyond which they can not substitute each other

3***. Constant technology***

They assumed that level of technology of production is constant in the short run.

Suppose a firm that uses two inputs: Capital (which is a fixed input) and labor (which is variable input). Given the assumptions of short run production, the firm can increase output only by increasing the amount of labor it uses.

Hence, its production function is given as: Q = f (L)K

Where Q is the quantity of production (Output)

L is the quantity of labor used, which is variable, and

K is the quantity of capital (which is fixed)

The production function shows different levels of output that the firm can obtain by efficiently utilizing different units of labor and the fixed capital. In the above short run production function, the quantity of capital is fixed. Thus output can change only when the amount of labor used for production changes. Hence, ***Q*** is a function of L only in the short run.

Total product, marginal product and average product

Total product: is the total amount of output that can be produced by efficiently utilizing a specific combination of labor and capital. The total product curve, thus, represents various levels of output that can be obtained from efficient utilization of various combinations of the variable input, and the fixed input. It shows the output produced for different amounts of the variable input, labor.

An increasing the variable input (while some other inputs are fixed) can increase the total product only up to a certain point. Initially, as we combine more and more units of the variable input with the fixed input output continues to increase. But eventually, increasing the unit of the variable input may not help output increase. Even as we employ more and more unit of the variable input beyond the carrying capacity of a fixed input, out put may tends to decline. Thus increasing the variable input can increase the level of output only up to a certain point, beyond which the total product tends to fall as more and more of the variable input is utilized. This tells us what shape a total product curve assumes. The shape of the total variable curve is nearly S-shape (see fig 2.1 Panel A)

Marginal Product (MP)

The marginal product of variable input is the addition to the total product attributable to the addition of one unit of the variable input to the production process, other inputs being constant (fixed). Before deciding whether to hire one more worker, a manager wants to determine how much this extra worker ($\Delta L = 1$) will increase output, Δq. The change in total output resulting from using this additional worker (holding other inputs constant) is the marginal product of the worker. If output changes by Δq when the number of workers (variable input) changes by ΔL, the change in out put per worker or marginal product of the variable input, denoted as MP_L is found as

$$MP_L = \frac{\Delta Q}{\Delta L} or MPL = \frac{dTP}{dL}$$

Thus, MPL measures the slope of the total product curve at a given point. In the short run, the MP of the variable input first increases reaches its maximum and then tends to decrease to the extent of being negative. That is, as we continue to combine more and more of the variable inputs with the fixed input, the marginal product of the variable input increases initially and then declines.

Average Product (AP)

The AP of an input is the ratio of total output to the number of variable inputs.

$$APlabour = \frac{totalproduct}{numberofL} = \frac{TP}{L}$$

The average product of labor first increases with the number of labor (i.e. TP increases faster than the increase in labor), and eventually it declines.

As the number of the labor hired increases (capital being fixed), the TP curve first rises, reaches its maximum when L3 amount of labor is employed, beyond which it tends to decline. Assuming that this short run production curve represents a certain car manufacturing industry, it implies that L3 numbers of workers are required to efficiently run the machineries. If the numbers of workers fall below L3, the machine is not fully

operating, resulting in a fall in TP below TP3. On the other hand, increasing the number of workers above L3 will do nothing for the production process because only L3 number of workers can efficiently run the machine. Increasing the number of workers above L3, rather results in lower total product because it results in overcrowded and unfavorable working environment.

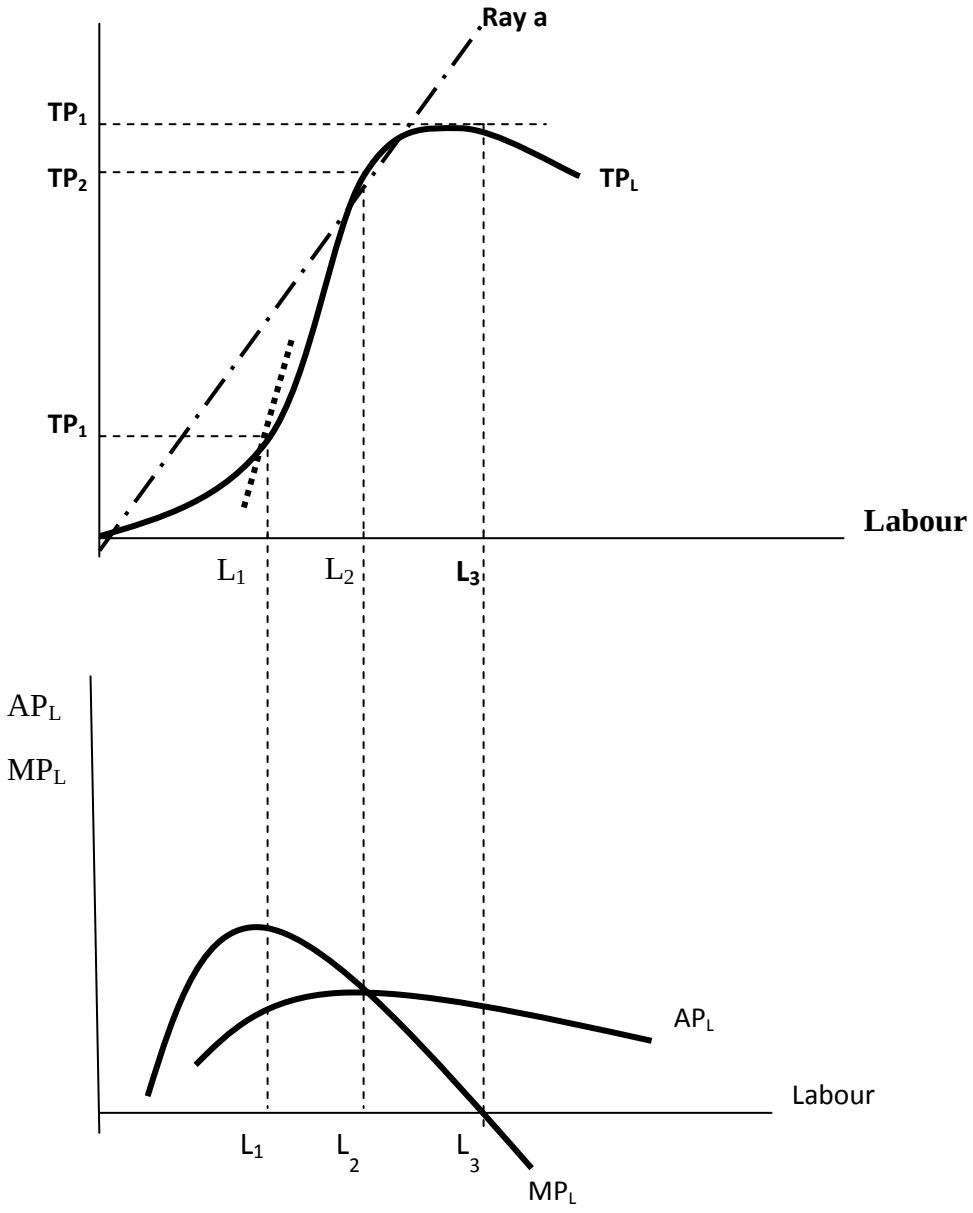


Fig 3.1 Total product, average product and marginal product curves:

Marginal product curve increases until L_1 number of labor reaches its maximum at L_1, and then it tends to fall. The MPL is zero at L3 (when the TP is maximal); beyond which its value assumes zero indicating that each additional worker above L3 tends to create over crowded working condition and reduces the total product. Thus, in the short run (where some inputs are fixed), the marginal product of successive units of labor hired increases initially, but not continuously, resulting in the limit to the total production. Geometrically, the MP curve measures the slope of the TP. The slope of the TP curve increases (MP increases) up to L1, it decreases from L1 to L3 and it becomes negative beyond L3.

The average product curve increases up to L2, beyond which it continuously declines. The AP curve can be measured by the slope of rays originating from the origin to a point on the TP curve. For example, the APL at L2 is the ratio of TP2 to L2. This is identical to the slope of ray a.

The relationship between AP and MP of the variable input

The relationship between MPL and APL can be stated as follows:

- For all number of workers (Labor) below L2, MPL lies above APL.
- At L2, MPL and APL are equal.
- Beyond L2, MPL lies below the APL

Thus, the MPL curve passes through the maximum of the APL curve from above. This relationship between APL and MPL can be shown algebraically as follows:

Suppose the production function is given as

TP = f (L), K -being constant

Given the total product function,

$$MPL = \frac{dTP}{dL} = \frac{df(L)}{dL} \text{ and } APL = \frac{TP}{L} = \frac{f(L)}{L}$$

To determine the relationship between APL and MPL, consider the slope of the APL function.

Slope of APL = $\frac{dAPL}{dL} = \frac{d(\frac{f(L)}{L})}{dL} = \frac{\frac{df(L)}{dL}.L - \frac{dL}{dL}.f(L)}{L^2}$ (quotient rule)

$= \frac{\frac{df(L)}{dL}.L}{L^2} - \frac{f(L)}{L^2}$ ---------- (note that $\frac{a+b}{c} = \frac{a}{c} + \frac{b}{c}$)

$= \frac{\frac{df(L)}{dL}}{L} - \frac{\frac{f(L)}{L}}{L}$

$= \frac{MPL - APL}{L}$, because $\frac{df(L)}{dL}$ = MPL and $\frac{f(L)}{L}$ = APL

- when MPL > APL, Slope of APL is positive (APL rises)
- When MPL = APL, Slope of APL is zero (APL is at its maximum).
- When MPL < APL, Slope of APL is negative (APL falls)

The law of production diminishing marginal returns (LDMR):

Short –run law of production (law of variable proportion)

The LDMR states that as the use of an input increases in equal increments (with other inputs being fixed), a point will eventually be reached at which the resulting additions to output decreases. When the labor input is small (and capital is fixed), extra labor adds considerably to output, often because workers get the chance to specialize in one or few tasks. Eventually, however, the LDMR operates: when the number of workers increases further, some workers will inevitably become ineffective and the MPL falls (this happens when the number of workers exceeds L1 in fig 3.1)

Note that the LDMR operates (MP of successive units of labor decreases) not because highly qualified laborers are hired first and the least qualified last. Diminishing marginal returns results from limitations on the use of other fixed inputs (e.g. machinery), not from decline in worker quality.

The LDMR applies to a given production technology (when the level of technology is fixed). Over time, however, technological improvements in the production process may allow the entire total product curve shift upward, so that more output can be produced with the same input.

3.3 Long run Production: Production with two variable inputs

For the sake of simplicity, assume that the firm uses two inputs (labor and capital) and both are variable. The firm can now produce its output in a variety of ways by combining different amounts of labor and capital. With both factors variable, a firm can usually produce a given level of output by using a great deal of labor and very little capital or a great deal of capital and very little labor or moderate amount of both. In this section, we will see how a firm can choose among combinations of labor and capital that generate the same output. To do so, we make the use of isoquant. So it is necessary to first see what is meant by isoquants and their properties.

Isoquants

An isoquant is a curve that shows all possible efficient combinations of inputs that can yield equal level of output. If both labor and capital are variable inputs, the production function will have the following form.

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

Given this production function, the equation of an isoquant, where output is held constant at q is

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

Thus, isoquants show the flexibility that firms have when making production decision: they can usually obtain a particular output (q) by substituting one input for the other.

Isoquant maps: when a number of isoquants are combined in a single graph, we call the graph an isoquant map. An isoquant map is another way of describing a production function. Each isoquant represents a different level of output and the level of out puts increases as we move up and to the right. The following figure shows isoquants and isoquant map.

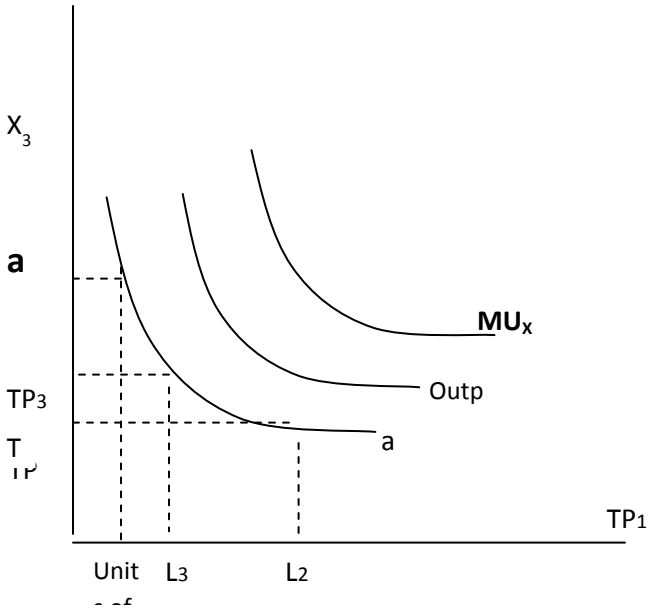


Fig 3.2 Isoquant and isoquant map.

Isoquants show the fact that long run production process is very flexible. A firm can produce q1 level of output by using either 3 capital and 1 labor or 2 capital and 3 labor or 1 capital and 6 labor or any other combination of labor and labor on the curve. The set of isoquant curves q1 q2 & q3 are called isoquant map.

Properties of isoquants

1. Isoquants slope down ward. Because isoquants denote efficient combination of inputs that yield the same output, isoquants always have negative slope. *Thus, efficiently requires that isoquants must be negatively sloped*. As employment of one factor increases, the employment of the other factor must decrease to produce the same quantity efficiently. Isoquants can never be horizontal, vertical or upward sloping

2. ***The further an isoquant lays away from the origin, the greater the level of output itdenotes***. Higher isoquants (isoquants further from the origin) denote higher combination of inputs. The more inputs used, more outputs should be obtained if the firm is producing efficiently. Thus efficiency requires that higher isoquants must denote higher level of output.

3. Isoquants do not cross each other. This is because such intersections are inconsistent with the definition of isoquants.

Consider the following figure.

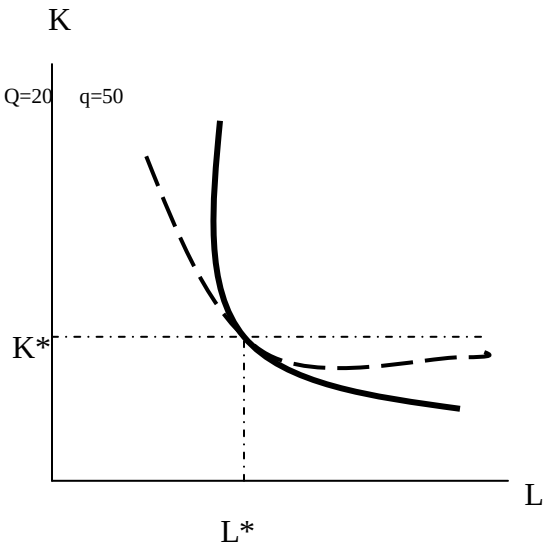


Fig 3.3Isoquant do not cross each other.

