MICROECONOMIC THEORY II

ECO 232

SCHOOL OF ARTS AND SOCIAL SCIENCES

STUDY GUIDE

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Introduction

Welcome to ECO: 232
MICROECONOMIC THEORY II
Microeconomic Theory II is a three-credit and one-semester undergraduate course for second year Economics student. The course is made up five modules of twenty units spread across fifteen lectures weeks. This course guide builds on the ECO 232 you studied in first semester. It also tells you about the course materials and how you can work your way through these materials. It suggests some general guidelines for the amount of time required of you on each unit in order to achieve the course aims and objectives successfully. Answers to your Tutor Marked Assignments (TMAs) are therein already.

Course Content

This course is basically an intermediate course on the Micro-economics aspect of economics theory. This course builds on the knowledge gained in ECO 201. The focus here is on the use of quantitative methods in analyzing advanced macro-economics. Topics include: the theory of demand; the theory of production; cost theory, general equilibrium theory and welfare economics with particular reference to Nigeria.

Microeconomic theory is quite abstract in nature, hence is one of the most challenging courses students. With this in mind this course material is to help overcome this difficulty by explaining microeconomic theory from a learn-by-doing procedure. However, you should read other current textbooks to supplement to this.

Course Aims

The aims of this course is to give you in-depth understanding of the economics as regards
- The behaviour of buyers and sellers in a particular industry in isolation from the conditions prevailing in other industries (market)

- The way in which households and firms actually pay for their purchases and as well as how individual economic agent and firm interact to meet their needs in an economy.

  Help you to understand clearly the relationship between input costs and the level of the firm's output. It also introduces the firm's production function, which shows the relationship between inputs used and the level of output those results.

  Equipping you with a kit of modern tools of economic analysis which will help to understand and analyze the practical economic complexities.

Course Objectives

To achieve the aims of this course, there are overall objectives which the course is out to achieve though, there are set out objectives for each unit. The unit objectives are included at the beginning of a unit; you should read them before you start working through the unit. You may want to refer to them during your study of the unit to check on your progress. You should always look at the unit objectives after completing a unit. This is to assist the students in accomplishing the tasks entailed in this course. In this way, you can be sure you have done what was required of you by the unit. The objectives serves as study guides, such that student could know if he is able to grab the knowledge of each unit through the sets of objectives in each one. At the end of the course period, the students are expected to be able to:

- Differentiate between the changes in quantity demanded and change in demand
- Explain the relationship among total revenue, marginal revenue and price elasticity with the use of graph.
- Explain how firms transforms resources allocated (input) into product (output) and understand the circular flow of supply and demand between households and firm
- To explain cost concepts and calculate minimum cost that will enable a producer to produce optimally
- Why the study of welfare economics is of essence to policy formulation in a country

Working through the Course

To successfully complete this course, you are required to read the study units, referenced books and other materials on the course.

Each unit contains self-assessment exercises called Self- Assessment Exercises (SAE). At some points in the course, you will be required to submit assignments for assessment purposes. At the end of the course there is a final examination. This course should take about 15weeks to complete and some components of the course are outlined under the course material subsection.

Course Material
The major component of the course, What you have to do and how you should allocate your time to each unit in order to complete the course successfully on time are listed follows:
1. Course guide
2. Study unit
3. Textbook
4. Assignment file
5. Presentation schedule

Study Unit

There are16 units in this course which should be studied carefully and diligently.

MODULE 1: INTRODUCTION AND THEORY OF DEMAND AND SUPPLY

Unit 1:   Theory of Demand
Unit 2:   Theory of Supply
Unit 3:   The Market Mechanism
Unit 4:   Elasticity of Demand and Supply

MODULE 2: THEORY OF PRODUCTION

Unit 1:   Theory of Production I
Unit 2:   Theory of Production II
Unit 3:   Theory of Production III
Unit 4:   Theory of Production IV

MODULE 3: THEORY OF COST

Unit 1:   Theory of Cost: Introduction
Unit 2:   Theory Cost II
Unit 3:   Theory Cost III
Unit 4:   Theory Cost IV

MODULE IV: GENERAL EQUILIBRIUM THEORY AND WELFARE ECONOMICS

Unit 1:   Introduction to General Equilibrium Concept
Unit 2:   General Equilibrium in Production and Exchange
Unit 3:   Welfare Economics I
Unit 4:   Welfare Economics II

Each study unit will take at least two hours, and it include the introduction, objective, main content, self-assessment exercise, conclusion, summary and reference. Other areas border on the Tutor-Marked Assessment (TMA) questions. Some of the self-assessment exercise will necessitate discussion, brainstorming and argument with some of your colleagues.

There are also textbooks under the reference and other (on-line and off-line) resources for further reading. They are meant to give you additional information if only you can lay your hands on any of them. You are required to study the materials; practice the Self-Assessment Exercise and Tutor-Marked Assignment (TMA) questions for greater and in-depth understanding of the course. By doing so, the stated learning objectives of the course would have been achieved.

Textbook and References

For further reading and more detailed information about the course, the following materials are recommended:

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Karl E.C. and Line C. F (2007):*Principles of Microeconomics*, Pearson Education International, New Jersey, USA.

Kelvin L. and Lipsey R. G., "The General Theory of the Second Best," Review of Economic Studies 24

Koutsoyiannis A. (1979): Modern Microeconomics 2ed., Macmillan Press Limited, Hampshire, London.

Nicholson W. and Snyder C. (2010): Intermediate Microeconomics 11Ed., South-Western Cengage Learning, Mason, USA

O'Sullivan A. and Sheffrin S.M. (2002):*Microeconomics: Principles And Tools:* Pearson Education, New Jersey, USA

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc. New York. USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing Company, Minnesota, USA.

Umo J.U.(1986): *Economics, African Perspective*; John West publications Limited, Lagos.

Assignment File

Assignment files and marking scheme will be made available to you. This file presents you with details of the work you must submit to your tutor for marking. The marks you obtain from these assignments shall form part of your final mark for this course. Additional information on assignments will be found in the assignment file and later in this Course Guide in the section on assessment.

There are four assignments in this course. The four course assignments will cover:
Assignment 1 -   All TMAs' question in module 1 Unit 1   24
Assignment 2 -   All TMAs' question in module 2 Unit 4   96, 101
Assignment 3 -   All TMAs' question in module 3 Unit 3   128
Assignment 4 -   All TMAs' question in module 4 Unit 2   159, 165

Presentation Schedule

The presentation schedule included in your course materials gives you the important dates for this year for the completion of tutor-marking assignments and attending tutorials and group discussion. Remember, you are required to submit all your assignments by due date. You should guide against falling behind in your work.

Assessment

There are two types of the assessment of the course. First are the tutor-marked assignments; second, there is a written examination.

In attempting the assignments, you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted as required by the University for formal Assessment in accordance with the deadlines stated in the Presentation Schedule and the Assignments File. The work you submit for assessment will count for 30 % of your total course mark.

At the end of the course, you will need to sit for a final written examination. This examination will also count for 70% of your total course mark.

Tutor-Marked Assignments (TMAs)

There are four tutor-marked assignments in this course. You will submit all the assignments. You are encouraged to work all the questions thoroughly. The TMAs constitute 30% of the total score.

Assignment questions for the units in this course are contained in the Assignment File. You will be able to complete your assignments from the information and materials contained in your set books, reading and study units. However, it is desirable that you demonstrate that you have read and researched more widely than the required

minimum. You should use other references to have a broad viewpoint of the subject and also to give you a deeper understanding of the subject.

When you have completed each assignment, send it, together with a TMA form, to your tutor. Make sure that each assignment reaches your tutor on or before the deadline given in the Presentation File. If for any reason, you cannot complete your work on time, contact your tutor/study centre before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances.

Final Examination and Grading

The final examination will have a value of 70% of the total course grade. The examination will consist of questions which reflect the types of self-assessment practice exercises and tutor-marked problems you have previously encountered. All areas of the course will be assessed

Revise the entire course material using the time between finishing the last unit in the module and that of sitting for the final examination to. You might find it useful to review your self-assessment exercises, tutor-marked assignments and comments on them before the examination. The final examination covers information from all parts of the course.

Course Marking Scheme

The Table presented below indicates the total marks (100%) allocation.

Assignment	Marks
Assignments (Best three assignments out of four that is marked)	30%
Final Examination	70%
Total	**100%**

Course Overview

The Table presented below indicates the units, number of weeks and assignments to be taken by you to successfully complete the course, Principle of Economics (ECO 111).

Units	Title of Work	Week's Activities	Assessment (end of unit)
	Course Guide		
	Module 1		
1	Theory of Demand	Week 1	Assignment 1
2	Theory of Supply	Week 2	Assignment 1
3	The Market Mechanism	Week 3	Assignment 1
4	Elasticity of Demand and Supply	Week 4	
	Module II		
1	Theory of Production I	Week 4	Assignment 2
2	Theory of Production II	Week 5	Assignment 2
3	Production Theory III	Week 6	Assignment 2
4	Theory of Production IV	Week 7	Assignment 2
	Module III		
1	Theory Of Cost: Introduction	Week 8	Assignment 3
2	Theory Cost II	Week 9	Assignment 3
3	Theory Cost III	Week 10	Assignment 3
4	Theory Cost IV	Week 11	
	Module IV		
1	Introduction to General Equilibrium Concept	Week 12	Assignment 4
2	General Equilibrium in Production and Exchange	Week 13	Assignment 4
3	Welfare Economics II	Week 14	
4	Welfare Economics II	Week 14	Assignment 4
	Total	**15weeks**	

How To Get The Most From This Course

In distance learning, the study units replace the university lecturer. This is one of the greatest advantages of distance learning; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as reading the lecture instead of listening to a lecturer. In the same way that a lecturer might set you some reading to do, the study units tell you when to read your books or other materials and when to embark on discussion with your colleagues. Just

as a lecturer might give you an in-class exercise, your study units provides exercises for you to do at appropriate points.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. You should use these objectives to guide your study. When you have finished the unit you must go back and check whether you have achieved the objectives. If you make a habit of doing this you will significantly improve your chances of passing the course and getting the best grade.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or from a readings section. Some units require you to undertake practical overview of historical events. You will be directed when you need to embark on discussion and guided through the tasks you must do.
The purpose of the practical overview of some certain historical economic issues are in twofold. First, it will enhance your understanding of the material in the unit. Second, it will give you practical experience and skills to evaluate economic arguments, and understand the roles of history in guiding current economic policies and debates outside your studies. In any event, most of the critical thinking skills you will develop during studying are applicable in normal working practice, so it is important that you encounter them during your studies.

Self-assessments are interspersed throughout the units, and answers are given at the ends of the units. Working through these tests will help you to achieve the objectives of the unit and prepare you for the assignments and the examination. You should do each self-assessment exercises as you come to it in the study unit. Also, ensure to master some major historical dates and events during the course of studying the material.

The following is a practical strategy for working through the course. If you run into any trouble, consult your tutor. Remember that your tutor's job is to help you. When you need help, don't hesitate to call and ask your tutor to provide it.

1.   Read this Course Guide thoroughly.
2.   Organize a study schedule. Refer to the `Course overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester is available from study centre. You need to gather together all this information in one place, such as your dairy or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working breach unit.
3.   Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their

course work. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.

4. Turn to Unit 1 and read the introduction and the objectives for the unit.

5. Assemble the study materials. Information about what you need for a unit is given in the `Overview' at the beginning of each unit. You will also need both the study unit you are working on and one of your set books on your desk at the same time.

6. Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.

7. Up-to-date course information will be continuously delivered to you at the study centre.

8. Work before the relevant due date (about 4 weeks before due dates), get the Assignment File for the next required assignment. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the exam. Submit all assignments no later than the due date.

9. Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your tutor.

10. When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

11. When you have submitted an assignment to your tutor for marking do not wait for it return `before starting on the next units. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also written on the assignment. Consult your tutor as soon as possible if you have any questions or problems.

12. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this Course Guide).

Tutors and Tutorials

There are some hours of tutorials (2-hours sessions) provided in support of this course. You will be notified of the dates, times and location of these tutorials. Together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter, and provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary. Contact your tutor if.

- You do not understand any part of the study units or the assigned readings
- You have difficulty with the self-assessment exercises
- You have a question or problem with an assignment, with your tutor's comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

Summary

The course, Microeconomic Theory (ECO 232), contains description of demand and supply analysis that you need to have basic understanding of economics principles.
The relationship between the price elasticity of demand for a firm's product and the behaviour of its total revenue were given attention in this material.

The conditions necessary for the production by a firm of a given level of output at the possible cost are derived first. The relationship between production and firm's costs are examined and the various types of cost concepts typically used in the analysis of firm behaviour are explained. The various possible goals of a firm is to maximize its profit.
Conclusively, the final module of this material centered on general equilibrium analysis and welfare economics.