This figure shows that the firm can produce at either output level (20 or 50) with the same combination of labor and capital (L* and K*). The firm must be producing inefficiently if it produces q = 20, because it could produce q = 50 by the same combination of labor and capital (L* and K*). Thus, efficiency requires that isoquants do not cross each other.

Slope of an isoquant: marginal rate of technical substitution (MRTS)

The slope of an isoquant ($-\Delta K/\Delta L$) indicates how the quantity of one input can be traded off against the quantity of the other, while output is held constant. The absolute value of the slope of an isoquant is called marginal rate of technical substitution (MRTS). The MRTS shows the amount by which the quantity of one input can be reduced when one extra unit of another input is used, so that output remains constant. MRTS of labor for capital, denoted as $MRTS_{L,K}$ shows the amount by which the input of capital can be reduced when one extra unit of labor is used, so that output remains constant.

This is analogues to the marginal rate of substitution (MRS) in consumer theory.

MRTS $_{L,K}$ decreases as the firm continues to substitute labor for capital (or as more of labor is used). In fig.2.9 to increase the amount of labor from 1 to 2, the firm reduces 4 units of capital ($\Delta K=4$), to increase labor from 2 to 3, the firm reduce 2 unit of capital ($\Delta K=2$), and so on. Hence, the firm reduces lower and lower number of capital for the successive one unit of labor.

The reason is that when the number of capital is large and that of labor is low, the productivity of capital is relatively lower and that of labor is higher (due to the low of diminishing marginal returns). Thus, at this point relatively large amount of capital is required to replace one unit of labor (or one unit of labor can replace relatively large amount of capital). As the employment of labor increases and that of capital decreases (as we move down ward along the isoquant), quite the reverse will happen. That is, productivity of capital increases and that of labor decreases. Hence, the amount of capital that needs to be reduced increase when one extra labor is used decreases. The fact that the slope of an isoquant is decreasing makes an isoquant convex to the origin.

MRTS L, K (the slope of isoquant) can also be given by the ratio of marginal products of factors. That is,

$$MRTS_{L,K} = -\frac{\Delta K}{\Delta L} = \frac{MPL}{MPK}$$

The long run law of production: The law of returns to scale

The laws of production describe the technically possible ways of increasing the level of production. Output may increase in various ways. In the long run output can be increased by changing all factors of production. This long run analysis of production is called ***Law ofreturns to scale***.

In the short run output may be increased by using more of the variable factor, while capital (and possibly other factors as well) are kept constant. The expansion of output

with one factor (at least) constant is described by the ***law of variable proportion orthe law of (eventually) diminishing returns of the variable factor***.

In the long run all inputs are variable. Expansion of output may be achieved by varying all factors of production by the same proportion or by different proportions.

The traditional theory of production concentrates on the first case, i.e. the study of output as all inputs change by the same proportion. The term returns to scale refers to the change in output as all factors change by the same proportion. Suppose initially the production function is $X_0 = f(L, K)$

If we increase all factors by the same proportion ***t***, we clearly obtain a new level of output X* where, $X^* = f(tL, tK)$

- If X* increases by the same proportion t or if $X^* = tX_0$, we say that there is constant returns to scale.
- If X* increases less than proportionally with the increase in the factors (or if X* increases by a proportion less than ***t***), we have decreasing returns to scale.
- If X* increases more than proportionally with the increase in the factors (by a more than ***t*** proportion), we have increasing returns to scale.

Returns to scale and homogeneity of production function

Suppose we increase both factors of the function $X_0=f(L, K)$ by the same proportion't', and we get the new level of output $X = f(tL, tK)$

If ***t*** can be factored out (that is, may be taken out of the brackets as a common factors), then the new level of output X* can be expressed as a function of ***t*** (to any power V) and the initial level of output, and the production function is said to be homogeneous.

$X^* = t^v f(LK)$ or $X^* = t^V X_0$

If tcannot be factored out, the production function is non-homogeneous. Thus, a homogeneous function is a function such that if each of the input is multiplied by t, then t

can be completely factored out of the function. The power ***V*** of ***t*** is called degree of homogeneity of the function and is measure of returns to scale.

If V=1, we have constant returns to scale. This is also called linear homogeneous

If V<1, decreasing return to scale prevails

If V>1, increasing return to scale prevails

For a Cobb-Douglas production function

$X = b0L^{b1} K^{b2,}$ V = b1 +b2 and it is a measure of returns to scale.

Proof: Let L and K increase by t. The new level of output is

$X^* = b0 (tL)^{b1} (tk)^{b2}$

$X^* = b0\ t^{b1}\ l^{b1}\ t^{b2}k^{b2}$

$X^* = b0L^{b1}K^{b2}\ t^{b1+b2}$

$X^* = X (t^{b1+b2})$

Thus V = b1+b2

Causes of increasing returns to scale

Technical and /or managerial indivisibility. Mostly, processes of production can be doubled but it may not be possible to half them. When the production system expands, workers will specialize in one extreme and their productivity increases.

Causes of decreasing returns to scale

The most common causes are 'diminishing returns to management'. If we expand the out put beyond optimum, the top management personnel will be over burdened and the productivity of additional unit of the variable inputs decline eventually. E.g., doubling fishing fleet may not double fish catch.

Technological process and production function

Technological improvement (progress) makes factors of production more productive or it makes production system more efficient; so that the firm will get higher output from the same combinations of labor and capital than before.

Graphically, this can be shown by ***upward*** movement of the total product curve (indicating higher output level can be achieved from the same input) and ***down*** ward movement of isoquant denoting lower combinations of factors of production can produce equal level of output. See the figures

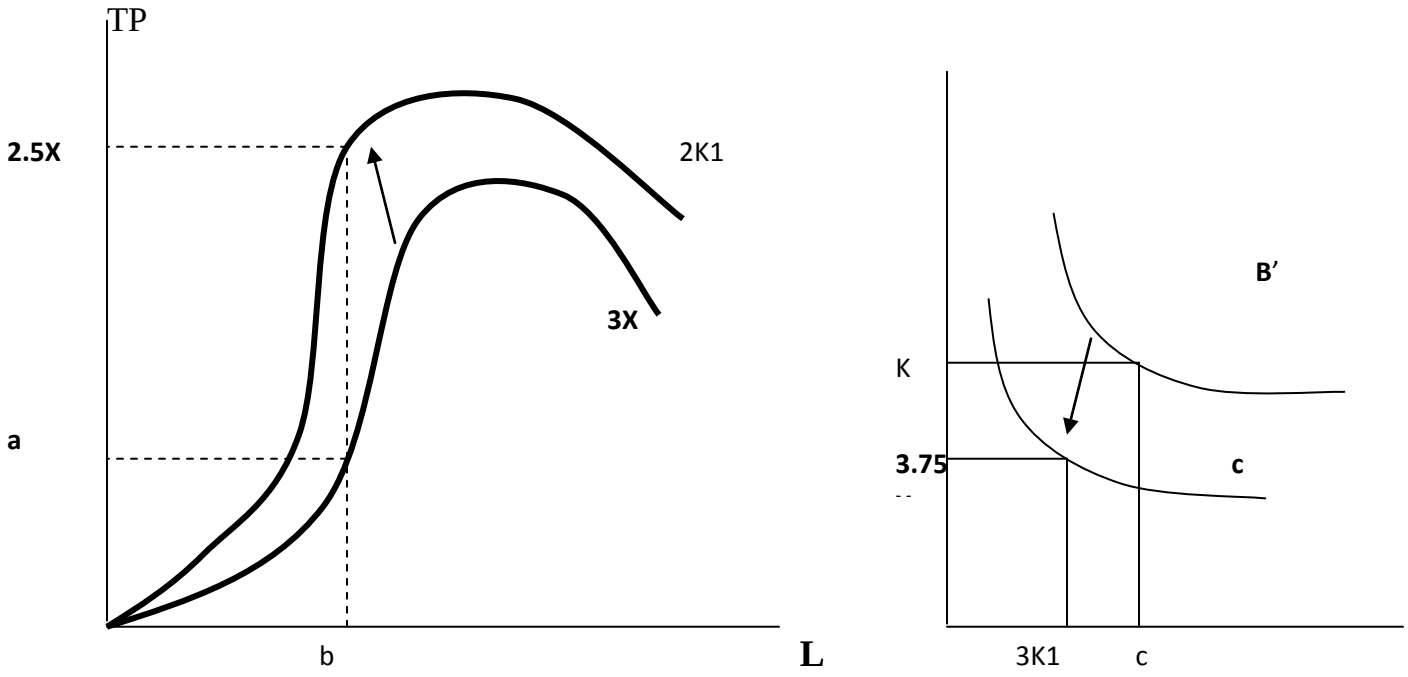


Fig 3.4 technological progress shifts the TP curve up ward &the isoquant down ward

3.3 Choice of optimal combination of factors of production

In our previous discussion we have said that an isoquant denotes efficient combination of labor and capital required to produce a given level of output. But, this does not mean that the monetary cost of producing a given level of output is constant along an isoquant. That is, though different combinations of labor and capital on a given isoquant yield the same level of output, the cost of these different combinations of labor and capital could differ because the prices of the inputs can differ. Thus, isoquant shows only technically efficient combinations of inputs, not economically efficient combinations.

Technical efficiency takes in to account the physical quantity of inputs whereas economic efficiency goes beyond technical efficiency and seeks to find the least cost (in monetary terms) combination of inputs among the various technically efficient combinations.

Hence, technical efficiency is a necessary condition, but not a sufficient condition for economic efficiency. To determine the economically efficient input combinations we need to have the prices of inputs.

To determine the economically efficient input combination, the following simplifying assumptions hold true:

Assumptions

1. The goal of the firm is maximization of profit ($\prod$) where $\prod = R - C$ Where $\prod$ - Profit, R-revenue and C-is cost outlay.
2. The price of the product is given and it is equal to $\overline{P_X}$.
3. The prices of inputs are given (constant).Price of a unit of labor is $\overline{w}$ and that of capital is $\bar{r}$.

Now before we go to the discussion of optimal input combination (or economically efficient combination), we need to know the isocost line, because optimal input is defined by the tangency of the isoquant and isocost line.

Isocost line

Isocost lines have most of the same properties as that of budget lines, an isocost line is the locus points denoting all combination of factors that a firm can purchase with a given monetary outlay, given prices of factors.

Suppose the firm has C amount of cost out lay (budget) and prices of labor and capital are w and r respectively. The equation of the firm's isocost line is given as:

$C = rK + wL$, *where* K *and* L are quantities of capital and labor respectively.

Given the cost outlay C , the maximum amounts of capital and labor that the firm can purchase are equal to $\frac{C}{r}$ and $\frac{C}{w}$ respectively. The straight line that connects these points is the iso-cost line. See the following figure:

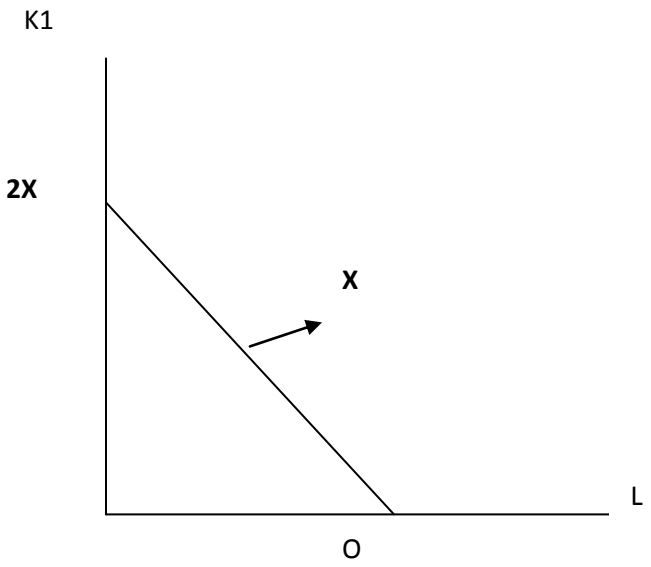


Fig: 3.5 the iso cost line: *shows different combinations of labor and capital that the firm can buy given the cost out lay and prices of the inputs.*

Now we are in a position to determine the firm's optimal in put combination. However, the problem of determining optimal input combination (economic efficiency) takes two forms. Sometimes, situations may happen when a firm has a constant cost outlay and seek to maximize its output, given this constant and cost out lay and prices of inputs. Still, there are also situations when the goal of the firm is to produce a predetermined (given) level of output with the least possible cost. Under we will discuss the two situations separately.

Case1: Maximization of output subject to cost constraint

Suppose a firm having a fixed cost out lay (money budget) which is shown by its iso-cost line. Here, the firm is in equilibrium when it produces the maximum possible output, given the cost outlay and prices of input. The equilibrium point (economically efficient combination) is graphically defined by the tangency of the firm's iso-cost line (showing the budget constraint) with the highest possible isoquant. At this point, the slope of the iso cost line ($\frac{w}{r}$) is equal to the slope of the isoquant ($\frac{MP_L}{MP_K}$).

The condition of equilibrium under this case is, thus: $\frac{w}{r} = \frac{MP_L}{MP_K}$ *or* $\frac{MP_L}{w} = \frac{MP_K}{r}$

This is the first order (necessary) condition. The second order (sufficient) condition is that isoquant must be convex to the origin. See the following figure:

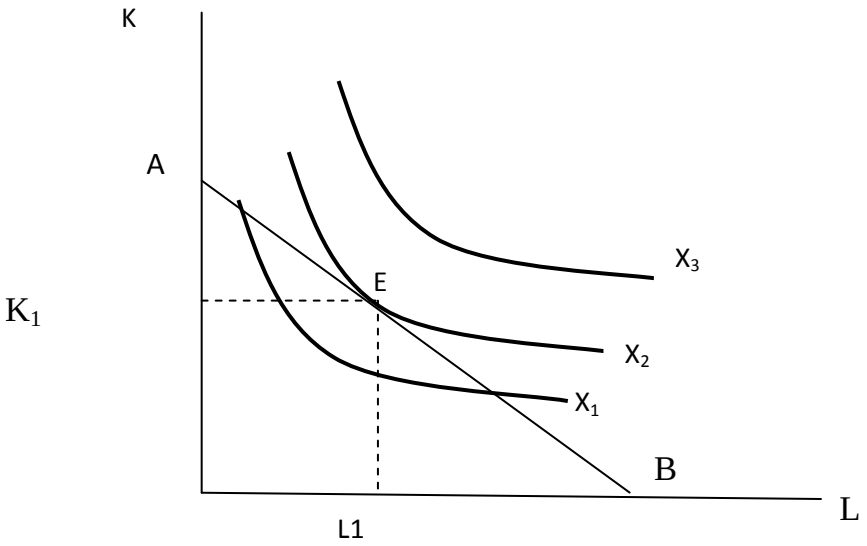


Fig: 3.6 the optimal combination of inputs (L_1 *and* K_1 ***)***

The optimal point is defined by the tangency of the iso-cost line (AB) and the highest possible isoquant (X_2), at point E. At this point the slope of iso-cost line ($\frac{w}{r}$) is equal to the slope of isoquant X_2 ($\frac{MP_L}{MP_K}$).The second order condition is also satisfied by the convexity of the isoquant.

Mathematical derivation of the equilibrium condition

The problem can be stated as:

Maximize $X = f(L,K)$.....*Objective function*

Subject to $\overline{C} = wL + rK$.....*Constra*int *function*

or $\overline{C} = wL + rK - C = 0$

We use the lagrangian method to solve the problem.

The lagrangian equation is written as:

$$\phi = X - \lambda(\overline{C})$$

Then we find $\frac{\partial\phi}{\partial L}, \frac{\partial\phi}{\partial K},$ *and* $\frac{\partial\phi}{\partial\lambda}$ and set all of them equal to zero to solve for L *and* K.

That is,

$$\phi = X - \lambda(wL + rK - \overline{C})$$

And, $\frac{\partial \phi}{\partial L} = \frac{\partial X}{\partial L} - wL = 0 \Rightarrow MP_L = w\lambda \Rightarrow \lambda = \frac{MP_L}{w}$

$\frac{\partial \phi}{\partial K} = \frac{\partial X}{\partial K} - r\lambda = 0 \Rightarrow MP_K = r\lambda \Rightarrow \lambda = \frac{MP_K}{r}$

$\frac{\partial \phi}{\partial \lambda} = -wL - rK + w = 0 \Rightarrow wL + rK = \overline{C}$

Solving these equations simultaneously, we obtain the equilibrium condition

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

The second order condition (the convexity of isoquant) would be insured when:

$$\frac{\partial^2 X}{\partial L^2} < 0 \ , \frac{\partial^2 X}{\partial K^2} < 0 \quad and \left(\frac{\partial^2 X}{\partial L^2}\right)\left(\frac{\partial^2 X}{\partial K^2}\right) < \left(\frac{\partial^2 X}{\partial L \partial K}\right)^2$$

Numerical Example

Suppose the production function of a firm is given as $X = 0.5L^{1/2}K^{1/2}$ prices of labor and capital are given as \$ 5 and \$ 10 respectively, and the firm has a constant cost out lay of \$ 600.Find the combination of labor and capital that maximizes the firm's output and the maximum output.

Solution

The condition of equilibrium is $\frac{MP_L}{w} = \frac{MP_K}{r}$ *or* $\frac{MP_L}{MP_K} = \frac{w}{r}$

$$MP_L = \frac{\partial X}{\partial L} = 0.25L^{-1/2}K^{1/2}$$

$$MP_K = \frac{\partial X}{\partial K} = 0.25L^{1/2}K^{-1/2}$$

Thus, the equilibrium exists when,

$$\frac{0.25L^{-1/2}K^{-1/2}}{0.25L^{-1/2}K^{-1/2}} = \frac{\$5}{\$10}$$

$$\frac{K}{L} = \frac{1}{2} \Rightarrow L = 2K \text{.....(1)}$$

The constraint equation is:

$$wL + rK = C$$
$$5L + 10K = 600 \text{.....(2)}$$

Solving equation (1) and (2) would give us the optimal combination of L and K.

$$L = 2K$$
$$5L + 10K = 600$$

$\Rightarrow$L=60 units and K=30 units.

Thus, the firm should use 60 units of labor and 30 units of capital to maximize its production (output). (Check the second order condition).

The maximum output can be found by substituting 60 and 30 for L and K in the production process.

Case -2: Minimization of cost for a given level of output

In this case, consider an entrepreneur (a firm) who wants to produce a given output (for example a bridge or a building or x tones of a commodity) with minimum cost outlay. That is, we have a single isoquant which denotes the desired level of output, but there are a set of isocost lines which denotes the different cost outlays. Higher isocost lines denote higher production costs. The production costs of a desired level of output will therefore be minimized when the isoquant line is tangent to the lowest possible isocost line (see fig) At the point of tangency, the slope of the isoquant and isocost lines are identical. That is $\frac{w}{r} = \frac{MPL}{MPK}$

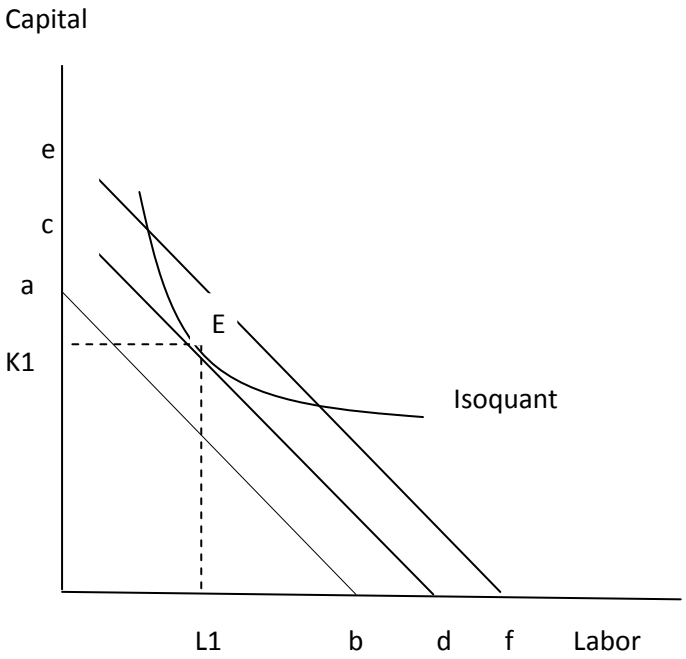


Fig: 3.7 the equilibrium combination of factors is K_1 and L_1 amounts of capital and labor respectively. Lower isocost lines such as 'ab' are economically desirable but un attainable given the desired level of output. So point E shows the least cost combination of labor and capital to produce X amount of output.

Now let us see the mathematical derivation of the equilibrium condition. As mentioned earlier, we minimize the cost of producing a given level of output.

Thus, the problem can be stated as:

Minimize C = f (q) = WL + rK ---------- (Objective function)

Subject to q = f (L, K) ---------- (Constraint function)

Or f (L, K) – q = 0

We use the LaGrange an method to obtain the equilibrium condition. Accordingly, the LaGrange an function will be:

$\phi = C - \lambda(f(L,K) - q)$

$\phi = WL + rK - \lambda(f(L,K) - q)$

The condition of equilibrium will be obtained by finding $\frac{\partial \phi}{\partial L}, \frac{\partial \phi}{\partial K} and \frac{\partial \phi}{\partial \lambda}$ and then solving them simultaneous after equating each to zero.

That is

$$\frac{\partial \phi}{\partial L} = w - \lambda \frac{\partial f(L,K)}{\partial L} = 0$$

$$w - \lambda MPL = 0 \Rightarrow \lambda = \frac{w}{MPL}$$

$$\frac{\partial \phi}{\partial K} = r - \lambda \frac{\partial f(L,K)}{\partial K} = 0$$

$$r - \lambda MPK = 0 \Rightarrow \lambda = \frac{r}{MPK}$$

$$\frac{\partial \phi}{\partial \lambda} = f(L,K) - q = 0$$

Thus, the equilibrium condition is $\frac{w}{MPL} = \frac{r}{MPK}$

Rearranging the above condition, we obtain $\frac{MPL}{MPK} = \frac{w}{r}$

This condition $\left(\frac{MPL}{MPK} = \frac{W}{r}\right)$ is only a necessary condition.

The sufficient condition is that the isoquant must be convex to the origin. That is

$$\frac{\partial^2 q}{\partial L^2} < 0, \frac{\partial^2 q}{\partial k^2} < 0 and \left(\frac{\partial^2 q}{\partial L^2}\right)\left(\frac{\partial^2 q}{\partial k^2}\right) > \left(\frac{\partial^2 X}{\partial L \partial K}\right)^2$$

Numerical example:

Suppose a certain contractor wants to maximize $\prod$ from building one bridge. The contractor uses both labor and capital, and efficient combinations of Labor and capital that are sufficient to make a bridge is by the function $0.25\ L^{\frac{1}{2}} K^{\frac{1}{2}}$. If the prices of labor (w) and capital (r) are $ 5 and $ 10 respectively, then find the least cost combination of L and K, and the minimum cost.

Solution:

The contractor wants to build one bridge. Thus, the constraint equation can be written as

$0.25\ L^{\frac{1}{2}}\ k^{\frac{1}{2}} = 1$

$MPL = 0.125\ L^{\frac{-1}{2}}\ K^{\frac{1}{2}}$

$MPK = 0.125\ L^{\frac{1}{2}}\ K^{\frac{-1}{2}}$

The equilibrium condition is $\frac{MPL}{MPK} = \frac{W}{r}$

$$\frac{0.125L^{\frac{-1}{2}}K^{\frac{1}{2}}}{0.125L^{\frac{1}{2}}K^{\frac{-1}{2}}} = \frac{\$5}{\$10}$$

$$\frac{K}{L} = \frac{1}{2} \Rightarrow L = 2K$$

Substituting L = 2K in the constraint equation we obtain

$0.125\ (2K)^{\frac{-1}{2}}\ K^{\frac{1}{2}} = 1$

$0.125\sqrt{2}\ .\ K = 1$

$K = \frac{1}{0.125\sqrt{2}} = K = \frac{8}{\sqrt{2}}$ $L = 2K \Rightarrow \frac{16}{\sqrt{2}}$

Therefore, least cost combination of L and K are $\frac{16}{\sqrt{2}}$ and $\frac{8}{\sqrt{2}}$ respectively.

The least cost is $C = 5\left(\frac{16}{\sqrt{2}}\right) + 10\left(\frac{8}{\sqrt{2}}\right) = \$\ \frac{160}{\sqrt{2}}$

Chapter Four

Theory of Costs of Production

Introduction

To produce goods and services, firms need factors of production or simply inputs. To acquire these inputs, they have to buy them from resource suppliers. Cost is, therefore, the monetary value of inputs used in production of an item.We can identify two types of cost of production: ***social cost*** and ***private cost***.

Social cost: is the cost of producing an item to the society. This cost is realized due to the fact that most resources used for production purpose are scarce and some production process, by their nature, emit dangerous chemicals, bad smell, etc to surrounding society.

For example, when a certain beer factory wants to produce beer in Ethiopia, the society as a whole also incurs a cost. Because, the next- best alternative of the raw material (such as barely) used for the production of beer is sacrificed. When the beer factories buy barley from the market, the amount of barely available for consumption by society may be reduced and the price may become dearer. Hence, the production of beer imposes an indirect cost on the society, moreover, by its nature; the production of beer emits bad chemicals to the environment, which pollutes waters, air, etc. To control the understandable consequences of the production process on the environment and their property, the society incurs cost.

Private cost: This refers to the cost of producing an item to the individual producer. It is the cost that the beer factory incurs to produce the beer, in our example:
Private cost of production can be measured in two ways:

i) Economic cost

In economics the cost of production to the individual producer includes the cost of all inputs used for the production of the item.

The producer may buy part of the inputs from the market. ***For example,*** he/ she hire workers, buy raw materials, the necessary machines, etc. the actual or out- of- pocket expenditures that the firm incurs to purchase these inputs from the market are called explicit costs.

But, the producer can also use his/ her own inputs which are not purchased from the market for the production purpose. For example, the producer may use his/ her own building as a production place, he/she may also manage his firm by himself instead of hiring another manager, etc. since these inputs are used for the purpose production, their value has to be estimated and included in the total cost of production. As to how to estimate the cost of these non- purchased inputs is concerned, we usually estimate their cost from what these inputs could earn in their best alternative use. For instance, if the 0firm uses his own building for production purpose, the cost of using this building for production is estimated by the rent income foregone. If the producer is a teacher with salary of 1000 birr per month and fruits his job to manage his factory, then the next best alternative of his labor is the salary that he sacrificed to be the manager of his factory. The estimated cost of the non- purchased inputs is called implicit costs.

Thus, in economics the cost of production includes the costs of all inputs used in the production process whether the inputs are purchased from the market or owned by the firm himself that is:

Economic cost: Explicit cost plus Implicit cost

ii) Accounting Cost

For accountant, the cost of production includes the cost of purchased inputs only. Accounting cost is the explicit cost of production only. Moreover, accountant's doesn't consider the cost of production from the opportunity cost of the resources point of view.

4.1 Short run Costs

Economics theory distinguishes between short run costs and long run costs. Short run costs are the costs over a period during which some factors of production (usually capital equipment and management) are fixed.

In the traditional theory of the firm, total costs are split into two groups: total fixed costs and total variable costs:

TC = TFC + TVC

Where – TC is short run total cost

TFC is short run total fixed cost

TVC is short run total variable cost

By fixed costs, we mean a cost which doesn't vary with the level of output. The fixed costs include:

a. Salaries of administrative staff
b. Expenses for building depreciation and repairs
c. Expenses for land maintenance
d. The rent of building used for production , etc

All the above costs are regarded as fixed costs because whether the firm produces much output or zero output, these costs are unavoidable, and the firm can avoid fixed costs only if he / she shut down the business stops operation.

Variable costs, on the other hand, include all costs which directly vary with the level of output. The variable costs include:

a. The cost of raw materials
b. The cost of direct labor
c. The running expenses of fixed capital such as fuel, electricity power, etc.

All these costs are regarded as variable costs because their amount depends on the level of output. For example, if the firm produces zero output, the variable cost is zero.

Graphical presentation of short run costs.

Total fixed cost (TFC)

Graphically, TFC is denoted by a straight line parallel to the output axis. The point of intersection of the TFC line with the cost axis (vertical axis) shows the amount of the fixed. For example if the level of fixed cost is $ 100, it can be shown as.