On successful completion of the course, you would have developed critical thinking skills with the material necessary for efficient and effective discussion of economic issues, factors of production and behaviour of firms and economic agent. We wish you success with the course and hope that you will find it fascinating and handy.
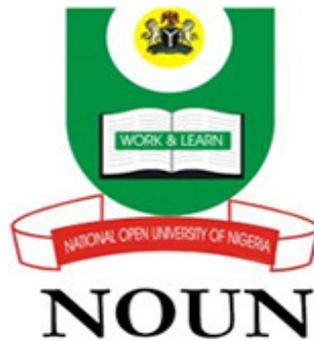
MICROECONOMIC THEORY II

ECO 232

SCHOOL OF ARTS AND SOCIAL SCIENCES

COURSE MATERIAL

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1.0   Introduction

The much of microeconomic theory revolves around the concepts of demand and supply and the workings of the price system. This module describes, demandand supply form the foundation of a market-oriented economy and determine the prices that are paid for many, if not all, products. Briefly we discuss the factors that determine the demand for a particular good or service and the effects of changes in them.

Themuch of microeconomic theory revolves around the concepts of demand and supply and the workings of the price system.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Define market and conditions to consider
2.   Differentiate between the changes in quantity demanded and change in demand
3.   Explain briefly five factors that affect demand for a particular product

3.0   MAIN CONTENT
3.1   The Market

A market is the network of communications between individuals and firms for the purpose of buying and selling goods and services. Markets provide the framework for the analysis of the forces of demand and supply.

A market consists of the potential buyers and sellers of some good or service (or a group of closely related goods or services) who are interacting for the purpose of exchange.

You should also note the actions of each buyer and seller will generally be affected by the number of participants in the market.

3.2   Concept of demand

In real life, individual make many decision at the same time. To understand how the forces of demand and supply work, however, let us first focus on the amount of single product that an individual household decides to consume within some given period of time, such as a month or a year.
Demand is the relationship between the quantity of a product that consumers are willing and able to buy over some given period and its price, other things remaining the same.

Quantity demanded of a product is the amount (number of units) of a product that an individual would buy in a given period if it could buy all it wanted at the current market price. The amount of a product that an individual finally buy depends on the amount of product actually available in the market.
The quantity that consumers are willing and able to buy at each price is called quantity demanded at that price.

The examination of these words (phrase) is quite critical to the definition of quantity demanded as it allows for the possibility that quantity supplied and quantity demanded are not equal.

3.3   Demand Schedule and Demand Curve

A market demand schedule is a table showing the quantity of commodity that consumers are willing and able to buy over agiven period of time at each price of the commodity, while holding constant all other relevant economic variables on which demand depends. Among the variables held constant are consumers' incomes, their tastes, the prices of related commodities (compliments and substitutes) and the number of consumers in the market.

Table 1.1 Biodun demand schedule for phone calls

Price (Naira /per call)	Quantity demand (call per week)
0	30
1.50	25
4.50	7
9.00	3
12.00	1
17.00	0

The above demand schedule above shows that at lower prices Biodun calls his friend frequently; at higher prices, she calls less frequently. There is thus a negative or inverse relationship between quantity demanded and price. When price rises quantity demanded falls, and when price falls, quantity demanded rises. Thus demanded curves always slope downward. This negative relationship between price and quantity demanded is often referred to as the law of demand, a term first used by economist Marshall in his 1890 textbook.
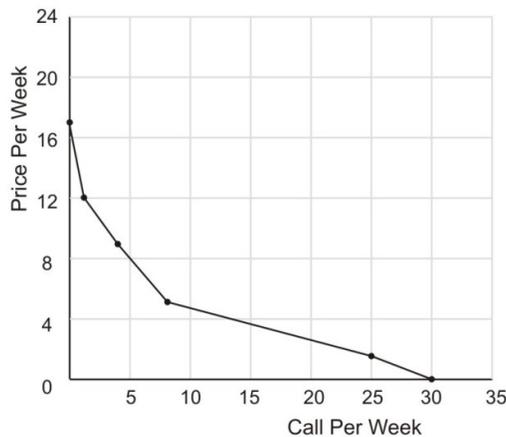
Figure 1.1: The Demand Curve

The term law means nothing more than a general proposition or statement of tendencies, more or less certain, more or less definite

In other words for the fact that demand curves slope downwards rest on the notion of utility.Economists the concept of utility to mean happiness or satisfaction. Presumably, we consume goods and services because they give us utility they give us utility. As we consume more of a product within a given period of time, it is likely that each additional unit consumed will yield successfully the same satisfaction. Thus, it is reasonable to expect the downward slope in the demand curve for such goods. Biodun's behaviour is well understood through the idea of diminishing marginal utility.

3.3   Changes in Quantity Demanded Versus Changes in demand

The most important relationship in individual markets is the between market and quantity demanded. We shall attempt to derive a relationship between the quantity demanded of a product per time period and the price of that product, holding income wealth, other prices, tastes, and expectations constant.

It is nice to differentiate between price changes, which affect the quantity demanded and changes in other factors (such as income), which change the whole relationship between price and quantity. Changes in the price of a product affect the quantity demanded per period of a product affect the quantity

demanded per period as shown by figure 1.2. Changes in any other factor, such as income or preferences, taste, substitute goods affect demand. Thus, we say that an increase in the price of Pepsi-Cola is likely to cause a decrease in the quantity of Pepsi- Cola demanded. Conversely, we can say that an increase in income is likely to cause an increase in the demand for most goods as illustrated by figure 1.3.
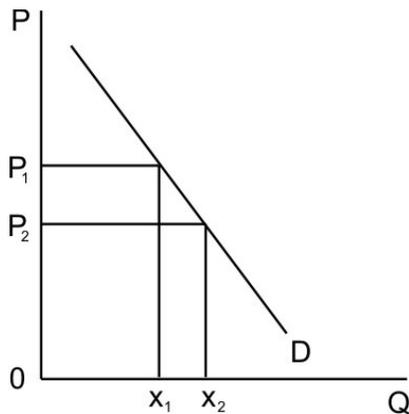
Figure 1.2
Movement along the demand
curve as the price of x changes.
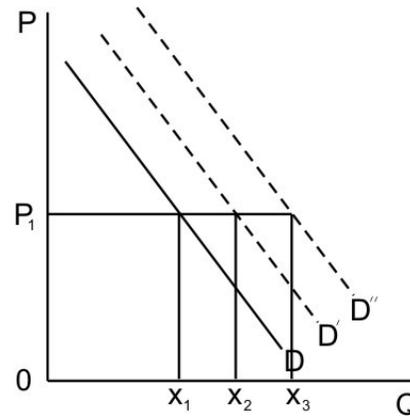
Figure 1.3
Shifts of the demand curveas,
for example, income increases.

SELF ASSESSMENT EXERCISE 1: Explain the difference between a change in demand and a change in quantity demanded.

3.4   The Market Demand

The quantity demanded in the market at each price is the sum of the individual demands of all consumers at that price. In other words, the sum of all the quantity of goods or services demanded per period by all the individuals buying in the market for that goods or services. A market demand curve shows the total amount of a product that would be sold at each price if individuals could buy all they wanted at that price.

The market or aggregate demand for a commodity gives the alternative amounts of the commodity demanded per time period, at various alternative prices, by all the individuals in the market. The market demand for a commodity thus depends on all the factors that determine the individual's demand and, in addition, on the number of buyers of the commodity in the market. The market demand curve for a commodity is obtained by the horizontal summation of all the individuals' demand curves for the commodity

EXAMPLE1. If there are two identical consumers in the market, each with a demand for commodity X given by $Qd_x = 7 - Px$, the market demand (QD_x) is obtained as indicated

Price(N)	Quantity demanded(Qd_{x1})	Quantity demanded(Qd_{x2})	Market Demand (QD_x)
7	0	0	0
3	3	3	6
0	7	7	14
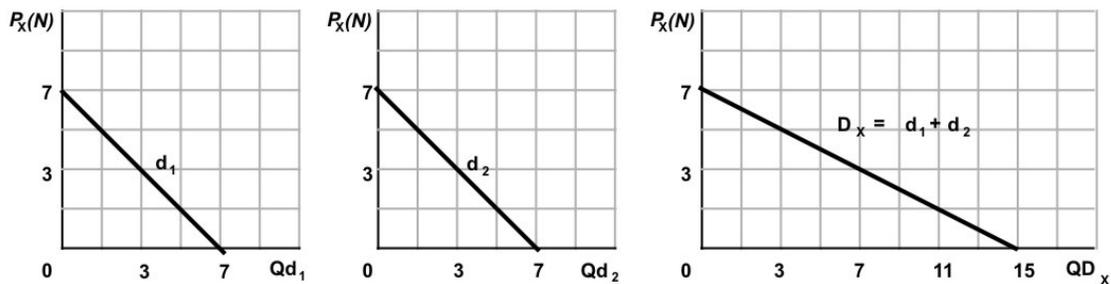
SELF ASSESSMENT EXERCISE 2: State and explain three factors that can affect quantity demanded in market

4.0   CONCLUSION

In this unit we have reviewed the basic elements of demand and supply and the functioning of a market system. A market is the interaction of buyers and sellers of some goods and service. Demand is the relationship between the quantity of a product that consumers are willing and able to buy over some given time period and its price. The quantity that consumers are willing and able to buy at each price is called quantity demanded.

5.0   SUMMARY

In this unit we have reviewed the basic elements of demand and supply and the functioning of a market system. A market is the interaction of buyers and sellers of some good or service.

Demand is the relationship between the quality of a product that consumers are willing and able to buy over some given time period and its price. The quantity that consumers are willing and able to buy at each price is called quantity demanded at that price.

A demand schedule is a table depicting the quantity demanded of a product over a given time period at various prices. A demand curve is a graphical

representation of a demand schedule. Demand schedules and demand curves typically obey the law of demand, which states that the quantity demanded of a good or service by consumers will fall as the price of the product rises and increase as its price falls.

6.0   TUTOR MARKED ASSIGNMENT

1.   What happens to demand for luxury cars when the price of petrol increases? What happens to the demand for big cars when the prices of luxury cars fall? Illustrates your answer with graphs of demand curves?

2.   The demand function of a good is given by QD = 500 - 100P, where QD stands for the market quantity demanded of the commodity per time period and P for the price of the commodity. (a) Derive the market demand schedule for this commodity when price changes from N1 to N5 (b) Draw the market demand curve for this commodity.

3.   Given the following demand schedule of a commodity

P (N)	6	5	4	3	2	1	0
QD	0	10	20	30	40	50	60

Show that by substituting the prices given in the table into the following demand equation or function, you obtain the corresponding quantities demanded given in the table:QD = 60 – 10P

7. 0   REFERENCES /FURTHER READINGS

Koutsoyiannis A. (1979): Modern Microeconomics 2ed., Macmillan Press
        Limited, Hampshire, London

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P)
        Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson
        Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc. New York. USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill
        Companies, Inc. USA

Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing
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UNIT 2:   THEORY OF SUPPLY

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1.0   INTRODUCTION

It would be inconclusive if we only deal with demand theory without explaining the supply theory as it required in economic theory. Economic theory deals with the behaviour of the business firms which supply in output markets and demand in input markets. Firms engage in production, and we assume that they do so to make profit. Firms makes profits because they are able to sell their goods for more its cost. The amount of revenue made is a function of price it sells its output in the market and how much of it sells.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1. Describe what supply and its relationship with price
2. Explain at least three determinants of supply in an output market
3. Calculate quantity supply at a given price

3.0   MAIN CONTENT

3.1   Supply in Output Markets

Thus, *the quantity supplied is the amount of a particular product that a firm would be willing and able to offer for sale at a particular price during a given time period.*

The quantity of a good that a single producer is willing to sell over a particular time period is a function of the price of the good and the producer's costs of production. To get a producer's supply schedule and supply curve of a

commodity, certain factors which influence costs of production should be held constant (ceteris paribus).

These are technology, the prices of the inputs necessary to produce the good, and for agricultural commodities, climate and weather conditions

It is reasonable to expect an increase in market price, all things been equal, to lead to an increase in quantity supplied. ***There is linear or positive relationship between the quantity of goods supplied and price***. This statement summed up the law of supply in economics. An increase in market price will lead to an increase in quantity supplied, and a decrease in market price will lead to a decrease in quantity supplied.