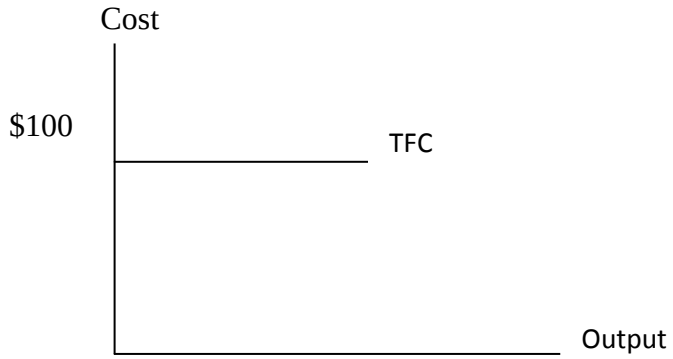


Fig 4.1 Total Fixed Cost

Total variable cost (TVC)

The total variable cost of a firm has an inverse s- shape. The shape indicates the law of variable proportions in production. According to this law, at the initial stage of production with a given plant, as more of the variable factor (s) is employed, its productivity increases. Hence, the TVC increases at a decreasing rate. This continues until the optimal combination of the fixed and variable factors is reached. Beyond this point, as increased quantities of the variable factors(s) are combined with the fixed factor (s) the productivity of the variable factor(s) declined, and the TVC increases by an increasing rate. Thus, the TVC has an inverse s-shape due to the law of diminishing marginal returns.

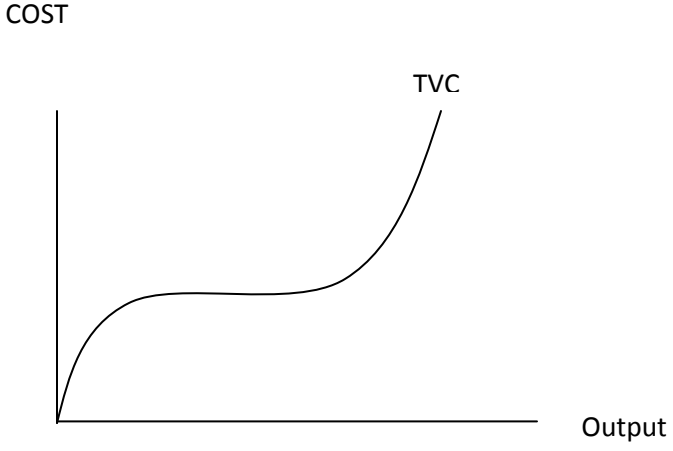


Fig 4.2 Total variable cost curve

Total Cost (TC)

The total cost curve is obtained by vertically adding the TFC and the TVC i.e., by adding the TFC and the TVC at each level of output. The shape of the TC curve follows the shape of the TVC curve. i.e. the TC has also an inverse S-shape. But the TC curve doesn't start from the origin as that of the TVC curve. The TC curve starts from the point where the TFC curve intersects the cost axis.

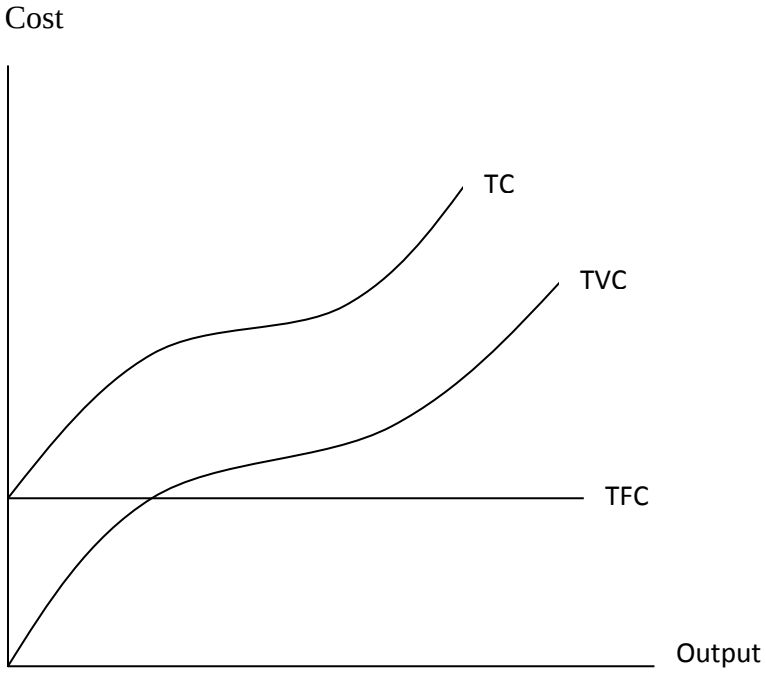


Fig 4.3 Total cost curves

The TC and TVC curve has an inverse S- shape. The vertical distance between them (TFC) is constant.

Per unit costs (average costs)

From total costs we can derive per-unit costs. These are even more important in the short run analysis of the firm. Average fixed cost (AFC) - is found by dividing the TFC by the level of output.

Graphically, the AFC is a rectangular hyper parabola. The AFC curve is continuously decreasing curve, but decreases at a decreasing rate and can never be zero. Thus, AFC gets closer and closer to zero as the level of output increases, because a fixed amount of cost is being divided by increasing level of output.

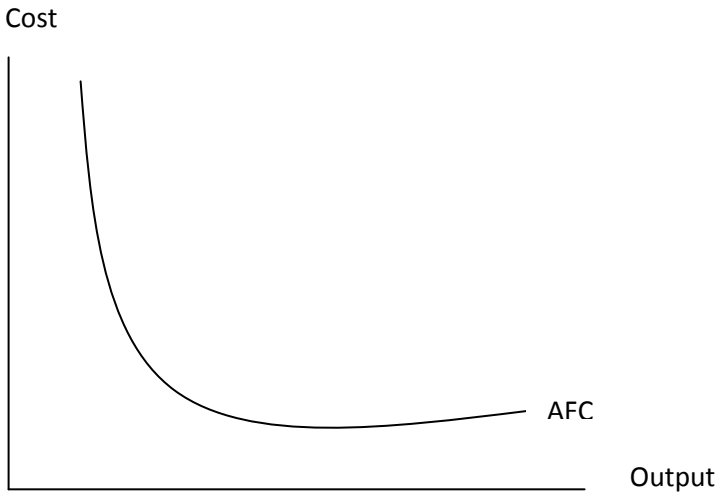


Fig 4.4 Average Fixed Cost Curve

Theaverage fixed cost curve is derived from the total fixed cost, and it represents the slope of straight lines drawn from the origin to a given point on the TFC curve.

Average variable cost (AVC)

The AVC is obtained by dividing the TVC with the corresponding level of output.

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

Graphically, the AVC at each level of output is derived from the slope of a line drawn from the origin to the point on the TVC curve corresponding to the particular level of output.

The following graph clearly shows the process of deriving the AVC curve from the TVC curve.

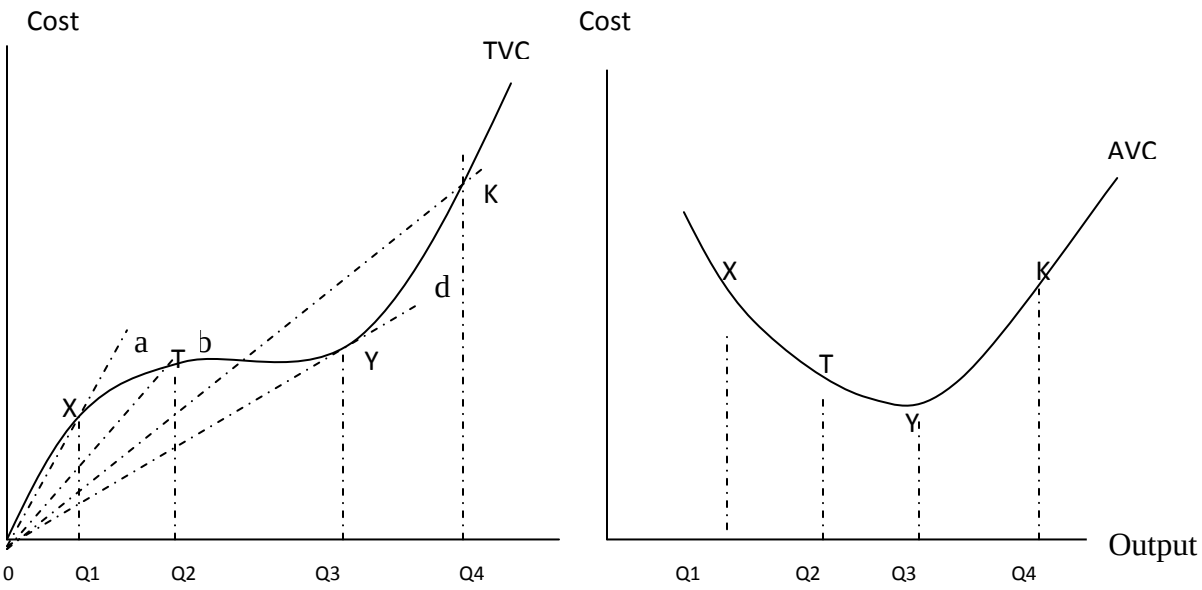


Fig 4.5 in the figure above, the AVC at Q1 from panel A is given by the slope of the ray 0a, the AVC at Q2 is given by slope of the ray 0b, and so on. The slope of the raysdecreases until Q3 andstarts to rise beyond Q3.

It is clear from this figure that the slope of a ray through the origin declines continuously until the ray becomes tangent to the TVC curve at Y. To the right of this point (Point Y) the slope of the rays through the origin starts increasing. Thus, the short run AVC (SAVC now on) falls initially, reaches its minimum and then start to increase. Hence, the SAVC curve has a U-shape and the reason behind is the law of variable proportions. Had the TVC not been inverse S-shaped, the SAVC would never assume a U-shape.

Generally, at initial stage of production, the productivity of each additional unit a variable input increases, thus, the variable input requires to produce each successive units of output decreases at this stage, implying that the AVC (Variable Cost Incurred to produce a unit of output) decreases. This process continues until the point of optimal combination between the fixed input and the variable input is reached. Beyond this point, the productivity of each additional unit of the variable combined with the existing fixed input decreases because the fixed input is over utilized. As the productivity of such variables decreases, more and more of the variables are required to produce successive units of the

output, implying that the variable cost incurred to produce each successive unit (AVC) increases.

Average total cost (ATC) or simply, Average cost (AC)

ATC (or AC, now on) is obtained by dividing the TC by the corresponding level of output. It shows the amount of cost incurred to produce each unit of successive outputs.

$$AC = \frac{TC}{Q} \text{ Or } AC = \frac{TVC + TFC}{Q} = \frac{TVC}{Q} + \frac{TFC}{Q} = \text{AVC} + \text{AFC}$$

Thus, AC can also be given as the vertical sum of AVC and AFC.

Graphically, AC curve can be obtained by vertically adding the AVC and AFC for each level of successive outputs. Alternatively, the AC curve can also be derived in the same way as the SAVC curve. The AC curve is U-shaped because of the law of variable proportions. Observe the figure that follows.

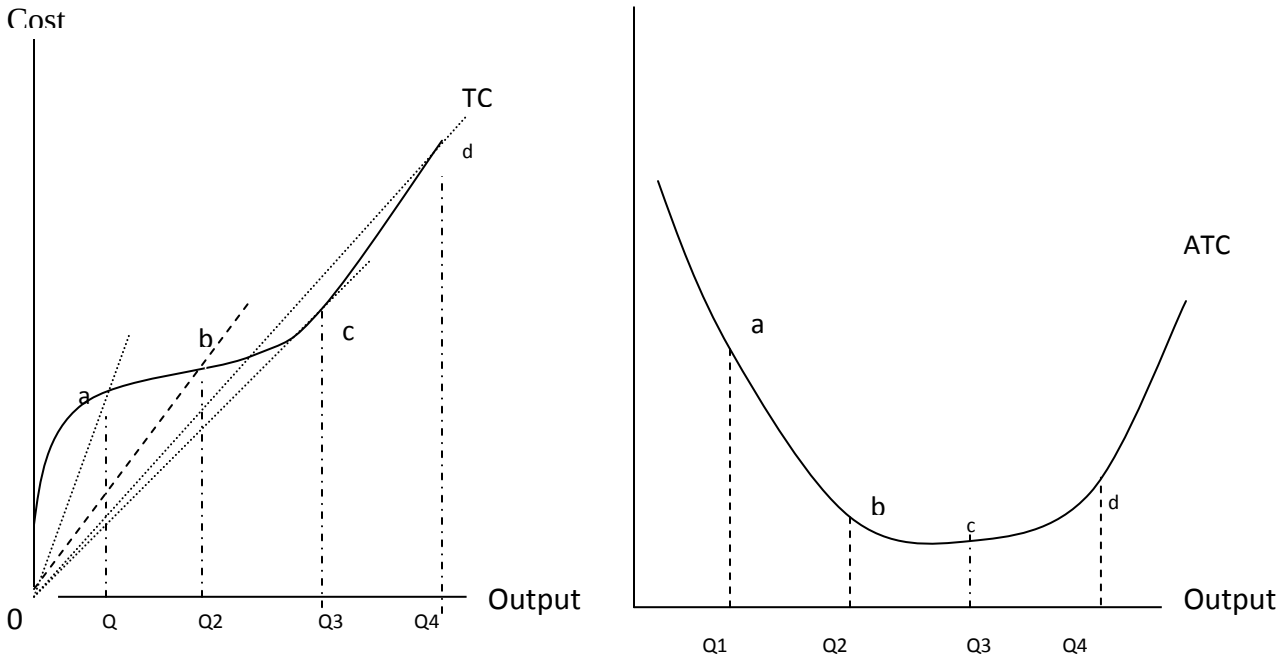


Fig 4.6 Panel-A(TC Curve)*Panel-B (ATC Curve)*

From this figure (Panel A), the AC at any level of output is the slope of the straight line from the origin to the point on the TC curve corresponding to that particular level of output. That is, for example, the AC of producing Q1 level of output is given by the slope of the line 0a, the AC of producing Q2 level of outputs is given by the slope of the line Ob and so on.

Marginal Cost (MC)

The marginal cost is defined as the additional cost that the firm incurs to produce one extra unit of the output. One thing to be noted here is that, the additional cost that the firm incurs to produce the 10^{th} unit of output is no0t equal to the additional cost of producing the 1000^{th} unit. They would be equal if the TC curve is straight line.

To sum up, the MC is the change in total cost which results from a unit change in output i.e. MC is the rate of change of TC with respect to output, Q or simply MC is the slope of TC function and given by:

$$MC = \frac{dTC}{dQ}$$

In fact MC is also the rate of change of TVC with respect to the level of output.

$$MC = \frac{dTFC + dTVC}{dQ} = \frac{dTVC}{dQ}, \quad \text{since} \quad \frac{dTFC}{dQ} = 0$$

Graphically, the MC the TC curve (or equivalently the slope of the TVC curve) obviously, the slope of curved lines at a given point is measured by constructing a tangent line to the curve at each point. So, the slope of the curve at a given point is equal to the slope of the tangent line at that specific point. Given the inverse S-shaped TC (or TVC) curve, the MC curve will be U-shaped. Thus given inverse S-shaped TC or TVC curve, the slope of the TC or TVC curve (i.e. MC) initially decreases, reaches its minimum and then starts to rise.

From this, we can logically infer that the reason for the U-shaped ness of MC is also the law of variable proportion. That is, had the TC or TVC curve not been inverse S-shaped,

the MC curve have would never assumed the U-shape, and obviously, the TC or TVC is inverse S-shaped due to the law of variable proportions. Observe the figure that follows for more discussion.

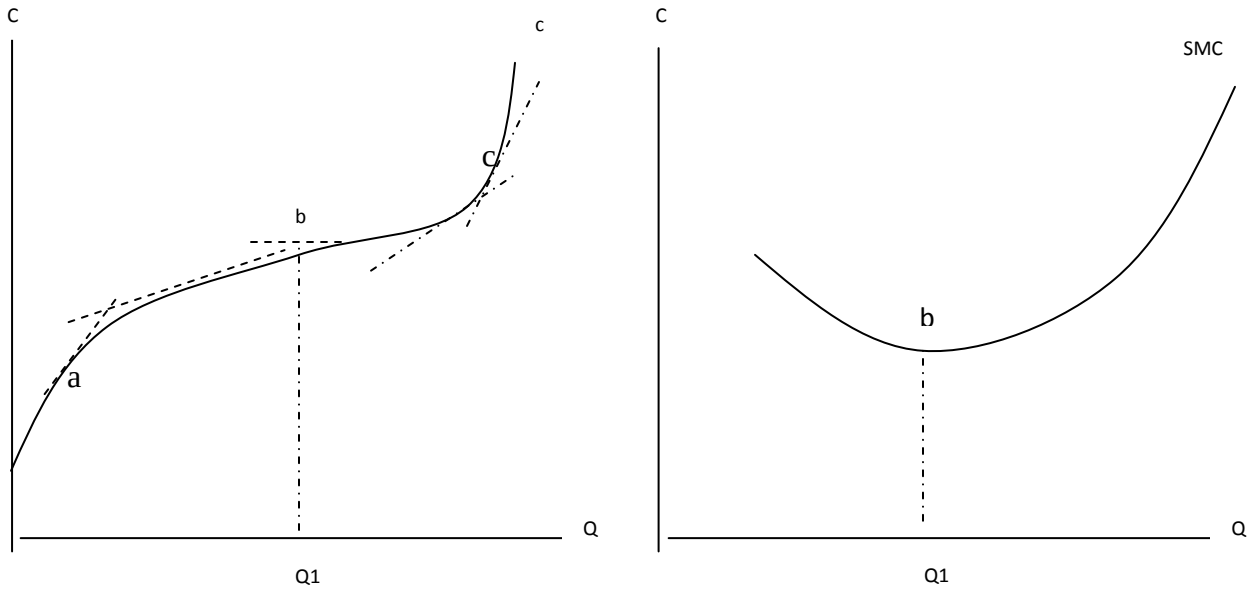


Fig 4.7 Panel-1(TC Curve) Panel-2 (MC Curve)

In Panel 2 the slope of the tangent lines to the TC curve (MC) decreases up to point **S** and then starts to rise.

In summary, AVC, ATC and MC curves are all U-shaped due to the law of variable proportions. The simplest total cost function which would incorporate the law of variable proportions is the cubic polynomial of the following form

$$TC = bo + b1Q - b2Q^2 + b3Q^3$$

TFC = b_0, AFC = $\frac{b_0}{Q}$,

TVC= $b_1Q - b_2Q^2 + b_3Q^3$

$$AVC = \frac{b_1 Q - b_2Q^2 + b_3Q^3}{Q} = b_1 - b_2Q + b_3Q^2$$

$$\text{ATC} = \text{AFC} + \text{AVC} = \frac{b0}{Q} + b1 - b2Q + b3Q^2$$

The relationship between AVC, ATC and MC

Given ATC = AVC + AFC, AVC is part of the ATC. Both AVC and ATC are u – shaped, reflecting the law of variable proportions however, the minimum of ATC occurs to the right of the minimum point of the AVC (see the following figure) this is due to the fact that ATC includes AFC which continuously decreases as the level of output increases.

After the AVC has reached its lowest point and starts rising, its rise is over a certain range is more than offset by the fall in the AFC, so that the ATC continues to fall (over that range) despite the increase in AVC. However, the rise in AVC eventually becomes greater than the fall in AFC so that the ATC starts increasing. The AVC approaches the ATC asymptotically as output increases.

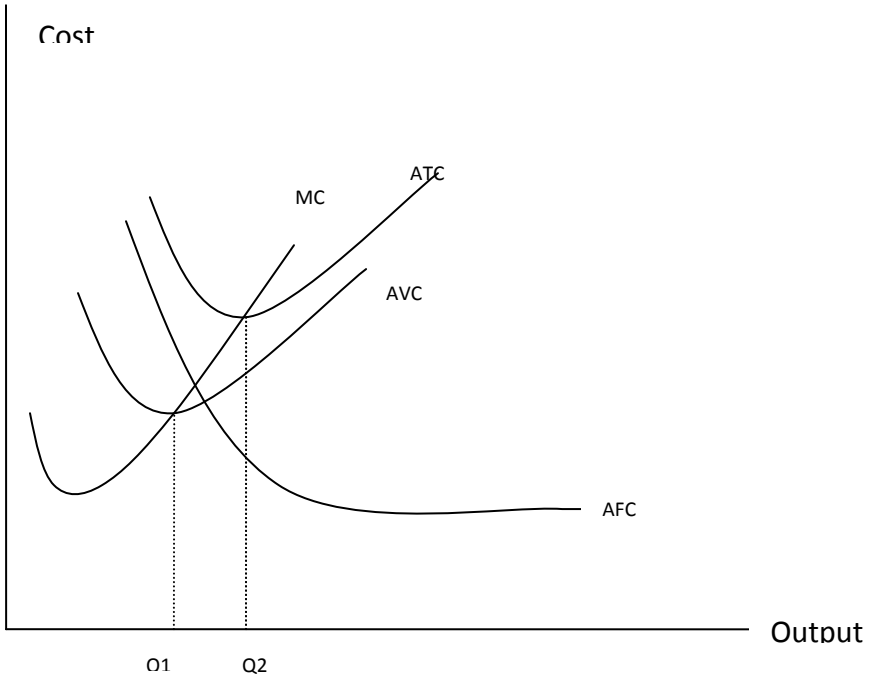


Fig 4.8 Average cost curves

The AVC curve reaches its minimum point at Q1 output and ATC reaches its minimum point at Q2. The vertical distance between ATC and AVC (AFC) decrease continuously as output increases. MC curve passes through the minimum point of both ATC and AVC

Finally, the MC curve passes through the minimum point of both ATC and AVC curves. This can be shown by using calculus.

Suppose the TC = f (Q)

$$MC = \frac{d(f(Q))}{dQ} = f(Q)$$

$$AC = \frac{TC}{Q} = \frac{f(Q)}{Q}$$

Slope of $AC = d\,\frac{\mathrm{d}\,(\mathrm{f}\ (\mathrm{Q}))}{dQ} = \frac{(f(Q))Q - Q.f(Q)}{Q2} = \frac{\mathrm{MC.Q\text{-}\,f(Q)}}{Q2} = \frac{\frac{MC}{Q} - \frac{f(Q)}{Q}}{Q}$

Slope AC = $\frac{1}{Q}(MC - AC), where \frac{f(Q)}{Q} = AC$

Now,

i) when MC<AC, the slope of AC is negative, i.e.
AC curve is decreasing (initial stage of production)

ii) When MC >AC, the slope of AC is positive, i.e. the AC curve is increasing (after optimal combination of fixed and variable inputs.

iii) When MC = AC, the slope of AC is zero, i.e. the AC curve is at its minimum point.

The relationship between AVC and MC can be shown in a similar fashion.

The relationship between short run per unit production & cost curves

Let's see the important relation that per unit production curves (i.e. AP and MP of the variable input) and per unit cost curves (i.e. AVC and MC) have. The relationship is that the short run per unit costs are the mirror reflection (against the x-axis) of the short run production curves. That is the short run AVC is the mirror reflection of the short run AP of the variable input. When AP variable input increases, AVC decreases; when AP variable input reaches its maximum, the AVC reaches its maximum point, and finally when AP variable input starts to fall, the AVC curve starts to rise. The same relationship exists between the short run MP of variable input curve the MC curve. This can be shown algebraically by using a linear short run cost function.

Suppose the firm uses two inputs, labor L (which is variable) and capital (which is fixed input). And suppose that the prices of both factors are given and equal to w, and r respectively. The total cost of production is then, $TC = rK + wL$ .The first term (i.e. rk) is the fixed cost because both r and k are constant and the second term (i.e.wL) represents the variable cost.

TVC = W, AVC = $\frac{TVC}{Q} = \frac{WL}{Q}$ = W. $\frac{1}{\frac{Q}{L}}$ But, $\frac{Q}{L}$ represents APL

Therefore, AVC = W. $\frac{1}{APL}$ Hence, AVC and AP_L are inversely related.

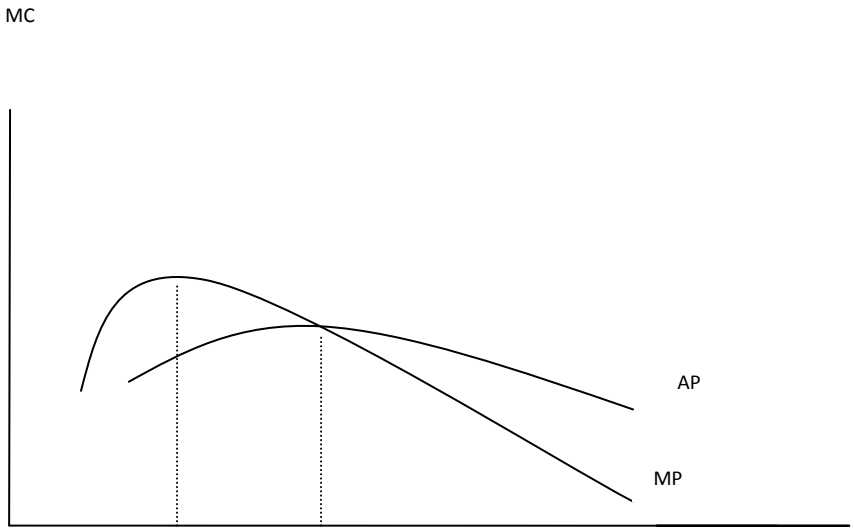
$MC = \frac{dTC}{dQ} = \frac{dTVC}{dQ}$ (Remember that MC = $\frac{dTC}{dQ}$

$MC = \frac{d(W.L)}{dQ}$ = W. $\frac{dL}{dQ}$ …… (because w is constant)

MC = W. $\frac{dL}{dQ}$ = W. $\frac{1}{\frac{dQ}{dL}}$ = W. $\frac{1}{MPL}$ …… (Because $\frac{dQ}{dL}$ = MPL)

Hence, MC and MPL have also an inverse relation.

Graphically



AVC, MC

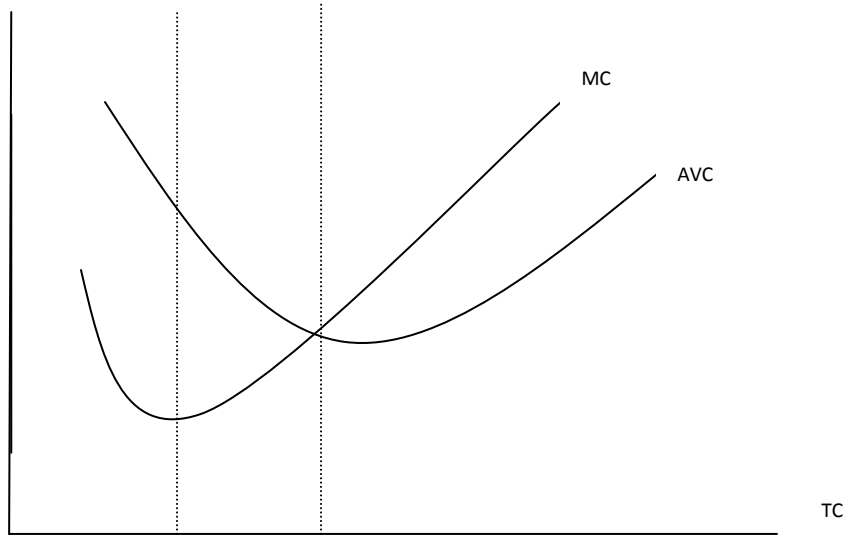


Fig 4.9 short run AVC and MC curves are the mirror reflection (along the horizontal axis) of short run AP_L and MP_L curves

4.2 Costs in the long run

The basic difference between long-run and short run costs is that in the short run, there are some fixed inputs which results in some amount of fixed costs. However, in the long run all factors are assumed to become variable. In the long run the firm can change the quantities of all inputs including the size of the plant. This implies that all costs are variable in the long-run in the sense that it is always possible to produce zero units of

output at zero costs. That is, it is always possible to go out of business. The long –run cost curve is a planning curve, in the sense that it is a guide to the entrepreneur in his decision to plan the future expansion of his plant.

Derivation of the long- run average cost curve

The long run average cost curve is derived from the short run average cost curves. Each point on the long run average cost (LAC, now on) corresponds to a point on the short run cost curve, which is tangent to the LAC at that point. Now let us examine in detail how the LAC is derived from the short run average cost (SAC) curves.

assume that the available technology includes large number (infinite number) of plant sizes, each suitable for a certain level of output, the points of intersection of consecutive plants cost curves (which are the crucial points for the decision of whether to switch to a larger plant) are numerous and we obtain a continuous curve, which is the planning LAC curve of the firm.The LAC curve is then the tangent to these SATC curves of various plant sizes and shows the minimum cost of producing each level of output.