Supply schedule Supply curve

Supply schedule is a table showing how much of goods firms will sell at different prices. The various price-quantity combinations of a supply schedule can be plotted on a graph to obtain the market supply curve. *Supply curve is a graph describing how much of a goods a firm will sell at different prices.*

Table 2.1   Adedeji Supply Schedule for Ball Pens

Price (₦)	Quantity Supplied
2.00	14
1.50	10
1.00	6
0.75	4
0.50	2
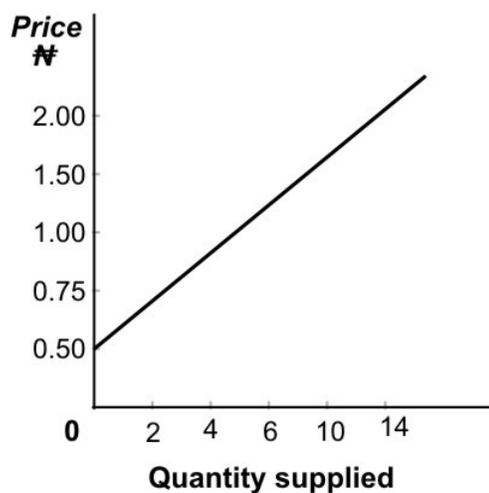
Figure 2.1: Supply curve for ball pens, it shows supply curve shows that the higher ball pens prices induces to supply greater quantities

Thepositive slope of the supply curve (i.e. its upward-to-the right inclination) reflects the fact that higher prices must be paid to producers to cover rising marginal, or extra, costs and thus induce them to supply greater quantities of the commodity.

The various points on the supply curve show price-quantity relationships. For instance, at the price of N.50 per pen, the quantity supplied is 2. The trend is repeated for all the various quantities of ball pen and prices. This direct relationship between price and quantityis reflected in the positive slope of the supply curveSupply curve above also shows the minimum price that producers must receive to cover their increasing marginal costs and supply each quantity of the commodity.

SELF-ASSESSMENT EXERCISE 1: Assume a producer's supply function for a ball pen is $Qs = -40 + 20P$ all things being equal. Use the prices provided to determine the quantity supplied to:**a**.   get supply schedule   **b**. draw supply curve

Price	Qs
8	
6	
4	
3	
2	

SELF-ASSESSMENT EXERCISE 2: What do you understand supply schedule and supply curve?

The difference between shift of supply curve and the movement along a supply curve

The supply curve is derived by holding everything constant except price. So, the movement along a supply curve is caused the change in quantity supplied brought by a change in price.The change that takes place in a supply curve corresponding to a new relationship between quantity supplied of a goods and the price of that goods. The shift is brought about by a change in the original conditions. Increases in input prices may also cause supply curves to shift.Change in prices of goods or services lead to change in quantity supplied-movement along a supply curve.*Change in costs, input prices, technology, or prices of related goods and services leads to change in supply – shift of a supply curve.*
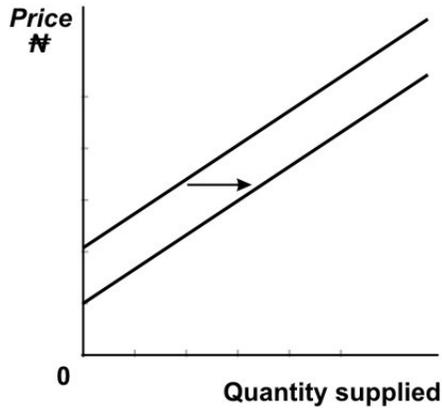
Figure 2.2

3.2   Determinants of Supply

Price has been so far discussed as one of the factors that affect the quantity of output supplied. Other factors that affect the supply include the cost of producing the product and the prices of related goods.

1.   **Cost of Production**: the difference between costs and revenues is called profit. Successful firms make profits because they are able to sell their goods for more than it costs to produce them. So, among other factors that determine size of profit to be made cost and price of inputs is one of them. But the way of production to maximize profit is to minimize cost of production. The increase in input prices raise costs of production and are likely to reduce supply.

2.   **Prices of Other Associated Goods:** Firms always react to changes in the prices of related products in the market. For example, if a plant can be used for either pen or pencil production, an increase in pen prices may cause individual entrepreneur to make use of time allotted to the production of pencil, thereby producing more of pens than pencils. Increase in price of mutton producer/entrepreneur may respond by raising more sheep.

3.2.1   SELF ASSESSMENT EXERCISE 3: State the difference between shift of supply curve and the movement along a supply curve

3.2.2   Market Supply

Market supply is determined in the same fashion as market demand. It is simply the sum of all that is supplied each period by all producers of a single product. The market supply curve is thus the simple addition of the individual supply curves of all the firms in a particular market – that is, the sum of all the individual quantities supplied at each price. The market or combined supply of

a commodity gives the alternative amounts of the commodity supplied per time period at various alternative prices by all the producers of this commodity in the market. The market supply of a commodity depends on all the factors that determine the individual producer's supply and, furthermore, on the number of producers of the commodity in the market

The position and shape of the market supply curve depend on the positions and shapes of the individual firms' supply curves from which it is derived. They as well as depend on the number of firms that produce in that market. If firms that produce for a particular market are earning high profits, other firms may be tempted to go into that line of business. When new firms enter into an industry, the supply curve shifts to the right.But whenfirms go out of business, or exit the market, the supply curve shifts to the left.
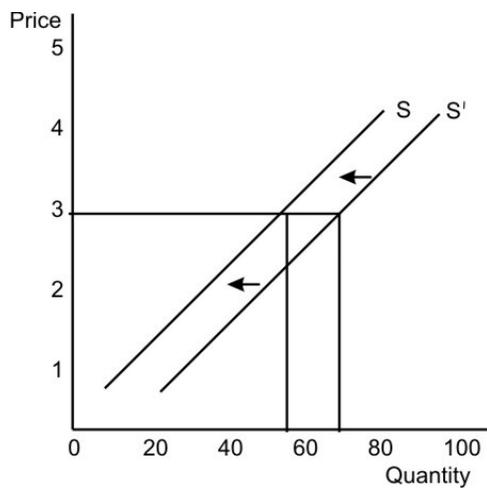
Figure 2.3
Market supply curves shift leftward
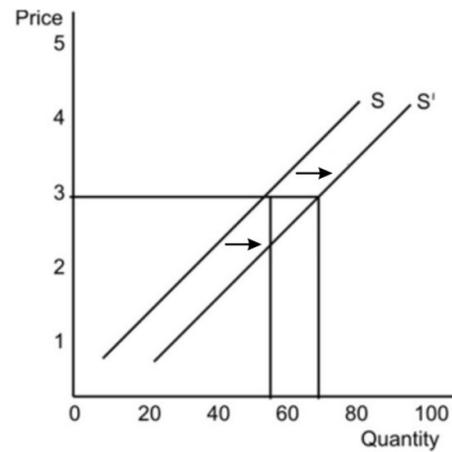
Figure 2.4
Market supply curves shift rightward

SELF-ASSESSMENT EXERCISE: If there are 80 identical producers in the market, each with a supply of commodity X given by Qs = -50 + 30P (all things being equal)the market supply (QS) is obtained as follows: QS = 80Q. Use prices provided below to determine (a) determine market quantity supplied (b) draw the market supply curve

Price	Qs
8	
6	
4	
3	
2	

4.0   CONCLUSION

The supply of goods is determined by price, costs of production, and prices of related goods. Costs of production are determined by available technologies of production and input prices.

5.0   SUMMARY

In this unit you have learnt the meaning and determinants of Supply in Output Markets. The difference between shift of supply curve and the movement along a supply curve were also discussed. Market Supply and Market equilibrium were also examined.

6.0   TUTOR MARKED ASSIGNMENT

1a.   Derive the supply schedule from the following supply function:
        QS =20P
b.   Derive the supply schedule from the following QS' = 20 + 10P
c.   On the same graph, plot the supply schedule of part (a) and label it a S and the supply curve of part (b) and label it S'
d.   What may have caused S to shift to S'?

2.   Will supply curve shift to the right or the left if (a) technology improves (b) input prices increase? (c) What happens if both (a) and (b) occur?

7. 0   REFERENCES /FURTHER READINGS

Koutsoyiannis A. (1979): Modern Microeconomics 2ed., Macmillan Press
        Limited, Hampshire, London

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P)
        Limited, Delhi
Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson
        Education, Inc. New Jersey, USA.
Salvatore D. (2003): Microeconomics Harper Publishers Inc, New York, USA

Salvatore D. (1991): Microeconomics. Schuams Series. McGraw-Hill
        Companies, Inc. USA
Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing
        Company, Minnesota, USA.

UNIT 3:   THE MARKET MECHANISM

CONTENTS
1.0   Introduction
2.0   Objectives
3.0   Main content
  3.1   The Market Mechanism
  3.2   Market equilibrium
  3.3   Types of Equilibria
  3.4   Adjustment to changes in demand and supply: comparative static analysis
  3.5   Price ceilings, price floors and excise taxes
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 5.0   Summary
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1.0   Introduction

The next is to put the supply curve and demand curve together. We want examine how the interaction of forces demand and supply determines the equilibrium price and quantity of a commodity in perfectly competitive market. The knowledge you have gained in the previous topics would be tested here.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Describe how forces of demand and supply interact to determine market clears.
2.   Calculatealgebrally and graphically the equilibrium price and quantity.
3.   Explain briefly effect of tax on the price and the quantity good demanded and supplied

3.0   MAIN CONTENT

3.1   The Market Mechanism

The market mechanism is the tendency for supply and demand to equilibrate (i.e., for the price to move to the clearing level), so that there is neither excess demand nor supply. This is a situation where the forces of demand and supply operate freely without any intervention from the government or the regulator. Some economists call it automatic stabiliser. The price that producers receive for a given quantity supplied, and the price that buyers will pay for a given quantity demanded.

3.2   Market equilibrium

The condition that exists when quantity supplied and quantity demanded are equal. At equilibrium, there is no tendency for price to change. The operation of the market clearly depends on the interaction between suppliers and demanders. At any moment, one of the three conditions prevails in every market: **1.** The quantity demanded exceeds the quantity supplied at the current price, a situation called excess demand; **2**. The quantity supplied exceeds the quantity demanded at the current price, a situation called excess supply or **3;** the quantity supplied equals the quantity demanded at the current., a situation called equilibrium. At equilibrium, no tendency for price to change exists.
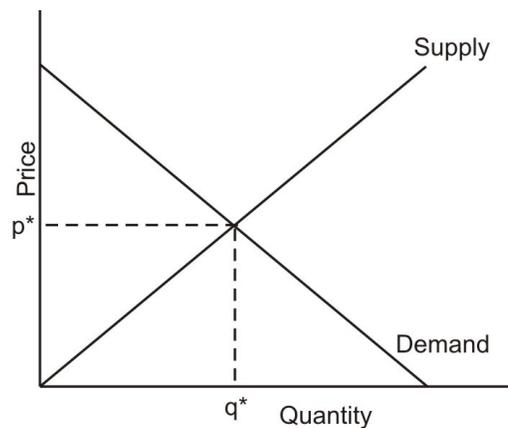
Figure 3.1: the market clears at P*and quantity q* At higher price P_1, a surplus develops, so price falls. At the price P_2, there is a shortage, so price is bid up.

Example 1:

Table 3.1

Px	QDx	QSx
6	20	80
5	30	60
4	40	40
3	50	20
2	60	0

From the table above we can determine the equilibrium price and the equilibrium quantity for commodity. At the equilibrium point, there exists neither a surplus nor a shortage of the commodity and the market clears itself.

Ceteris paribus, the equilibrium price and the equilibrium quantity tend to persist in time.
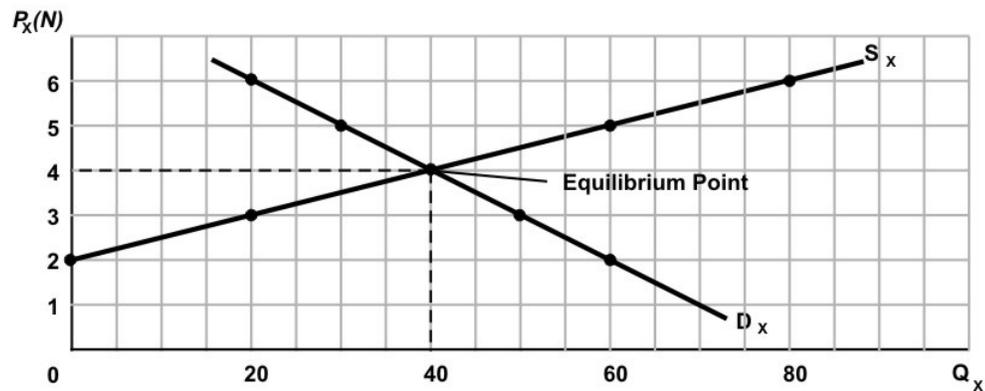
Figure 3.2

Meanwhile, we know that at equilibrium $QDx = QSx$, we can determine the equilibrium price and the equilibrium quantity mathematically

$QDx = QSx$

$80 + 10Px = -40 + 20Px$

$120 = 30Px$

$Px = \$4$ (equilibrium price)

Replacing this equilibrium price either into the demand equation or into the supply equation, we get the equilibriumquantity.