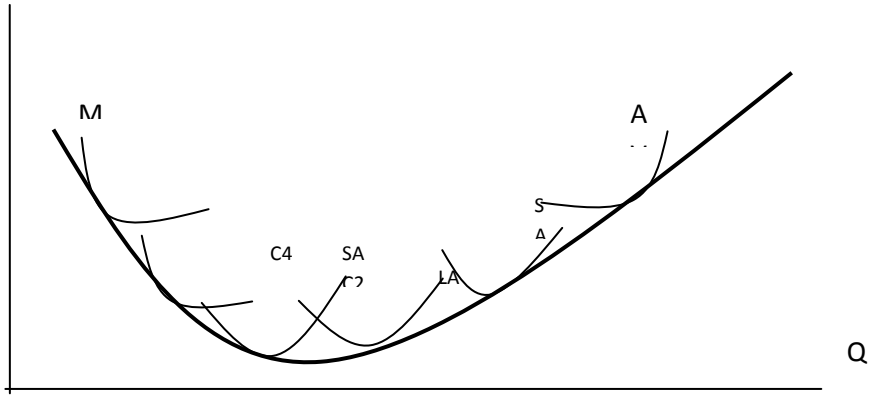


Fig: 4.11 long run average cost curve, assuming large number of plant sizes

In summary, the LAC curve shows the minimum per-unit cost of producing any level of output when the firm can build any desired scale of plant in the sense that the firm chooses the short –run plant which allows it to produce the anticipated (in the long run)output at the least possible cost.

Why is the LAC U-shaped?

Similar to the SAC curve, the LAC curve of a firm is also U-shaped, but the reason for the U-shapes ness of LAC curve is different from that of the SAC curve.

The LAC curve is U-shaped due to the laws of returns to scale(i.e increasing and decreasing returns to scale).that is, as out put expands from a very low levels increasing returns to scale prevails (i.e., out put rises proportionally more than inputs), and so the cost per-unit of output falls(assuming that input prices remain constant).As output continues expand, the forces of decreasing returns to scale eventually begin to overtake the forces of increasing returns to scale and the LAC begins to rise.

In other words, the per unit costs of production decreases initially as the plant size increases, due to the economies of scale which larger plant size makes possible.

Economies of scale is the cost dimension of increasing returns to scale and thus, they are like the two sides of a coin. If a firm has increasing returns to scale in production (i.e., if it requires the firm less than double inputs to produce double output) the firm will have economies of scale in costs (it will require the firm less than double cost to produce double output). Thus, the reason for the decreasing part LAC curve is increasing returns to scale or economies of scale. Economies of scale may prevail for various reasons such as specialization of skills, lower prices for bulk-buying of raw materials, decentralization of management system and etc.

The traditional theory of the firm assumes that economies of scale exists only up to a certain size of plant, which is known as optimal plant size, because with this plant size all possible economies of scale are fully exploited. If the plant size increases further than this optimal size diseconomies of scale will start to prevent, arising from managerial in efficiencies, the price advantage from bulk-buying may also stop beyond a certain limit etc. These diseconomies of scale will lead to increasing LAC curve. Thus, the increasing portion of the LAC curve shows the existence of diseconomies of scale or decreasing returns to scale.

In general, the reason for the U-shaped ness of the LAC curve are the existence of increasing returns to scale at initial stage of expansion decreasing returns to scale at a later stage of expansion.

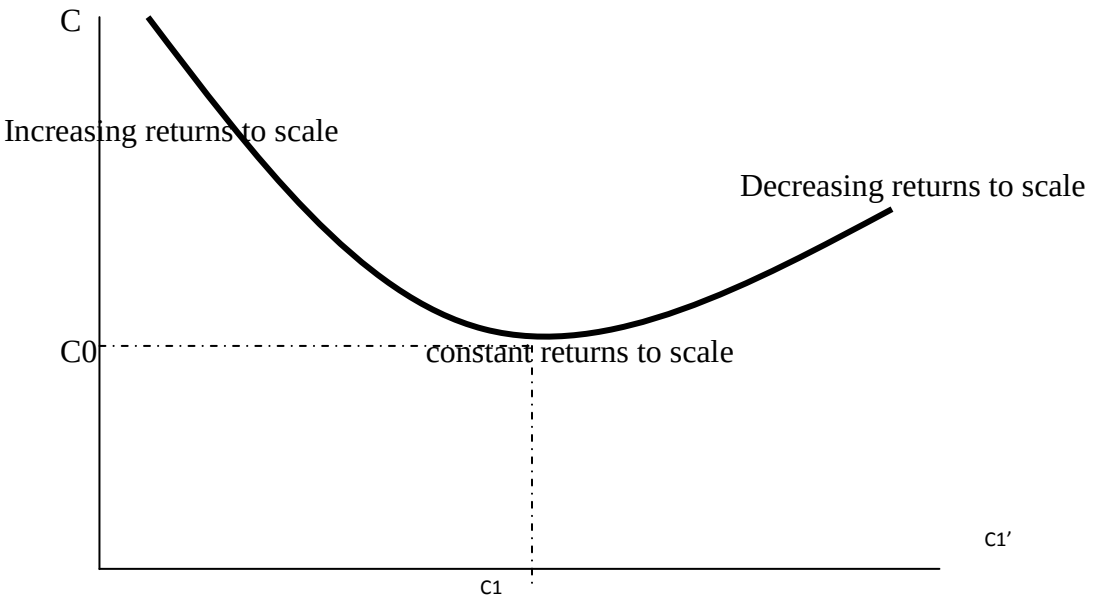


Fig 4.12 the LAC curve is U-shaped due to the combined effects of increasing, constant and decreasing returns.

The long-run marginal cost curve.

The long-run marginal cost curve (LMC) is derived from the short run MC curve but does not envelope them. The LMC is formed from points of intersection of the SMC curves with the vertical lines (to the x-axis) drawn from the points of tangency of corresponding SAC curves and the LAC curve.

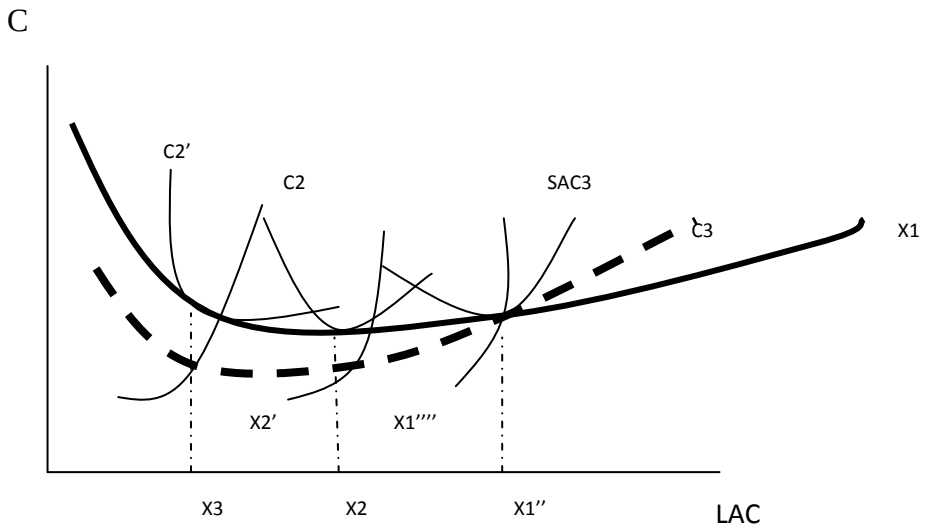


Fig4.13: Long run marginal cost curve; it is derived from the short run marginal cost curves by connecting the points of intersection of the vertical lines drawn from the point of tangency of SAC curves with the LAC curves with and the corresponding SMC curves.

Note that, the LMC curve passes through the minimum of the LAC curve.

4.3. Derivation of Cost Functions from Production functions

4.4 Dynamic changes in costs: the learning curve

So far we have suggested one reason why a large firm may have a lower long-run average cost than a small firm: increasing returns to scale in production it is tempting to conclude that firms which enjoy lower average cost over time are growing firms with increasing returns to scale .but this need not be true.

In some firms, long-run average cost may decline over time because workers and managers absorb new technological information as they become more experienced at their job. That is, as workers get experience their efficiency increases which then reduces the average and marginal costs of producing a unit of product.

As management and labor gain experience with production, the firm's marginal and average costs of producing a given level of out put fall for four reasons:

1. Workers often take long-run to accomplish a given task the first few times they do it. As they become more adept, their speed increases. For example, a worker packing 20 dozens of soups per hour in the first few months can pack more than 20dozens of soups in latter months when he/she gains experience.

2- Managers learn to schedule the production process more effectively.

3- Engineers who are initially cautious in their product designs may gain enough experiences to be able to allow for tolerances in design that save costs with though increasing defects. Better and more specialized tools and plant organization may also lower cost.

4- Suppliers may learn how to process required materials more effectively and pass on some of this advantage in the form of lower costs to the firm.

In general, a firm 'learns' over time as cumulative output increases. Managers can use this learning process to help plan production and for cast future costs. The following figure illustrates this process in the form of learning curve: a curve that describes the relationship between the firms cumulative output and the amount of inputs needed to produce each unit of output.

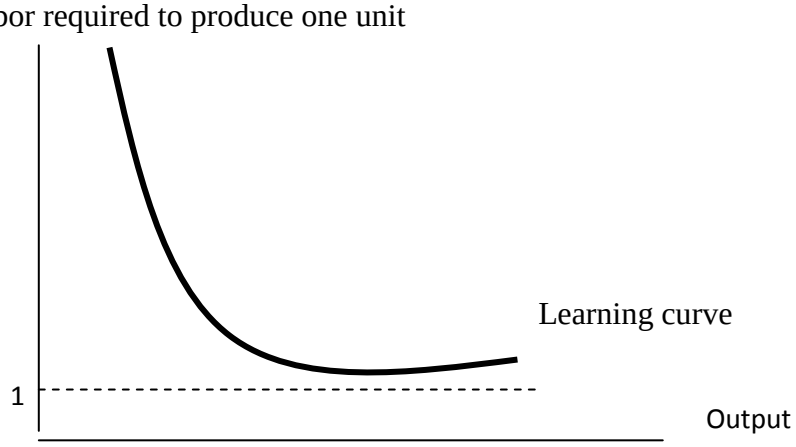


Fig4.14: Learning Curve: shows that at the firm's cumulative output increases(as the firm gets experienced),the amount of inputs(such as labor)required to produce one unit of output decreases.

In the above graph, the per unit production costs decreases along with the amount of labor required to produce a unit of the commodity. This happens because labor input Per unit of output directly affects the production costs. The fewer the hours of labor needed to produce a unit of the commodity, the lower the marginal and average costs of production.

Learning vs Economies of scale

A firm's average cost of production can decline overtime because of growth of sales (output) when increasing returns to scale prevails in the firm (a move from A to B on curve AC,), or it can decline because there is a learning curve (a move from A on AC, to C on AC2).Thus, increasing returns to scale reduces average cost of production with increase in output, whereas learning shifts the average cost curve down ward.

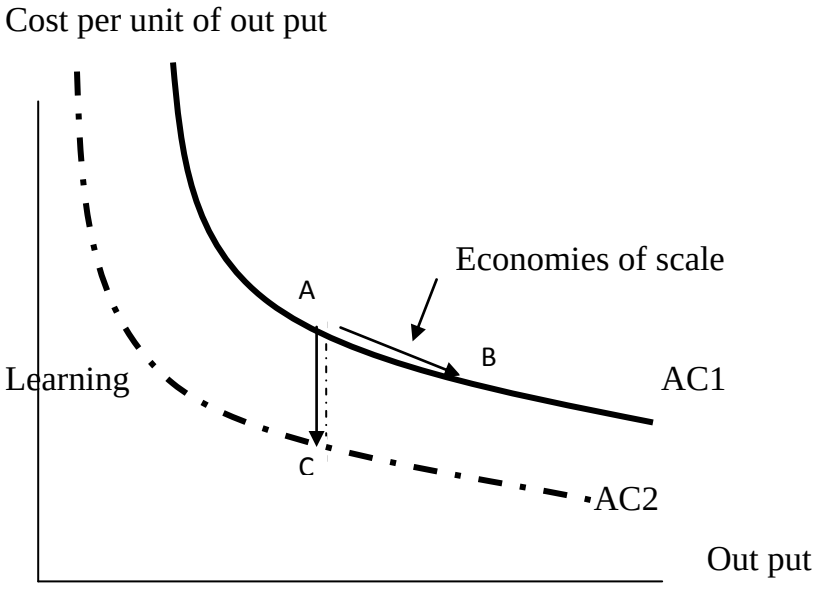


Fig4.15 Learning shifts the average cost curve down wards.

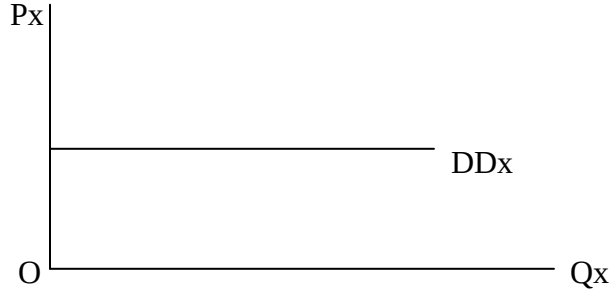
CHAPTER FIVE
PERFECT COMPETTION MARKET

Perfect, unlike everyday usage of the word, is characterized by a complete absence of rivalry (competition) among firms.

Assumptions

- Large number of buyers and sellers: because of the very large number of buyers and sellers an individual buyer or seller is too small to affect the market price.
- Identical commodities are produced by all firms in an industry in terms of its technical characteristics and services associated with its sale and delivery ruling out non-price competition.
- There is free entry to and exit from the industry.

These assumptions will imply that the firms are price takers so they are faced with perfectly elastic demand curve.



- Profit maximization is the sole objective of firms in the industry (no other objectives like welfare, etc.)
- No government intervention
- Perfect mobility of productive resources between or among firms.(Skills can be learned and no factor monopolization and labor unionization.)
- Perfect (complete) knowledge of market condition in the part of sellers and buyers both of the present and the future, and information is free and costless.

These assumptions rule out any uncertainty.

Short-run Equilibrium of the Firm and the Industry

The equilibrium output of the firm is the output that maximizes its total profit. Total profits equal the difference between total revenues and total costs, i.e.