$QDx = 80 - 10(4)$	*or*	$QSx = -40 + 20(4)$
$= 80 - 40$		$= -40 + 80$
= 40 (units of X)		*= 40 (units of X)*

SELF-ASSESSMENT EXERCISE 1:

The table below gives the market demand schedule and the market supply schedule of commodity Y. Is theequilibrium for commodity Y stable or unstable? Why?

Py	QDy	QSy
5	50	10
4	60	40
3	70	70
2	80	100
1	90	130

3.3   Types of Equilibria

An equilibrium condition is said to be stable if any deviation from the equilibrium will bring into operation market forces which push us back toward equilibrium. If instead we move further away from equilibrium, we have a situation of unstable equilibrium. For unstable equilibrium to occur, the market supply curve must be negatively sloped and less steeply inclined than the (negatively sloped) market demand curve

3.4   Adjustment to changes in demand and supply: comparative static analysis

What is the effect of a change in the behaviour of buyers and sellers, and hence in demand and supply, on the equilibrium price and quantity of a good? As the behaviour of buyers and sellers often does change, causing demand and supply curves to shift over time, it is important to analyse how these shifts affect equilibrium. This is referred to comparative static analysis. Comparative statics thus implies an instantaneous adjustment to disturbances to equilibrium

Adjustment to changes in demand

You should know by now, that the market demand curve for a commodity shifts as result of a change in consumer' income, their tastes, the price of substitutes and complements, and the number of consumer in the market.Given the market supply curve of a commodity, an increase in demand results both in a higher equilibrium price and a higher equilibrium quantity. While a reduction in demand has the opposite effect.
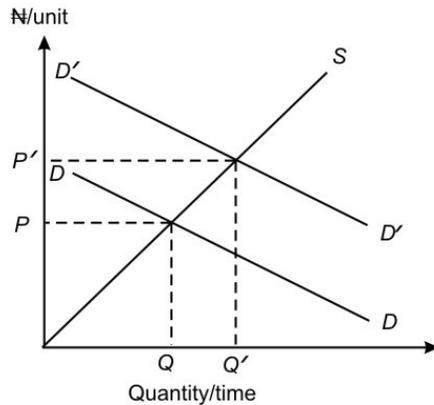
Figure 3.3An increase in demand increases price and quantity exchanged, from P to P` and Q to Q`, respectively.

Adjustment to changes in supply

The market supply curve of a commodity can shift as a result of a change in cost, technology, resource prices, or weather conditions especially for agricultural produce. Given the market demand for the commodity, an increase in supply results in a lower equilibrium price but a larger equilibrium quantity. While a reduction in supply has the opposite effect.
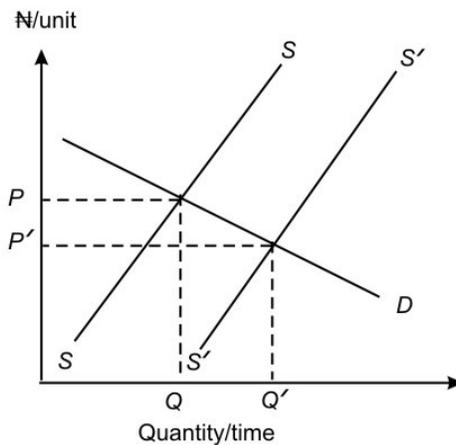
Figure 3.4An increase in supply decreases price and increases quantity exchanged.

Simultaneous shifts

When both the demand and supply curves, the effect on price and quantity will depends upon the direction of the shifts and their relative magnitudes. If both demand and supply shift left, the equilibrium quantity will decline. The change

in the price depends upon the relative magnitudes of the shifts. If both demand and supply shift right, the quantity will increase. If supply and demand shift in opposite directions, the price change will be determined, but change in quantity will depend upon the relative magnitude of the shift.
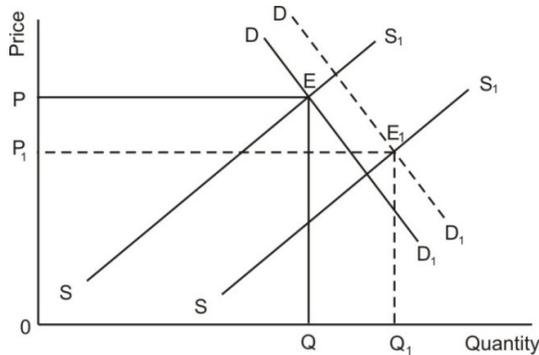
Figure 3.5

SELF-ASSESSMENT EXERCISE2:

Suppose the demand curve for a commodity is given by **$QD = 500 – 2P + 4M$**, where M represents average income measured in Naira. The supply curve is **$QS = 3P – 50$**.

a.   If I = 35, find the market-clearing price an quantity for the commodity

b.   If I = 60, find the market-clearing price and quantity for the commodity

c.   Draw a graph to demonstrate your answer

3.5   Price ceilings, price floors and excise taxes

Market that are perfectly competitive may be altered by the imposition of a price ceiling, a price floor or excise tax. Such interventions in a market are likely to alter price and quantity.

Price ceiling

An effective price ceiling holds price below equilibrium level. The ceiling produces the quantity exchanged in the market and creates shortages, if the sellers decrease the quantity supplied at the lower price. Government imposed rent control is a type of price ceiling; that is the rent cannot exceed some amount, some amount, such as P' indicated by **figure 3.6.** The price declines from P_2 to P_1, and the quantity of rental units declines from Q_1 to Q_2.
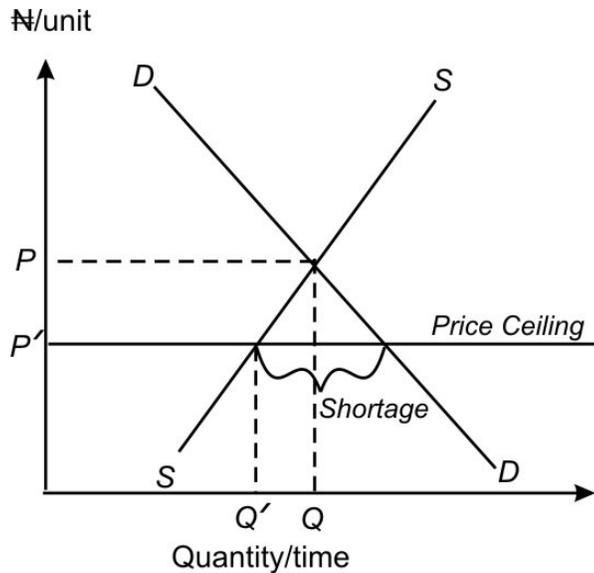
Figure 3.6

Price floors

An effective price floor holds price above equilibrium level. The floor reduces the quantity exchanged and creates surpluses if the sellers are allowed to produce all they are willing at the higher price. Example of the intervention is subsidy for petroleum product in Nigeria which often set at minimum prices. A price floor increases price from P to P' and reduces the quantity supplied from Q to Q'.
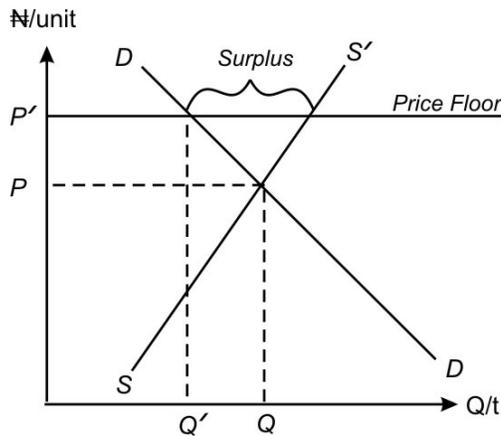
Figure 3.7

An Excise Tax

An excise tax imposed on a product will increase the equilibrium price and reduce the quantity sold. An excise tax is a tax or levy assessed on a particular product such as liquor or cigarette. If the tax is placed on the producers, it will

increase their cost of production and shift the supply curve leftward. If it is imposed on the demander it will shift the demand curve leftward too. The price will increase from P to P' as indicated in figure 3.8 and the quantity will reduce from Q to Q'.
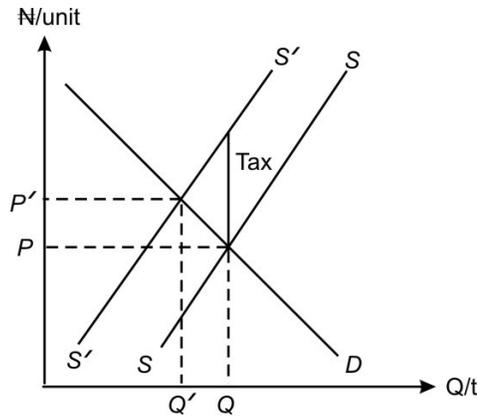
Figure 3.8

SELF-ASSESSMENT EXERCISE 2:

Federal government minimum wage act specifies that workers must be paid at least some minimum monthly wage. Analyse this effect of this act on the demand and supply of unskilled and skilled labour in Nigeria.

A Mathematical Example

Changes in market equilibria can be illustrated with a simple numerical example. Suppose, in single market that the quantity of T- Shirts demanded per week (Q) depends on their price (P) according to the simple relation

Demand: *QD = 10 - P*   (1)

Suppose also that the short-run supply curve for T- Shirts is given by Supply:

Q = P -2 or P = Q + 2   (2)

Figure 3.9 graphs these equations. As before, the demand curve (labeled D in the figure) intersects the vertical axis at *P = N10*. At higher prices, no T- Shirts are demanded. The supply curve (labeled S) intersects the vertical axis at P = 2. This is the shutdown price for firms in the industry—at a price lower than *N2*, no T- Shirts will be sold. As Figure 9.6 shows, these supply and demand curves intersect at a price of *N6* per T- SHIRT. At that price, people demand four T- Shirts per week and firms are willing to supply four T- Shirts per week. This equilibrium is also illustrated in Table 3.1, which shows the quantity of T- Shirts demanded and supplied at each price. Only when P = N6 do these

amounts agree. At a price of N5 per T- SHIRT, for example, people want to buy five T- Shirts per week, but only three will be supplied;
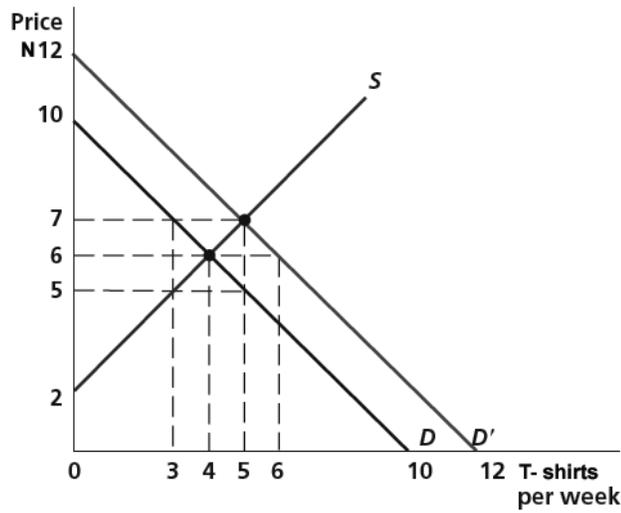
Figure 3.9
Table 3.1 Supply and Demand Equilibrium in the Market for T-Shirt

Supply		Demand	
	Case 1		Case2
P (N)	**QS(T-Shirt per week)**	**QD (T-Shirt per week)**	**QD (T-Shirt per week)**
10	8	0	2
9	7	1	3
8	6	2	4
7	5	3	5
6	4	4	6
5	3	5	7
4	2	6	8
3	1	7	9
2	0	8	10
1	0	9	11
0	0	10	12

There is an excess demand of two T- Shirts per week. Similarly, at a price of N7, there is an excess supply of two T- Shirts per week. If the demand curve for T- Shirts were to shift outward, this equilibrium would change. For example, Figure 3.9 also shows the demand curve D_0, whose equation is given by *Q = 12 -P* .With this new demand curve, equilibrium price rises to N7 and quantity also rises to five T- Shirts per week.

This new equilibrium is confirmed by the entries in Table 3.1, which show that this is the only price that clears the market given the new demand curve. For example, at the old price of N6, there is now an excess demand for T- Shirts because the amount people want *(Q = 6)* exceeds what firms are willing to supply *(Q = 4)*. The rise in price from N6 to N7 restores equilibrium both by prompting people to buy fewer T- Shirts and by encouraging firms to produce more.

Further example of market equilibrium

Market demand and supply schedule for bread

Price (N)	Qd	Qs
2.00	2	14
1.50	4	10
1.00	6	6
.75	7	4
.50	8	2

To show the algebraic determination of equilibrium, we start by expressing the market demand function QD = 10 - 4P and the supply function QS = -2 + 8P.
Let   *QD = 10 - 4P*   *(1)*
and
                        QS = -2 + 8P   (2)

From equation (1), we see that *if P = N2, QD =2; if P =N1, QD = 6* and if P =N.50, QD = 8, as shown above the demand function. Similarly, from equation (2) you can see that *if P = N0.5, QS = 2; if P =N1, QS = 6, and if P = N2, QS = 14*.

To find the equilibrium price (P) let
QD = QS

10 – 4P = -2 + 8P

12 = 12P

So P = N1

Substituting the equilibrium price of *P = N1* either into demand equation or supply equation, we get the equilibrium quantity Q of

QD =10- 4(N1) = 6 = Q

Or

QS = -2 + 8(N1) = 6 = Q
As shown in the figure above

At the non-equilibrium price **P = N1.50**

QD = 10 – 4(N1.50) = 4
While   QS = -2 + 8(N1.50) = 10

Thus, we would have a surplus of *6 units*, as above the figure.

On the other hand,   *at P = N0.50,*

QD = 10 – 4(N0.50) = 8

While   QS = -2 + (N0.50) = 2

Therefore; we would have a shortage of 6 units, as shown in the figure above.

SHIFT IN DEMAND AND SUPPLY, AND EQUILIBRIUM

To the shift in the demand curve
       QD' = 16 – 4P

The new equilibrium price is determined by **QD'** equal to **QS**. That is,

       16 – 4P = -2P +8P

       18 = 12P

Thus,   ***P = N1.50***

And

*QD' = 16 – 4(N1.50) = 10 = **Q***

*QS' = -2 + 8(N1.50) = 10 = **Q***

On the other hand, the shift in the supply curve can also be represented

QS' = 4 + 8P

The new equilibrium price is determined by equating QD = QS'. That is

10 – 4P = 4 + 8P

10 – 4P = 4 + 8P

6 = 12P

***P** = N0.50*

And

*QD = 10 – 4(N0.50) = 8 = **Q***

*Or QS = 4 + 8P(N0.50) = 8 =**Q***

THE EFFECT OF AN EXCISE TAX

The effect of the tax
Let   ***S'' = -8 + 8P***

Setting QD = QS'' we get the equilibrium price of

10 – 4P = -8 + 8P

18 =12P

P = N1.50

And   *QD = 10 – 4(N1.50) = 4 = **Q***

*QS'' = -8 + 8(N1.50) = 4= **Q***

At **Q = 4** sellers gets a price of

QS = -2 + 8P

4 = -2 + 8P

6 = 8P

P *= N0.75*

4.0   CONCLUSION

In this unit you have been able to see the relationship between market demand and supply and how the equilibrium price and quantity are arrived at. Mathematically, the equilibrium price and quantity are determinable as well the cause of changes in the equilibria positions. The extent of adjustment in demand and supply are also discussed and described graphically for your understanding.

It is my hope that you will answer all the TMA questions to improve mastery level of the topic.

5.0   SUMMARY

In this unit you have learnt the meaning of market mechanism and its implications in both free market and regulated system. The types of equilibria we have and the reasons for the changes. The unit gives the meaning of comparative static analysis and how the adjustments in both the demand and supply.

6.0   TUTOR MARKED ASSIGNMENT

1.   (a) Under what form of market organization is equilibrium determined exclusively by the forces ofdemand and supply? (b) How could interferences with the operation of the market mechanismprevent the attainment of equilibrium?

2.   Suppose that from the equilibrium condition in **Example 2**, the government decides to collect a salestax of N2 per unit sold, from each of the 1000 identical sellers of commodity X.
(a)   What effect doesthis have on the equilibrium price and quantity of commodity X?
(b)   Who actually pays the tax?
(c)   What is the total amount or taxes collected by the government?

7. 0   REFERENCES /FURTHER READINGS

Koutsoyiannis A. (1979): Modern Microeconomics 2ed., Macmillan Press
        Limited, Hampshire, London

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P)
        Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson
        Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc.New York.USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill
        Companies, Inc. USA

Truet L.J and Truet D.B. (1984): Intermediate Economics; West Publishing
        Company, Minnesota, USA.

Walter N. and Christopher S. (2010): Intermediate Microeconomics,
        Eleventh Edition, South-Western Cengage Learning,USA.

UNIT 4:   ELASTICITY OF DEMAND AND SUPPLY

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3.0   Main Content
         3.1   Elasticities of Demand
         3.2   Price Elasticity of Demand
         3.3   Price Elasticity and Total Revenue
         3.4   Price elasticity and Marginal Revenue
         3.5   The Income Elasticity of Demand
         3.6   The Cross-Elasticity of Demand
4.0   Conclusion
5.0   Summary
6.0   Tutor Marked Assignment
7.0   References /Further Readings

1.0   INTRODUCTION

Economist and policy makers and business managers often are interested in having information that tells how the quantity demanded of a specific goods and service will react to changes certain key variables. The concept of elasticity is one tool that is used to describe the responsiveness of the quantity demanded of a good to the various factors that affect it.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   State the importance of elasticity of demand and calculate price elasticity of demand
2.   State three forms of elasticity of demand
3.   Explainthe relationship among Total Revenue, Marginal Revenue and Price Elasticity with the use of graph.

3.0   MAIN CONTENT

3.1   Elasticities of Demand

The importanceof actual measurement cannot be overstated. Without the ability to measure and predict how much people are likely to respond to economic changes, all the economic theory in the world would be of little help to policy makers. Economists commonly measure responsiveness using the concept of elasticity. Elasticity is a general concept that can be used to quantify the response in one variable when another variable changes If some variable A changes in response to changes in another variable B, the elasticity of A with

respect to B is equal to the percentage change in A divided by the percentage change in B.

Elasticity of A with respect to B $= \dfrac{\%\Delta A}{\%\Delta B}$

One can speak of the elasticity of demand or supply with respect to price, of the elasticity of investment with respect to the interest rate, or of tax payments with respect to income. There are as many elasticities of demand as its determinants. The most important of these elasticities are (a) the price elasticity, (b) the income elasticity, (c) the cross-elasticity of demand.

3.2   Price Elasticity of Demand

The price elasticity is a measure of the responsiveness of demand to changes in the commodity's own price. In other words price elasticity of demand simply as the ratio of the percentage of change in quantity demanded to the percentage change in price.So, *price elasticity of demand is the positive value of the percentage change in quantity demanded for a percentage in price.*

Price elasticity of demand = % change in quantity demanded
                                       % change in price

Figure 4.1. Price Elasticity of Demand
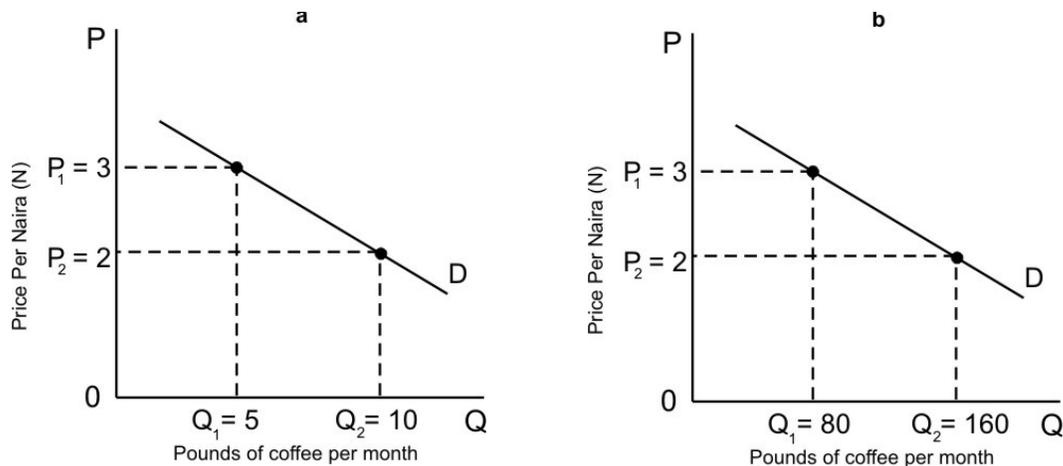
$slope: \dfrac{\Delta Y}{\Delta X} = \dfrac{P_2 - P_1}{Q_2 - Q_1}$

$= \dfrac{20 - 10}{50 - 100} = \dfrac{10}{50}$

$slope: \dfrac{Y}{X} = \dfrac{P_2 - P_1}{Q_2 - Q_1}$

$= \dfrac{20 - 10}{1600 - 800} = \dfrac{10}{800}$

Demand is said to be elastic if e $>$1, inelastic if e $<$1, and unitary elastic if e = 1.

EXAMPLE: The price elasticity od demand between point A (10, 40) and B (20, 30) is found by using the arc elasticity formula:

Demand schedule

Price	Quantity
50	0
40	10
30	20
20	30
10	40
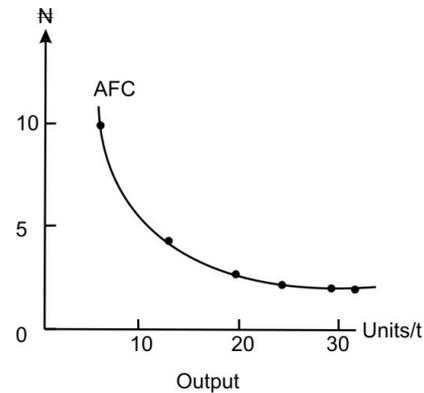
Point and Arc elasticities

Arc elasticity of demand
The arc elasticity is calculated over a range of prices. It is used for calculating elasticity between two points on a demand schedule or curve.
The formula is:

$$e = \frac{(Q2 - Q1)}{(P2 - P1)} \times \frac{(P2 + P1)}{(Q2 + Q1)}$$

From the demand schedule above we calculate:

$$e = \frac{20-30}{30-40} \times \frac{30+40}{20+10} = \frac{7}{3} = 2.33 \text{ (absolute)}$$
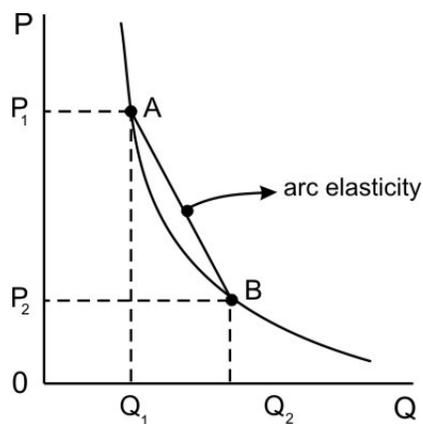
Figure 4.2

Point Elasticity

Elasticities at a particular point on the demand curve or supply curve. The point elasticity for instance is the price elasticity of demand at a particular point on the demand curve. It can vary depending on where it is measured along the demand curve.

Point elasticity can be measured using derivatives .supposing sing the demand equation is given as Q = 50 –P, elasticity at a any point may be found through the use of derivatives. From the above demand schedule calculate point elasticity of demand.

The formula is

$$e = \frac{dQ}{dP} \times \frac{P}{Q}$$

$$e = -1 \times \frac{40}{10} = 4(absolute)$$

The critical valuefor price elasticity is one

Economists categorize price elasticity coefficients depending upon whether the coefficient is greater than, equal to, or less than one

Table 4.1

elasticity	Description	implications
> 1	elastic	0% change in Q >% change in P
= 1	unit elastic	0% change in Q = % change in P
< 1	inelastic	0% change in Q< % change in P
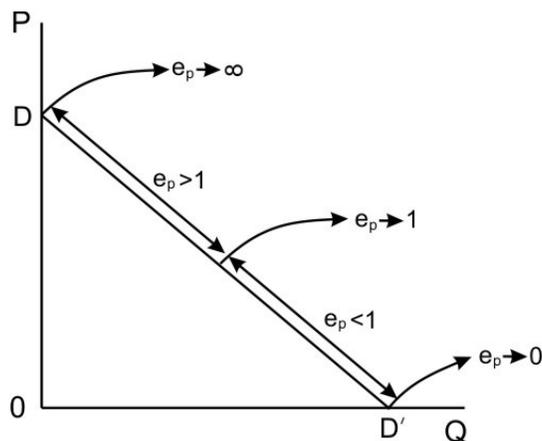
Figure 4.3

SELF-ASSESSMENT EXERCISE:

1.   The number of passengers weekly on the Abuja Mass transit declined from 70,000 to 65,000 when the fare was increased from N35 to N40. Calculate the price elasticity of demand. Was the demand for bus rides elastic or inelastic?

2.   Which of the following elasticities measure a movement along a curve rather than a shift in the curve?
(a)   The price elasticity of demand. (c) The cross elasticity of demand. (b) The income elasticity of demand. (d) The price elasticity of supply.