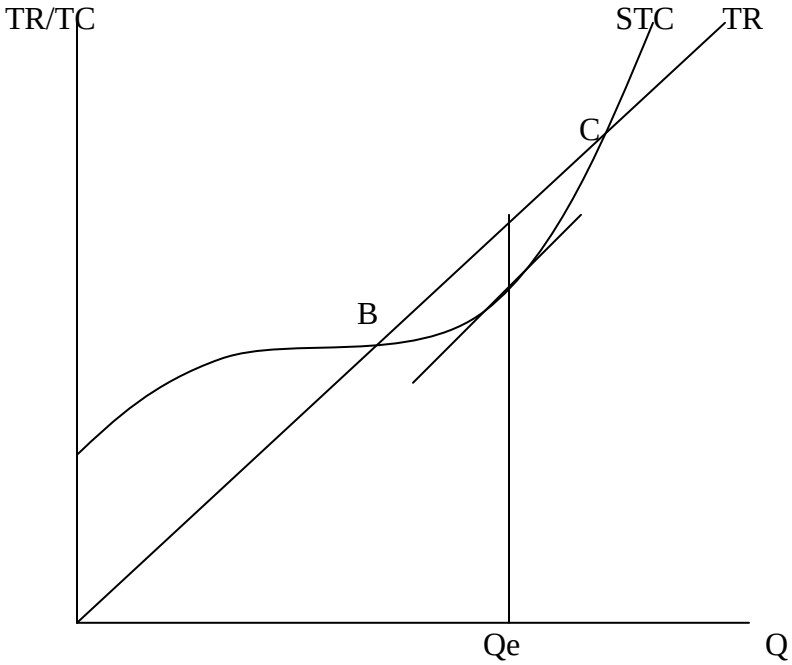
$\prod = TR - TC$

$\prod = PQ - ATC(Q)$

$\prod = Q(P - ATC)$

In a perfectly competitive market structure, price is given (firms are price takers). Thus firms decide on the level of output (Q) they produce to attain their equilibrium points. Two approaches are used in determining a firm's equilibrium.

1. ***The total approach***: total profits are maximized when the positive difference between total revenues and costs is largest.



To the left of point B and to the right of C, STC>TR so that the firm is in a loss (negative ∏). Between B and C, however, the firm is enjoying a positive profit and it is maximized at the point where the vertical difference between the TR and STC is largest (at Qe). Point B is the break-even point where the firm just covers its cost of production and operates at zero economic profit.

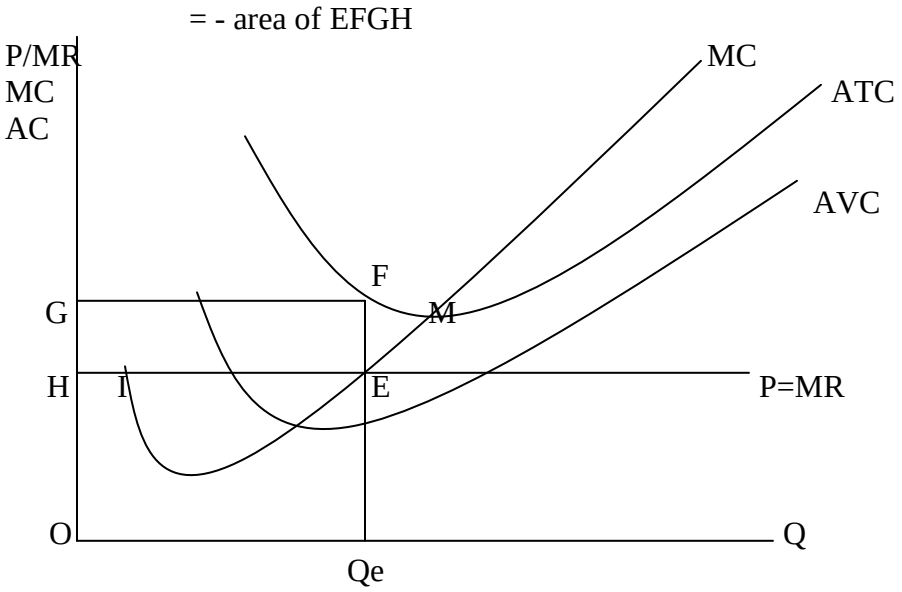
2. ***The marginal approach***: the perfectly competitive firm is a price taker and faces a perfectly elastic demand curve. Since marginal revenue (MR) is dTR/dQ and price(P) is constant, then P = MR.

$$MR = \frac{dTR}{dQ} = \frac{d(PQ)}{dQ} = p\frac{dQ}{dQ} = P$$

Total profit is maximum when the slope of the TR and total cost curves are equal. That is, when MR (P) = MC

The firm is at equilibrium at quantity level Qe (where MR = P = MC at point E). To the left of E, MR > MC (i.e., benefits > costs) and it should increase production. To the right of E, MC>MR and the firm should cut back its production. This particular figure represents the case where the firm operates at a loss (= area of rectangle EFGH).

$$\prod = Q(P - ATC)$$
$$\prod = Qe(-EF)$$
$$\prod = -(EH)(EF)$$



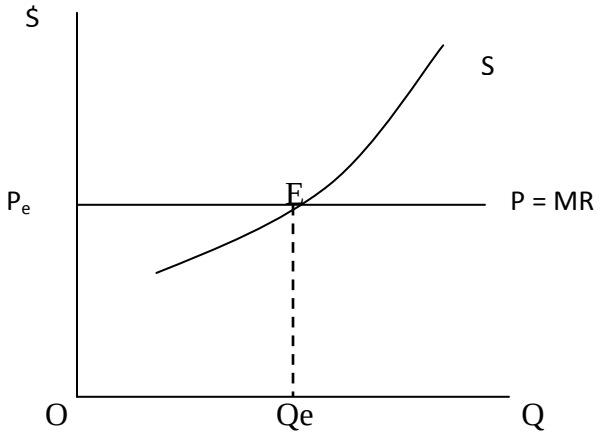
It can be the case that competitive firms may operate at losses, at positive profits, or at a normal (zero) profit. For instance, a firm operates at a positive profit if the demand curves (MR) lies above point M. On the other hand, a firm gets only a normal (zero) profit if the demand curve passes through M. In general,

If	Then
P > AC	Positive (economic) profit
P = AC	Normal (zero) profit, i.e., break-even point
AVC < P < AC	Loss, but the firm continues to produce
P = AVC	Shut-down point
P < AVC	Loss or no operation

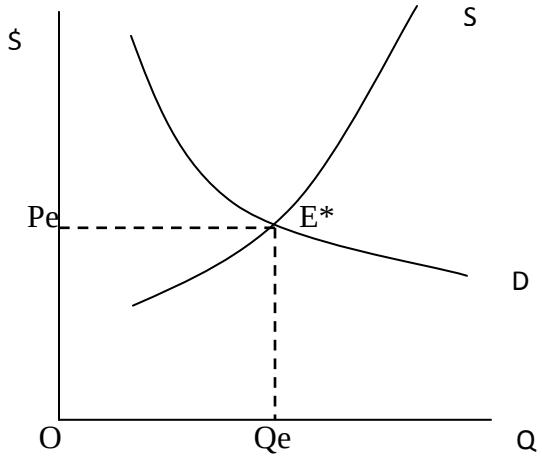
N.B.: in the figure above, P(MR) = MC at two points, E and I. But the profit maximizing level of output is that level of output which corresponds to E. Condition for profit maximization is

1. MR = MC this implies $\frac{d\prod}{dQ} = 0$
2. MC is rising => $\frac{d^2\prod}{dQ^2} < 0$ or $\frac{dM\prod}{dQ} < 0$

The firm operates at different points at the marginal cost curve depending on the level of price it faces. Thus, its supply curve is its MC curve but above the shut-down point. The industry supply curve is the simple horizontal summation of the supply curves of the individual firms. Thus, the industry is at equilibrium when the industry demand curve intersects the industry supply curve.



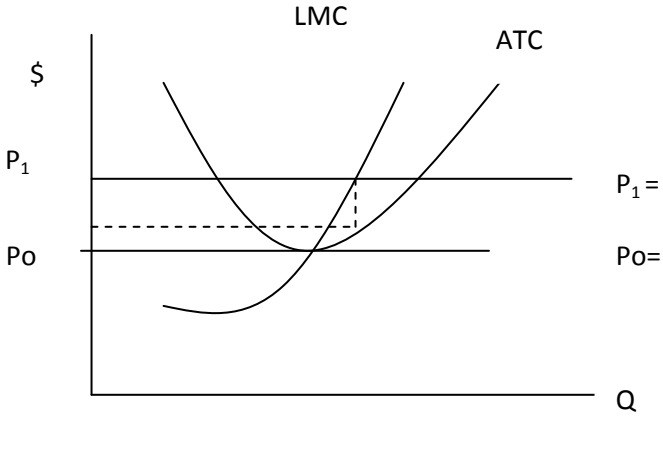
Panel A – short-run equilibrium the firm.



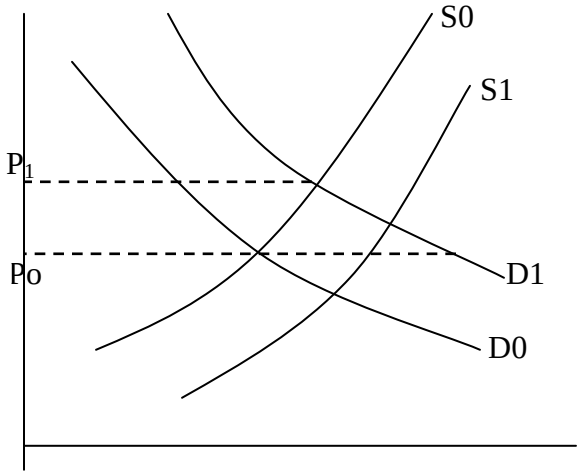
Panel B – Equilibrium of the Industry.

LONG RUN EQUILIBRIUM OF THE FIRM AND INDUSTRY

When long-run equilibrium is achieved, product prices will be exactly equal to, and production will occur at each firm's point of minimum ATC. This is illustrated below for a constant cost industry (the case where the expansion of the industry through entry of new firms will have no effect up on resource prices and, therefore, up on production costs) and a respective firm.



Firm



Industry

Suppose that a change in consumer tastes increase and thus product demand from D0 to D1. This favorable shift in demand obviously makes production profitable; the new price (P1) exceeds ATC. This economic profit will lure new firms into the industry. As the firms enter, the industry supply of the product will increase causing product price to

gravitate downward towards the original level. The economic profits caused by the boost in demand have been completed away to zero and as a result the previous incentive for more firms to enter the industry has disappeared.

Therefore, in the long-run, all firms operate at a point where

(1) P = MR = LMC = LAC = SMC = SAC for the firm and
(2) Supply curve crosses demand for the industry.

In the long-run, all firms in a perfectly competitive industry (market) enjoy only normal profit (zero profit) or at the break-even where TR = TC.

EXERCISE

Suppose you are the manager of a watch-making firm operating in a competitive market. Your cost of production is given by $C = 100 + Q^2$, where Q is the level of output and C is total cost.

a) If the price of watches is birr 60, how many watches should you produce to maximize profit?
b) What will your profit level be?
c) At what minimum price will you produce a positive output?

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CHAPTER SIX

PURE MONOPOLY

Pure monopoly is the form of a market in which a single firm sells a commodity for which there are no close substitutes. Thus the monopolist represents and faces the industry's negatively sloped demand curve for the commodity.

Monopoly can arise from several causes (barriers to entry). Some are:

1. A firm may own or control the entire supply of essential raw material(s).

2. A firm may own a patent for the exclusive right to produce a commodity or to use a particular production process.

3. Economies of scale may operate over a sufficiently large range of outputs so as to leave a single firm supplying the entire market. Such a firm is called *Natural monopoly.*

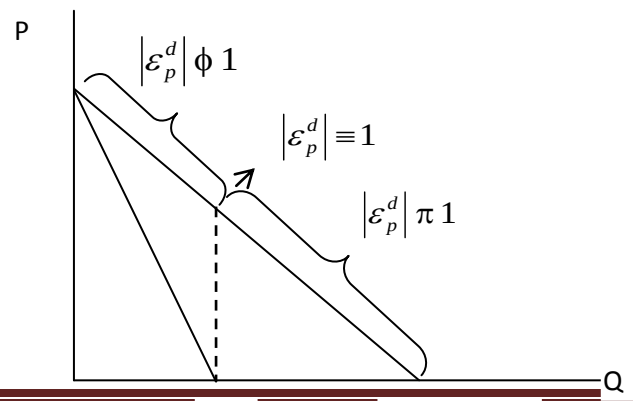
4. Licenses protect present license holders from new competition. i.e., confer monopoly power to them as a group.

The crucial difference between a pure monopolist and a pure competitive seller lies on the demand side of the market. A pure monopoly can increase its sales only by charging a lower unit price for its product. But each additional unit sold will add to total revenue its price less: the sum of the price cuts which must be taken on all prior units of output. Price cuts will apply not only to the extra output sold but also to all other units of output which otherwise could have been sold at a higher price. Hence, marginal revenue is less than price (average revenue) for every level of output except the first.

$TR = PQ$ Or $AR = \frac{TR}{Q} = \frac{PQ}{Q} = P$ =>

$MR = \frac{d(TR)}{dQ} = \frac{d(PQ)}{dQ} = P.\frac{dQ}{dQ} + Q.\frac{dP}{dQ}$ $AR = P$

$=> MR = P + Q.\frac{dP}{dQ}$



Since $\frac{dP}{dQ} < 0$, MR equals P + some negative numbers, => $MR < P$

$$MR = P + Q.\frac{dP}{dQ}$$

$$MR = P\left(1 + \frac{Q}{P}.\frac{dP}{dQ}\right)$$

$$MR = P\left(1 + \frac{1}{\varepsilon_p^d}\right)$$

$$MR = P\left(1 - \frac{1}{\left|\varepsilon_p^d\right|}\right)$$

From the above relation it can be shown that:

a) MR is positive (but less than P), when demand is elastic

b) MR is zero when demand is unitary elastic,

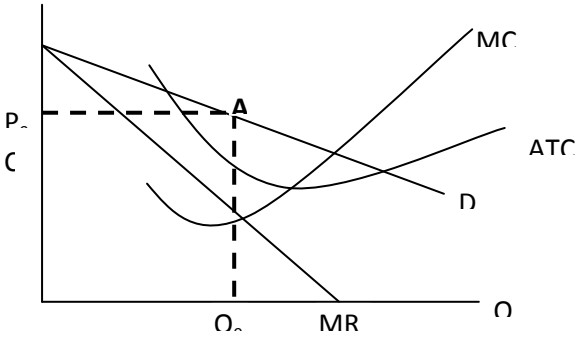
c) MR<0 when $\left|\varepsilon_p^d\right|$<1, and

d) MR=P when $\left|\varepsilon_p^d\right| = \infty$

6.1 Short Run and Long Run equilibria

In the short-run, a monopolist maximizes total profits by producing the level of output at which marginal revenue equals marginal cost or where the distance between the total revenue and total cost curves is the largest).

$$\pi = TR - TC$$
$$\pi = PQ - Q(ATC)$$
$$\pi = Q.(P - ATC)$$



In this particular case P (=P_e)> ATC and hence the monopolist enjoys a positive profit equal to the area P_eABC.