The range of values of the elasticity are $0 < e_p < 1$
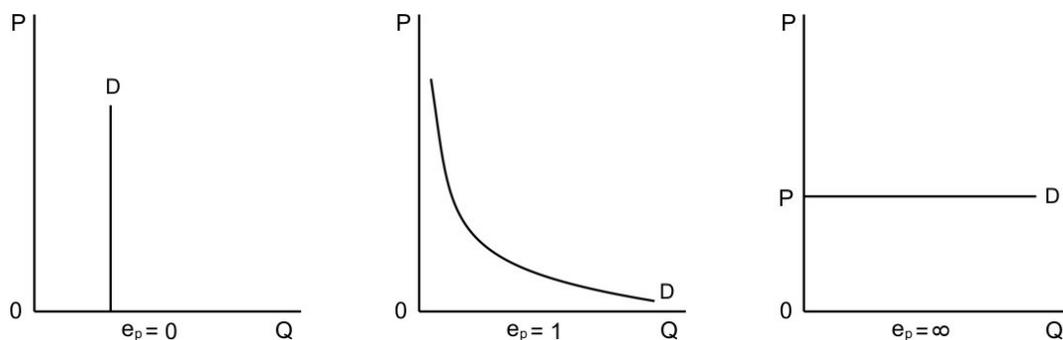
Figure 4.4: Elasticity of demand

The basic determinants of the elasticity of demand of a commodity with respect to its own price are:

(l)   The availability of substitutes the demand for a commodity is more elastic if there are close substitutes for it.
(2)   The nature of the need that the commodity satisfies. In general, luxury goods are price elastic. While necessities are price inelastic,
(3)   The time period. Demand is mort elastic in the long run.
(4)   The number of uses to which a commodity can be put. The more the possible uses of a commodity the greater its price elasticity will be.
(5)   The proportion of income spent on the particular commodity.

3.3   Price Elasticity and Total Revenue

The total revenue (TR) is derived by the product of price and quantity of goods sold. We shall consider rice as staple food in Nigeria and orange as fruit. The producers of rice decide to increase the price of rice and if similar stance was also taken by the orange sellers, they would probably fail. Why? The quantity of rice demanded is not as responsive to change in price as is the quantity of orange demanded. In other words, the demand for rice is more inelastic than is demands for oranges.

We can now use the more formal definition of elasticity to make more precise our argument of why rice producers would succeed and orange producers would fail. We know already that price multiply by quantity is equal to total revenue received by the producer. Thus: **TR = P × Q**

When price increases in a market, quantity demanded declines. As you have seen when price declines, quantity demanded increases. The two factors, P and Qmove in opposite directions:

3.4   Price elasticity and Marginal Revenue

The change in total revenue for a unit change in quantity sold is referred to as marginal revenue. A reduction in price will increase total revenue when demand is elastic. A reduction in price will reduce total revenue when the demand is inelastic. The percentage increase in quantity sold will be less than the percentage decrease in price.

Marginal revenue is positive when e $>$ 1

Marginal revenue will be positive when total revenue is increasing and negative when total revenue is decreasing. Thus, there will be a tie between marginal revenue and elasticity.

Table 4.2

Elasticity	Marginal revenue	Implications
Elastic	Positive	As price decreases, quantity and total revenue increase
Unitary	Zero	As price decreases, the increase quantity exactly offsets it and total revenue constant
Inelastic	Negative	As price decreases, quantity increases and total revenue decreases

Marginal Revenue Elasticity Formula

The relationship between price elasticity and marginal revenue is given by:
MR = P(1- 1/e). The above formula can be used to determine marginal revenue for various values of elasticity

e	MR	Calculation
0.5	-P	MR =P(1 − 1/0.5)= P ×1
1	0	MR =P(1 − 1/1)= P × 0
2	5P	MR =P(1 − 1/2)= P × 0.5
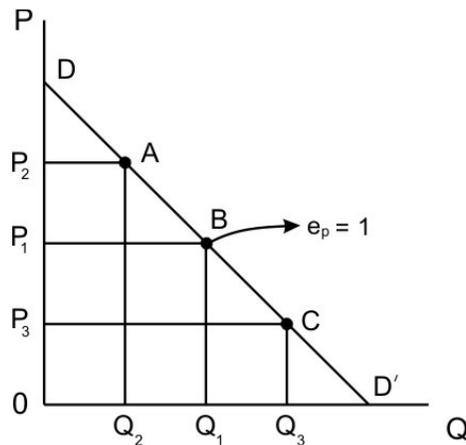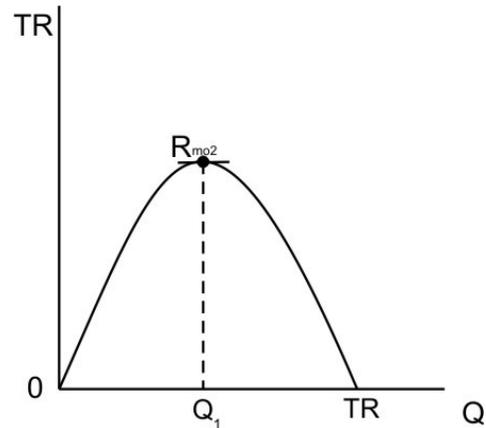
Figure 4.5   Figure 4.6

At any one price the total revenue is the area of rectangle defined by drawing perpendiculars from the price and the corresponding quality to the demand curve. For example, in figure 4.5, the total revenue at price P_2 is the area of the rectangle P_2AQ_2O

SELF-ASSESSMENT EXERCISE: mathematically, determine whether the price elasticity of demand is elastic or inelastic given the following demand function: $Q = 500 - 4Px; Px = 25$

3.5   The Income Elasticity of Demand

The income elasticity (e_y) is defined as the proportionate change in the quantity demanded resulting from a proportionate change in income. Symbolically we may write

$$(e_y) = \frac{\Delta Q}{Q} \div \frac{\Delta Y}{Y} = \frac{\Delta Q}{\Delta Y} \times \frac{Y}{Q}$$

Income Elasticities Classification
Income elasticities may be positive, zero or negative and the signs are important in the interpretation.

Table 4.3

Elasticity	Classification	Implication
Positive	Income-superior/ normal	Consumption of goods changes directly with income
Zero	Income-independent	Consumption of goods does changes with income
Negative	Income-inferior	Consumption of goods changes inversely with income

SELF-ASSESSMENT EXERCISE 1: Calculate the elasticities for the income-quantity schedule given below and indicate whether the goods is normal, independent or inferior at each level of income.

Income /year	Quantity/year
200	20
300	40
400	40
500	30

3.6   The Cross-Elasticity of Demand

The cross-elasticity of demand is defined as the proportionate change in the quantity demanded of x resulting from a proportionate change in the price of y. in other words, it is the percentage change in the quantity demanded of good X to changes in the price of good Y.

Symbolically we have

$$e_{xy} = \frac{dQ_x}{Q_x} \bigg/ \frac{dP_y}{P_y} = \frac{dQ_x}{dP_y} \cdot \frac{P_y}{Q_x}$$

The sign of the cross-elasticity is *negative* if X and Y are complementary goods, and *positive* if X and Y are substitutes. The higher the value of-the cross-elasticity the stronger will be the degree of substitutability or complementarily of X and Y. meanwhile independent goods are goods that not related in consumption.

Example : Calculate the cross elasticity of demand for goods X and Y

Price of good Y	Quantity of goods X bought	Cross elasticity e_{xy}
10	5	-
5	10	-1.0
0	15	-0.2

$$exy = \frac{10-5}{5-10} \times \frac{5+10}{10+5} = \frac{5}{-5} \times \frac{15}{15} = -1.0$$

Table 4.4   **Cross-Elasticity Classification**

Elasticity	Classification	Implications
Positive	Substitute	Goods are substitutes for one another
Zero	Independent	Goods are unrelated
negative	Compliment	Goods are consumed together

Self-Assessment Exercise:
1.   A negative income elasticity of demand for a commodity indicates that as income falls, the amount of the commoditypurchased
(a) rises, (b) falls, (c) remains unchanged, or (d) any of the above.

2.   If the amount of a commodity purchased remains unchanged when the price of another commodity changes, the cross elasticity of demand between them is (a) negative, (b) positive (c) zero, or (d) 1.

Elasticity of Supply

The coefficient of price elasticity of supply (es) measures the percentage change in the quantity supplied of a commodity per unit of time $(\Delta Q \div Q)$ resulting from a given percentage change in the price of the commodity $(\Delta P \div P)$.
Thus

$$e_s = \frac{\Delta Q}{Q} \div \frac{\Delta P}{P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

When the supply curve is positively sloped (the usual case), price and quantity move in the same direction and $e_s > 0$. The supply curve is said to be elastic if $e_s > 1$, inelastic if $e_s < 1$, and unitary elastic if $e_s = 1$. Arc and point e_s can be found in the same way as arc and point e. When the supply curve is a

positively sloped straight line, then, all along the line, $e_s >$ 1, if the line

crosses the price axis; $e_s >$ 1, if it crosses the quantity axis; and $e_s =$ 1, if it goes through the origin.

4.0   TUTOR MARKED ASSIGNMENT

1.   The Table below shows the quantity of "regular cuts of meat" that a family of four would purchase per yearat various income levels. ("Regular cuts of meat" might refer to pork chops and pot roast; "superiorcuts of meat" might refer to steaks and roast beef while "cheap cuts" to hamburger and chicken.) (a)Find the income elasticity of demand of this family for regular cuts of meat between the various successive levels of this family's income. (b) Over what range of income are regular cuts of meat aluxury, a necessity, or an inferior good for this family? (c) Plot on a graph the income-quantityrelationship given above

Income ($/year)	400	600	800	1000	1200	1400	1600	1800
Quantity (1b/year)	10	20	30	35	38	39	35	25

2.   Calculate the price, income, and cross elasticities of demand, given the following demand function and the values for the variables as listed below:

$$X = \frac{2MPy}{5Px} \; for \; M = N1000; Px = N20; \text{Py} = N5$$

5.0   CONCLUSION

At the end of this unit you should be able to analyse, estimate how market system works and as well be able to evaluate the importance of price and income in determining the quantity of goods to be sold and demanded. The concept of elasticitity also shows responsiveness of quantity demanded/supplied to price changes. This was analysed and calculated examples, classification table were provided for easy reference

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6.0 SUMMARY

Elasticities describe the responsiveness of supply and demand to changes in price, income, or other variables. The relationship between price elasticity and marginal revenue, income elasticity and income normal or income-inferior were dealt with in unit. You are also exposed to the relation that exist between cross elasticity and substitutes or compliments

7. 0 REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc.New York.USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

MODULE II: THEORY OF PRODUCTION

UNIT 1:   **THEORY OF PRODUCTIONI**

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      3.3   Inputs and Time
      3.4   Production With On Variable
      3.5   Law of Diminishing Returns
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1.0   INTRODUCTION

Like the theory of consumer behaviour as discussed in your ECO 201 the economic theory of production assumes rational behaviour. We have seen that rational consumer behaviour is interpreted to mean utility-maximizing behaviour. 'What is rational producer behaviour? To some extent, this depends on who the producer is. If the producer is a business firm it is often argued that rational behaviour is profit-maximizing behaviour, where profit is defined as the difference between total sales revenue and total cost of production.
You will learn about relationships among product curves using graphs and figures.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Explain what is production?
2.   Describe the concept of production function
4.   Calculate and draw the total product, average product and marginal product

3.0 MAIN CONTENT
3.1 Nature of Production

What is production? In a fundamental sense it is the act of making some-thing; but there is more to it than this. After all something (a service) is produced when a courier delivers a parcel or when a masseur gives someone a massage. Basically, production involves the combining and organizing of economic resources (inputs or factors of production) that transforms them into a different but useful output. The process by which inputs are combined, transformed, and turned into outputs. Firms vary in size and internal organization, but they all take inputs and transform them into things for which there is some demand. For instance an independent accountant combines labour, paper, telephone and email service, time, learning, and a Web site to provide help to confused taxpayer. An automaker plant uses steel, labour, steel, plastic, electricity, machines and countless other inputs to produce cars. Also, a courier service combines time human effort, fuel, and capital goods to produce an output we call delivered packages. A farmer combines land seed fertilizer human effort and capital goods to produce a crop such as corn or wheat.

3.2 Production not only for firms

It is important to remind you that the production is not limited to profit-making business firms, it is important to understand that production and productive activity are not restricted to private business firms. Individual households also engage in the act of production/transforming factors of production (labour, capital, energy, natural resources, and so on). When one work in my compound, I am combining land, labour, fertilizer, seeds and tools (capital) into the vegetables one eats and flower one enjoy. The government also combines land, labour and capital to produce public services for which demand exists: national defense, police, and fire service and education and so on.

Business firms are set apart from other producers, such as households and government, by their purpose. A firm exists when a person or a group of people decides to produce a good or service to meet perceived demand. So firm engage in production –that is, they transform inputs to outputs – because they can sell their products for more than its costs to produce them

3.3 Technology and the Production Function

Every production unit whether a firm or some other kind of organization, is somewhat a captive of existing technology. This is not to say that technology does not change, for it is one of the most dynamic elements in economic progress. Rather, what we mean is that technology tends to change by fits and starts, as well as by gradual improvement in knowledge and techniques. Breakthroughs occur and entirely new categories of goods and methods of production emerge. However, in the interim between such changers firms are

likely to be stuck with a certain array of production techniques that substantially describe the possibilities of combining inputs to get output.