If P is smaller than ATC at the point where MR = MC, the monopolist will incur a loss in the short-run. However, if P > AVC, it pays for the monopolist to continue to produce because production covers part of the fixed costs.

In the long-run, the best or profit maximizing level of output is given by the point where the monopolist's LMC = MR (and LMC curve intersects MR curve from below).

>graph

Even though profits attract additional firms in to the perfectly competitive industry until just all firms break-even in the long-run, the monopolist can continue to earn profits in the long-run because of blocked entry.

The monopolist, as opposed to a perfectly competitive firm, doesn't produce at the lowest point on its LAC curve. Only if the monopolist's MR curve happened to go through the lowest point on its LAC would this be the case.

6.2. Discriminating Monopoly

To this point it has been assumed that the monopolist charges a uniform price to all buyers. Under certain conditions the monopolist might be able to exploit its market position fully and thus increase profits by charging different prices to different buyers. By doing so the seller is engaging in price discrimination. Price discrimination refers to charging different prices (for different quantities of a commodity or in different markets) that are not justified by cost differences. In general, price discrimination is workable when three conditions are realized.

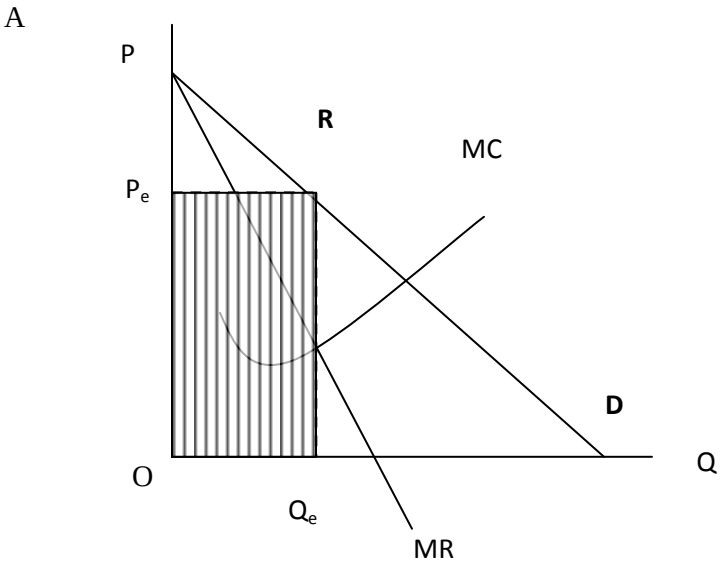
1. The seller must possess some degree of monopoly power,

2. The seller must be able to segregate buyers into separate classes where in each group has a different ability and willingness to pay for the product.

3. The original purchaser cannot resell the product.

Price discrimination (the practice of charging different prices to different customers for similar goods) can take three broad forms which we call first, second and third degree price discrimination.

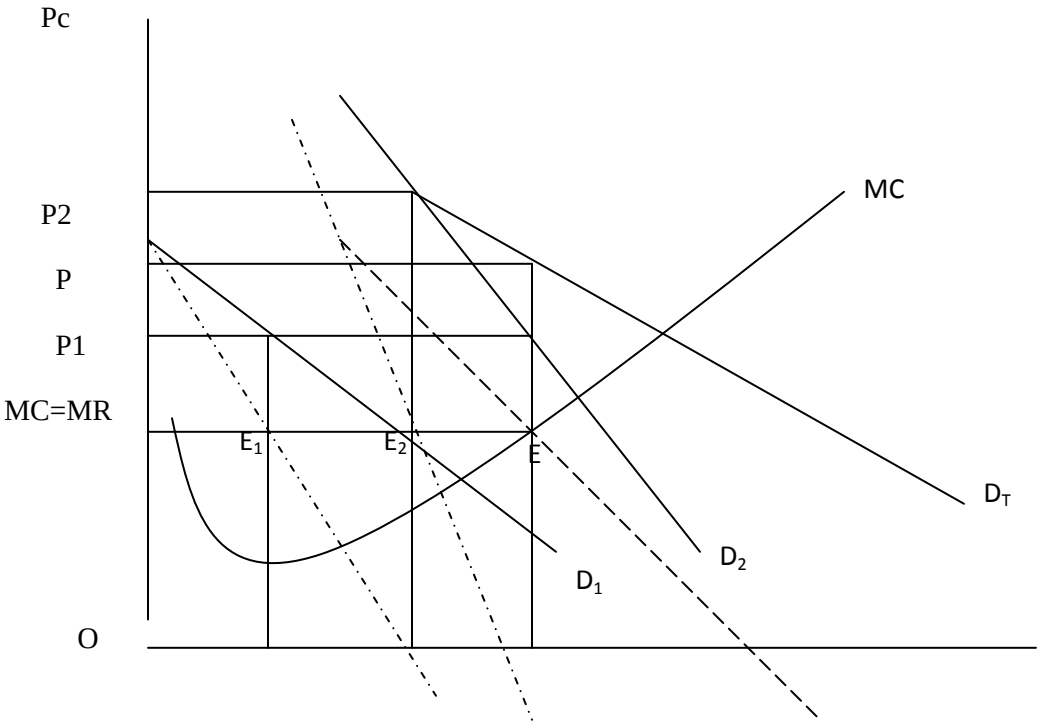
If the monopolist could sell each unit of the commodity separately and charge the highest price each customer would be willing to pay for the commodity - reservation price - the monopolist would be able to extract the entire customer's surplus. This is called first degree or perfect price discrimination.



Without price discrimination, the monopolist charges $P_{e,}$ sells quantity $Q_{e\ and}$ thus total revenue equals the area of $P_eRQ_eO_.$ With perfect price discrimination, the monopolist captures the entire consumer surplus ARP_e by selling its product at a maximum price that consumers are willing to pay for the commodity (shown by point A). this method is also known as "take-it-or-leave-it" price discrimination, because the monopolist charges the maximum price consumers are willing to pay.

Knowing the exact shape of each consumer's demand curve (and be able to charge reservation prices) and be able to prevent arbitrage is impossible or prohibitively expensive to carry out. Thus, first degree price discrimination is not very common in the real world. More practical and common is second-degree or multipart price discrimination. This refers to the charging of a uniform price per unit for a specific quantity of the commodity, a lower price for an additional batch or block of the commodity, and so on. Quantity discounts are an example of second degree price discrimination. Here the monopolist extracts part, but not all, of the consumer's surplus.

Third degree price discrimination is the practice of dividing consumers in to two or more groups with separate demand curves and charging different prices to each group. Some characteristic is used to divide customers in to distinct group. For many goods, for example, students are usually willing to pay less on average than the rest of the population.



The total quantity produced, X is determined by the intersection of the MR_T and MC curves. This quantity is then divided between the two groups of customers (assuming only two groups for simplicity) so that marginal revenues for each group are equal. Otherwise, the firm would not be maximizing profit. For example, if $MR_1 > MR_2$, the firm could clearly do by shifting output from the second group to the first. Not only should the two marginal revenues equal, but also the marginal cost should be equal to the marginal revenues. If this were not the case the firm could increase its profitability by raising or lowering total output (and lowering or raising its prices to both groups).

Total profit of the firm is given by $\pi = P_1Q_1 + P_2Q_2 - C(Q_T)$

Where P1 = the price charged to group one

P2 the price charged to group two

$C(Q_T)$ = total cost of producing output $Q_T = Q1 + Q2$

The firm should increase its sells to each group until the incremental profit from the last unit sold is zero.

$$\frac{d\pi}{dQ_1} = 0, and \frac{d\pi}{dQ_2} = 0$$

$$\frac{d(PQ_{1_1})}{dQ} - \frac{dC}{dQ_1} = 0, and \frac{d(PQ)_2}{dQ} = 0$$

$$MR_1 - MC = 0, and MR_2 - MC = 0$$

$$MR_1 = MC, and MR_2 = MC$$

Prices and output must be set so that $MR_1 = MR_2 = MC$

- Recall that

$$MR = P\left(1 + \frac{1}{e_p}\right)$$

$$=> MR_1 = P_1\left(1 + \frac{1}{e_{p1}}\right) and MR_2 = P_2\left(1 + \frac{1}{e_{p2}}\right)$$

$But, MR_1 = MR_2$ At the maximum profit

$$=> P_1\left(1 + \frac{1}{e_{p1}}\right) = P_1\left(1 + \frac{1}{e_{p2}}\right)$$

Rearranging gives

$$\frac{P_1}{p_2} = \frac{\left(1 + \frac{1}{e_{p2}}\right)}{\left(1 + \frac{1}{e_{p1}}\right)}$$

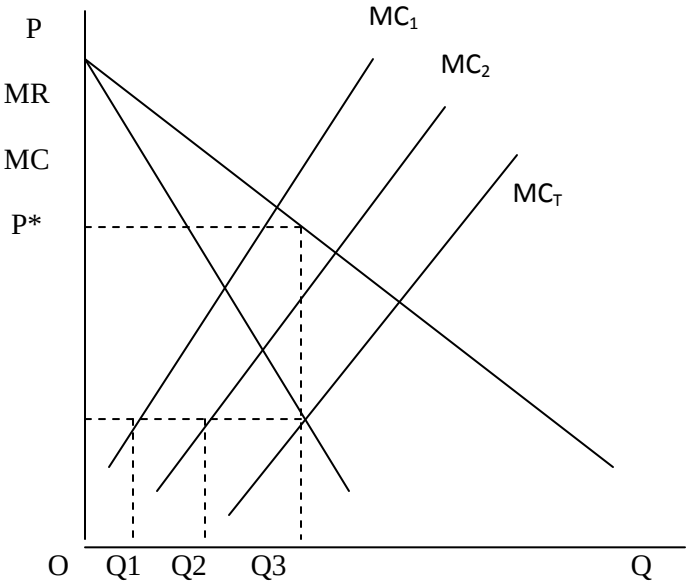
If the demand in market segment 2 is relatively elastic,(i.e. if $e_{p2} < e_{p1}$, then

$$1/e_{p2} > 1/e_{p1} => \left(1 + 1/e_{p2}\right) > \left(1 + 1/e_{p2}\right) => P_1 > P_2$$

The higher price will be charged to consumers with the lowest demand elasticity.

6.3 MULTIPLANT MONOPOLY

A monopolist maximizes profit by setting output at a level where MR =MC. For many monopolists, production takes place in two or more different plants whose operating costs can differ. However, the logic used in choosing output levels is very much similar to that for the single-plant firm. Suppose a firm has two plants. Whatever the total output, it should be divided between the two plants so that MC is the same in each plant. Otherwise, the firm could reduce its costs and increase its profit by reallocating production. For example, if MC1 > MC2, the firm could produce the same output at a lower total cost by producing less at plant 1 and at plant 2.



Profit is maximized when MR = MC at each plant. If MR > MC, the firm would do better by producing more at both plants.

$\prod = PQt - C1(Q1) - C2(Q2)$

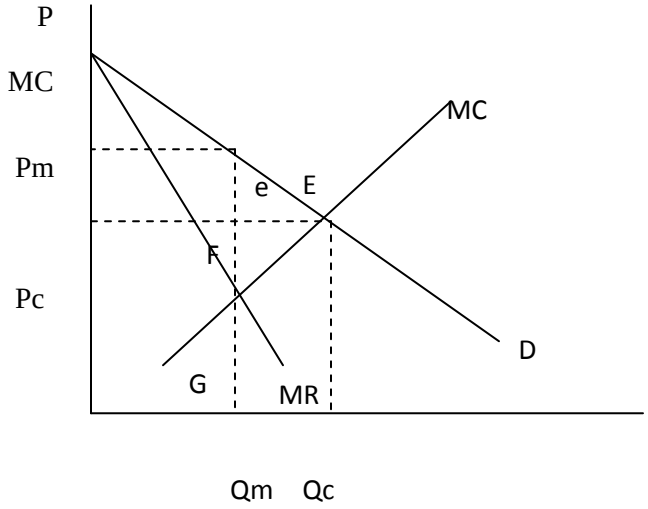
⇨ $\frac{d\prod}{dQ_1} = \frac{d(PQt)}{dQ_1} - \frac{dC_1}{dQ_1} = 0$, and $\frac{d\prod}{dQ_2} = \frac{d(PQt)}{dQ_2} - \frac{dC_2}{dQ_2} = 0$

⇨ $MR = MC_1$, and $MR = MC_2$

⇨ $MR = MC_1 = MC_2$

6.4 SOCIAL COST OF MONOPOLY

In a competitive market, price equals marginal cost. Monopoly power on the other hand, implies that price exceeds marginal cost. Because monopoly power results in higher prices and lower quantities produced, we would expect it to make consumers worse off and the firm better off. Suppose we value welfare of consumers the same as that of producers. In the aggregate, does monopoly power make consumers and producers better or worse off?



Pc, the competitive firm's price, equals MC and thus Qc quantity is produced. If this firm is replaced by a monopolist, Pm price will be charged and Qm quantity will be produced. Consumer's surplus declines from PcEY to PmeY (by the amount equal to PmEPc). But, only PmeFPc is extracted by the monopolist. Similarly, GEF is the proportion of the producers' surplus lost. In sum, while PmeFPc represents transfer from consumers' surplus to producers, eEF + EFG represents the dead-weight loss due to monopoly – the social cost of monopoly.

EXERCISE

1) A monopolist is deciding how to allocate output between two markets that are separated geographically. Demands for the two markets are $P_1 = 15 - Q_1$ and $P_2 = 25 - 2Q_2$. The monopolist's TC is $C = 5 + 3(Q_1+Q_2)$. What are price, output, profits, and MR if:

a) The monopolist can price discriminate?

b) The law forbids (prohibits) charging different prices in the two regions?

2) A drug company has a monopoly on a new patented medicine. The product can be made in either of two plants. The costs of production for the two plants are $MC_1 = 10 + 2Q_1$ and $MC_2 = 25 + 5Q_2$. The firm's estimate of demand for the product is

$P = 2000 - 3(Q_1+Q_2)$. How much should the firm plan to produce in each plant? At what price should it plan to sell the product?