At a given point in time, the statement of the manner in which a firm can combine inputs to obtain a given product is known as the production function for that product.

A production function is a statement relating how inputs can be combined to achieve various possible levels of output.

The production function describes not only a single isoquant, but the whole array of isoquants, each of which shows a different level of output. It shows how output varies as the factor input change.

Production functions involve (and can provide measurements of) concepts which are useful tools in all fields of economics. The main concepts are:

1.   The marginal productivity of the factors of production
2.   The marginal rate of substitution and the elasticity of substitution
3.   Factor intensity
4.   The efficiency of production
5.   The returns to scale.

It is quite reasonable to think of a production function as a recipe. A recipe for meat pie is one kind of production function. It tells how you can mix flour, sugar, and a variety of other ingredients (inputs) to get one or more meat pies. The size and type of inputs will vary depending upon how many meat pies you want to produce during a given period of time. An output of 10 pies per day might be accomplished with a home-size mixer, but to make 50 pies a day might require five such mixers or one large, commercial mixer. Furthermore, it may be possible to substitute one input for another, such as honey for sugar.

3.3   Inputs and Time

The degree of flexibility that firms have in changing the amounts of the various inputs used to produce a given product frequently depends on time. Although it is possible for a firm to change the amount of raw materials fuel and labour it employs in a very short time (from day to day or week to week) it may require many months or even years for a firm to change the size of its plant and equipment. The latter will vary from one industry to another. For example a firm that sells novelty T-shirts might be able to increase its plant and equipment very quickly by just purchasing an additional heat transfer machine and leasing an additional store front in a shopping center. However, a firm in the electric power industry might find out that increasing its plant and equipment would require a construction project costing many millions of Naira and taking several years to complete.

SELF ASSESSMENT EXERCISE: State the difference between production and production function with real-world example.

3.4   Production With On Variable

A ***Total Product Curve*** *shows the levels of total output corresponding to different amounts employed of a given short-run variable input.*

The TP_L curve of Figure 1.1a verifies that plant K_1 cannot produce more than 60 units of output per week, something which is also true in the isoquant diagram in panel (a). In addition, the total product curve shows that beyond L= 4 the marginal product of labour is negative since further increases in L will cause output to fall.

3.5   Law of Diminishing Returns

In our two-input case, $Q = f(K, L)$ the amount of capital (K) is fixed in the short run. Thus, as more and more labour is added to the fixed amount of plant and equipment, it will become increasingly difficult to obtain increases in output. Why? Because additional workers will not have additional capital goods to work with. Their efforts may provide some increase in output but as the number of workers is increased again and again, surely the output added by one more worker (MP_L) will fall. This proposition, known as the ***Law of DiminishingReturns*** is virtually inescapable anytime the amount of some input is fixed; thus anytime the firm is in the short run.

The ***Law of Diminishing Returns*** *states that the marginal product of a variable input will eventually fall, if that input is used with one or more fixed inputs.*

In Table 1.1 labour at first has an increasing marginal product but its marginal product does eventually fall. It is easy to see why the marginal product might first rise. For example a few workers might be able to divide up tasks in a way that would make production more efficient, up to a point. However after such opportunities are exhausted, MP_L will fall. Clearly, MP_L can become negative, if so many workers are employed that they get in each other's way. Of course it would not be rational for a firm to operate where MP_L is negative if labour is a variable input.

3.6   Marginal Product of an Input

It is possible to change one of the inputs of the production function while the other remains constant. (In fact we argued that in the short run this would be the only possible change in inputs in the two-input case.) What happens to output will depend on the marginal product of the input.

The marginal product of an input is *the rate of change in output as the amount of that input is changed while the amount of all other inputs remains constant.*

Algebraically, the marginal product of labour can be written as follows:

$$MP_L = \frac{\text{change in output}}{\text{change in labour input}} = \frac{\Delta Q}{\Delta L}$$

We say that this rate is approximate because we have calculated an *arc value* for MP_L. Actually, MP_L will generally vary as we move from point to point across the production function.

Note: The calculus or point formula for the marginal product of labour is given by $MP_L = \frac{\delta Q}{\delta L}$, the partial derivative of output with respect to the quality of labour.

Marginal product is an important concept because it says what we can expect to get from employing an additional unit of an input. In general, we will be willing to consider using more of an input when it has a marginal product greater than zero. Whether or not we *actually* decide to use more of an input when its MP > 0 depends on the input's price and the prices and marginal products of other inputs, as well as the effect of increased output on profit. More details on this will be provided later.

3.7   Marginal-Average Product relationship

*The **marginal-average relationship** states that when a marginal value is above its corresponding average value, the average value will rise. When the marginal is below the average, the average value will fall.*

The marginal-average relationship is not restricted to economics. For example grade averages also obey it. If you have a "B" average and get a grade of "A" in an additional course, your average grade will rise. However, your "B" average would fall if the additional course netted you a "C." Note also that if a marginal value is equal to a corresponding average value, the average will neither rise nor fall' it will remain constant. (If you now have a "B" average and continue to get "Bs," your average will remain a "B.")

The marginal-average relationship is very important in economic analysis, since it holds for many frequently encountered variables. For example, in the product market it is known that marginal revenue (MR) would always be below price (AR) when the demand curve is falling (slopes downward to the right). As you will learn later in the theory of firm cost (next module) especially those on cost, the relationship will again be relevant. We will see that the curve of average cost falls when marginal cost is below it but rises when marginal cost is above it.

3.8   Product Curves

The graph showed first increasing and then diminishing marginal returns to labour the TP_L curve at first rises rapidly, but then increases at an ever-slower rate. The rate of change of TP_L, which is MP_L, can be determined by drawing lines tangent to the TP_L curve and noting whether their slopes get steeper or less steep (see Figure 2-15).

In the lower panel of Figure 2-14 average product of labour, AP_L, rises until MP_L cuts it from above. At this L value (L = 2), in keeping with the marginal-average relationship, average product reaches its maximums. At this same L
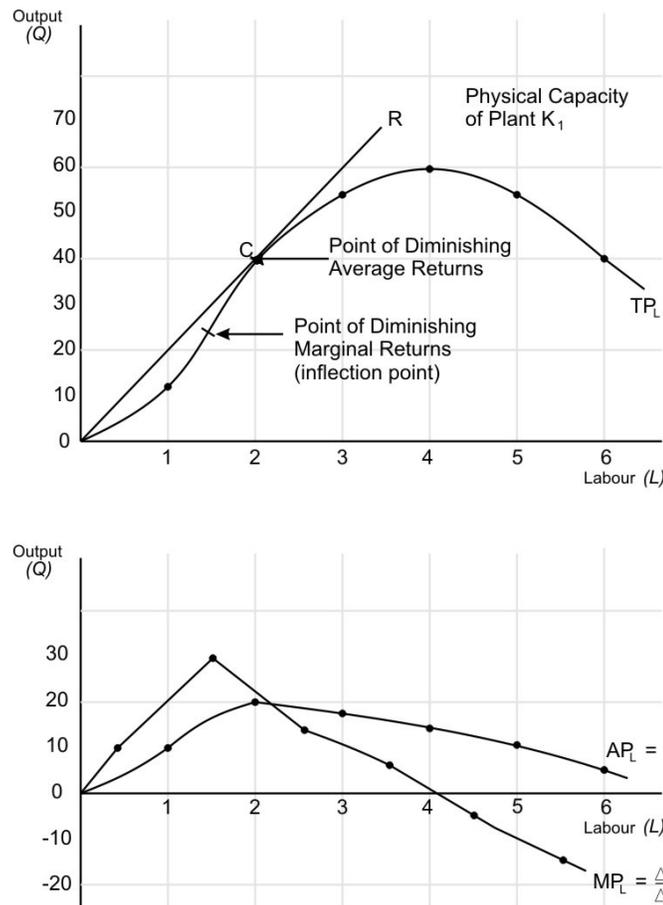
Figure 1.1(a)(b) Geometry of Short-Run Product Curves
A complete set of short-run product curves for input L includes those of total marginal and average product. If the marginal product of labour first increases eventually falls and finally becomes negative the total product curve will have a point of diminishing marginal returns (inflection point), a point of diminishing average returns, and a point of physical capacity of plant. The inflection point corresponds to maximum MP_L, the point of diminishing average returns to maximum AP_L, and the point of physical capacity to the input level where $MP_L = 0$.
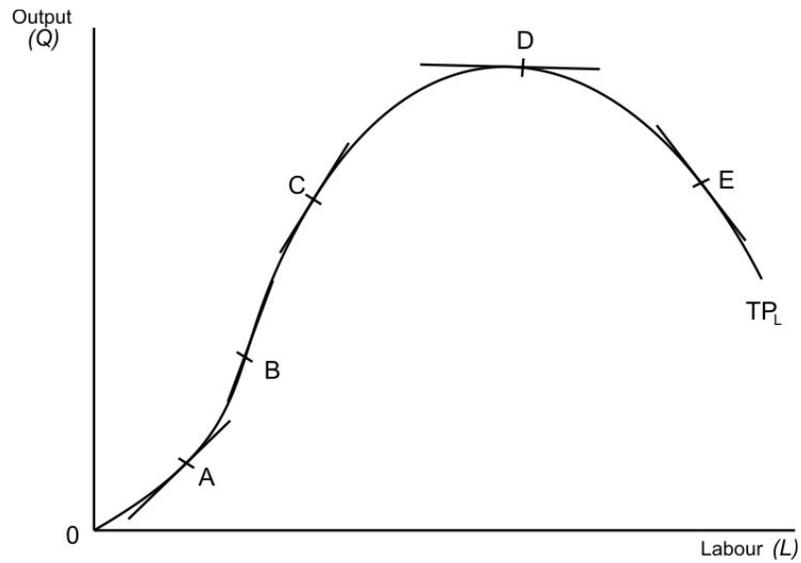
Figure 1.2: Use of Tangents to Determine Marginal Product

Since MP_L is the slope of the total product curve tangents to all can be used to evaluate marginal product. Here, MP_L is positive and rising up to point B. Between B and C, MP_L begins to fall but is still positive. At point D, $MP_L = 0$, and thereafter it is negative.
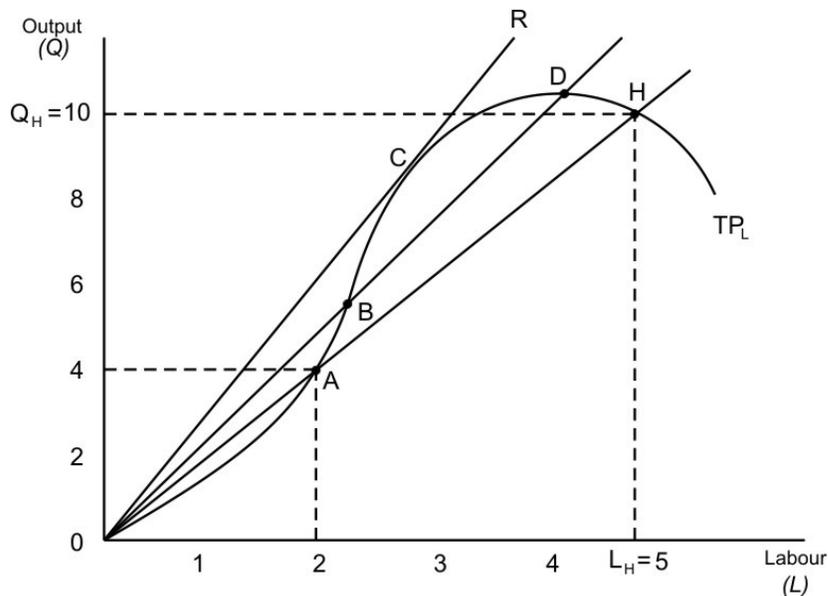
Figure 1.3. Determination of Average Product from Slope of Lines to total Product

Note that the slope of line 0H is either $\frac{0Q_A}{0L_A}=\frac{4}{2}=2 \, or \, \frac{0Q_H}{0L_H}=\frac{10}{5}=2$. *Since*

these ratios are $\frac{Q}{L}$, *respectively, for points A and H, they measure* AP_L *at those points.* AP_L *is higher and equal to the slope of line 0D at points B and D. Finally* AP_L *is the highest possible for this total product curve at point C.*

value, there is a point of diminishing average returns on the total product curve. This point occurs where the line 0R is just tangent to TP_L. In general, lines from the origin will intersect the total product curve if their slope is less than that of 0R. Their slope will be equal to AP_L at such points of intersection (**see Figure 1.3),** and the same is true at the tangency point C in **Figures 1.1 and 1.3** Since 0R is the steepest line that can be drawn from the origin to the total product curve, AP_L is at its maximum at point C.

A final point of interest in Figure 1.1 occurs where L = 4 and MP_L = 0. Since MP_L is negative beyond L = 4, further additions of labour will reduce output. At L = 4, the TP_L curve reaches its maximum value and output cannot be increased beyond this level unless the firm's plant size is increased.

Note:*A line from the original point to any point on the* TP_L *curve has a slope equal to* AP_L *at that point. This relationship holds because between the origin and the given point on* TP_L, *the rate of change of the line equals the vertical distance* TP_L, *divided by the horizontal distance,*

L, or $\frac{TP_L}{L}=AP_L$.

Thus the maximum point of the TP_L curve is identified as the point of physical capacity of the existing plant. This corresponds with point J in the isocost diagram in Figure 1.1a. Furthermore, if the size of plant (K_1), were increased in Figure 1.1a, to say, K_2, the TP_L curve would shift generally upward and have a higher point of physical capacity than it first had. (**See Figure 1.4)**

3.9   Relationship of Total to Average and Marginal Product

The first three columns of Table 1.1 give a hypothetical short-run production function for wheat. Land ismeasured in acres, labour in worker-years, and total product (TP) in bread per year. All units of land, labour, or wheat areassumed to be homogeneous or of the same quality. The average product of labour (APL) figures in column (4) are obtainedby dividing each quantity in column (3) by the corresponding quantity in column (2). The marginal product of labor (MPL)figures in column (5) are obtained by finding the differences between the successive quantities in column (3).

Table 1.1

(1)Land	(2)Labour	(3)TP$_L$	(4)AP$_L$	(5)MP$_L$
1	0	0	0	
1	1	3	3	3
1	2	8	4	5
1	3	12	4	4
1	4	15	3.75	3
1	5	17	3.40	2
1	6	17	2.83	0
1	7	16	2.28	-1
1	8	13	1.63	-3

SELF-ASSESSMENT EXERCISE 1:
Use the above table 1.1 to draw TP$_L$, AP$_L$ and MP$_L$ and also answer these questions:

1.   When the TP falls, (a) the AP Labor is zero, (b) the MPLabor is zero, (c) the APLabor is negative, or (d) the APLabor is declining.

2.   When the APLabor is positive but declining, the MPLabor could be (a) declining, (b) zero, (c) negative, or (d) any ofthe above.

3.   At what point on the table 1 the law of diminishing return set in?

3.5   Cost Minimization in the Short Run

If there is only one variable input in the short run, cost minimization for a given output level can be easily described using the total product curve. **Figure 2-18** shows a total product curve for a plant with a physical capacity of 80 units of output per week. If the firm wishes to produce an output of 60 units, it has only two short-run options.
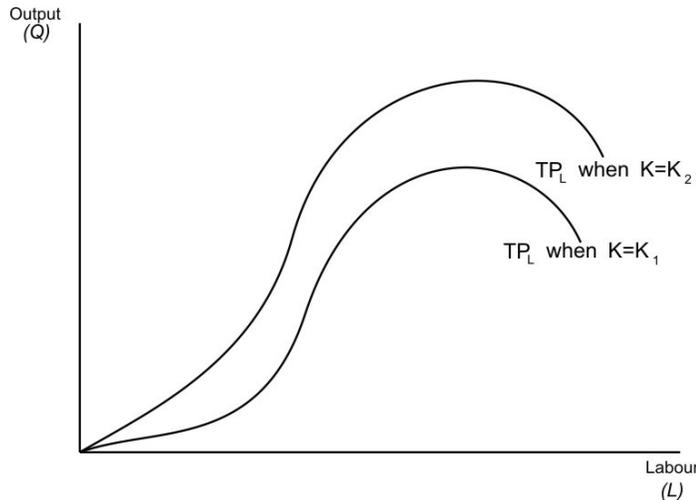
Figure 1.5: Total Product curves for two Different Plant Sizes

If we assume that K_2 is a larger size plant than K_1 (refer to Figure 1.1), the total product curve for input L given $K = K_2$ will exhibit a larger physical capacity of plant than that for $K = K_1$.

One is to use L_1 of labour and the other is to use L_2. It is clearly not rational to pay for L_2 workers when the job can be done with L_1. Thus, cost minimization for 60 units of output per week will occur at L_1.

We can conclude that the firm's total product curve, up to its maximum point (physical capacity) describes the amounts of variable input that will be used to produce each possible short-run level of output. Because of this fact short-run cost will depend in a very important way on the behaviour of total product average product and marginal product. It will be the job of next module (theory of cost) to fully describe the connection between output and cost
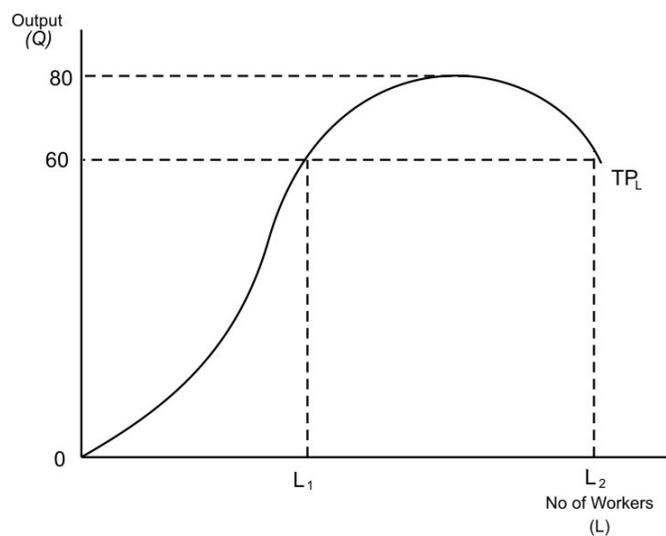
Figure 1.5: Cost Minimization Use of Labour in the Short Run

If Q = 60 is the desired output of the firm with this total product curve either L_1 or L_2 of labour can be employed to produce it with the given size plant. If we assume that labour is not costless it is clearly cheaper to employ L_1 units of labour than to employ L_2 units. Then the short-run cost of producing Q = 60 will be minimized when $L = L_1$.

4.0   CONCLUSION

The short-run curve shows how output varies as the amount of labour used is changed is the firm's total product curve. Because of the law of diminishing returns, which is the rate of change of total product, or marginal product, is expected to eventually fall as more and more of the variable input (labour) is added to the fixed amount of capital. When the marginal product of the variable input drops to zero, total product will reach its maximum.

A typical total product curve for a variable input first has a range of increasing marginal product (up to its inflection point) followed by diminishing and later negative marginal product. When marginal product follows this pattern, the average product (output per unit of variable input employed) will at first rise but later fall. Average product will be at a maximum where MP = AP.

In the short run the firm will avoid input combinations where the marginal product or the variable input is negative. However, at some output levels it may have to operate where the marginal product of the fixed input is negative. If the latter situation persists, the firm will reduce its use of the fixed input when time permits such a long-run adjustment.

The firm's short-run total product curve describes the relation between use of its variable inputs and level of output produced. Thus, it contains the basic data necessary to analyze short-run variable costs.

5.0   SUMMARY

This unit seeks to explain the production in the short run. the. You also learnt relationship that exit among Total product, Average product and Marginal Product. The concept of diminishing returns as well as Cost Minimization in the short run was also described in the unit.

6.0   TUTOR MARKED ASSIGNMENT

From Table below (a) find the AP and the MP of labour and (b) plot the TP, and the AP and MP of labour curves.

Land	Labour	Total Product
1	0	0
1	1	2
1	2	5
1	3	9
1	4	12
1	5	14
1	6	15
	7	15
1	8	14

7. 0   REFERENCES /FURTHER READINGS

Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing Company, Minnesota, USA.

Karl E.C. and Line C. F (2007):*Principles of Microeconomics*, Pearson Education International, New Jersey, USA.

Umo J.U.(1986): *Economics, African Perspective*; John West publications Limited, Lagos.

O'Sullivan A. and Sheffrin S.M. (2002):*Microeconomics: Principles And Tools:* Pearson Education, New Jersey, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 2: THEORY OF PRODUCTION II

CONTENTS

1.0   INTRODUCTION

In the previous unit you learnt about the concept production and the relationship between input and output. We used one input situation to describe the production function. Here, attempt is made to use two-input situation and as well give basic idea about isoquant and its relevance to the producer.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   State the differences between short run and long run
2.   List the characteristics of isoquant
3.   Describe the relationship between total product curve and isoquant

3.0   MAIN CONTENT
3.1   Long Run and Short Run Period

In the unit 1 of this module you already aware of short run period as most of the product curves are from one-input data. Now, you would be reminded of it so to be able to differentiate between short run and long run for purposes of analysis.
In the long run all of the firm's inputs are viewed as variable, including its plant and equipment.

The long run is a period of time in which all of the inputs in a given production function can be changed in amount.

Since firms can either build new plants or get rid of old ones in the long run, it

is also a period of time in which new firms can enter an industry or old firms can leave.

In the short run, *firms produce output from a given size plant.* Thus they can vary their rate of output, up to a point, but the time period is not long enough to change plant size add a new plant or get rid of an old one. This means of course, that the fundamental characteristic of the short run is that some of the firm's inputs cannot be increased or decreased.

The short run *is a period of time in which at least one of the inputs in a firm's production function is totally fixed in amount, while one of more other inputs are variable*.

If we return to our earlier example of an electric utility firm we can see easily that the short run would be a period in which the firm could vary its output of electricity by changing the amount of fuel and other inputs used in its generating plant but could not change the size of the plant itself.

Therefore, in this course material the terms long run and short run will be used in much the same sense as they were defined above. However, it would be erroneous to get the idea that there is no middle ground between the two time periods. For example the electric utility might be able to increase its output by installing some bigger generators in its old plant-a change that has to do with capacity but one that is much easier to accomplish and requires much less time than a major plant expansion or the construction of a new plant. Thus, in analyzing a particular real-world case we might find that some intermediate time period between the long run and the short run is readily definable.

SELF ASSESSMENT EXERCISE 1: Mention the difference between the long run and short run period

3.2   Production in the Two-Input

In algebraic notation a production function might be represented by an equation such as the following:

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

where

Q is output per time period (day, week, month, year),
K is the amount of capital equipment employed,
L is the amount of labour employed,
M is the amount of raw materials input, and
E is the amount of energy used in production of the output.

The production function of equation as mentioned above tells *what* inputs the quantity of output produced depends on, but it does not say *how* the amounts of

the inputs used cause output to change. For this reasons it is called an *unspecified production* function.

A production function for some particular product may have any number of inputs than the one stated above and could be a very complicated equation. Fortunately, to understand the economics of production, we can use a simple model that assumes only **two inputs**, capital and labour. In the following discussion our production function will be

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

and we will assume that capital (K) represents plant and equipment while labour (L) represents the services of production workers. In the long run, both K and L will be variable; but in the short run, K will be fixed in amount and only L will be variable. Our choice of K as the short-run fixed factor is not arbitrary. Remember K represents physical capital or plant and equipment. For most firms physical capital will be the input that does not change in amount over the short run. Thus even though our two-input production function is an abstract concept, it is meant to represent input choices much the way they are made by real-world firms.

It is very useful to have some idea of what a two-input production function looks like in diagram form. Since we are concerned with three variables output (Q), K, and L, the production function diagram will be three dimensional. As in Figure 2.1, its base is the quadrant K0L; and the function itself will be represented by a surface whose height indicates the level of output, Q .

In general, when more of both K and L are used, we will expect output to increase. Thus in Figure 2.1 if we are using K_1 , and L_1 of inputs K and L, we will produce Q_1 of output at point A on the production function. When both K and L are increased to combination K_2, L_2, output increases to point B where Q_2 is produced. Of course, such a change in both K and L would be possible only in the long run, given our previous assumption that the amount of K cannot be changed during the short run time period.

3.3   lsoquants and Their Characteristics

It is possible to resolve our three-dimensional production surface of Figure 2.1 into a two-dimensional diagram using the method of contour lines that was used in the indifference curve
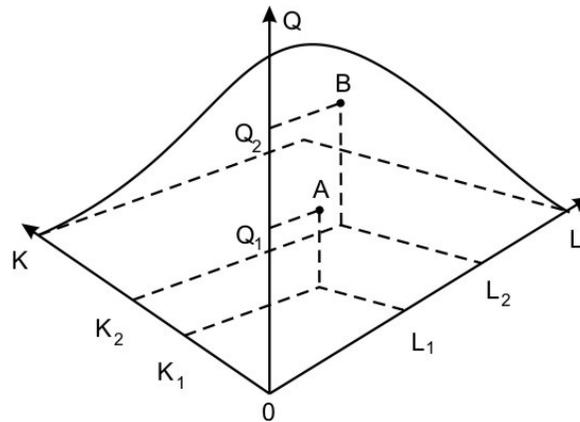
Figure 2.1:   A Production Function Q = f (K L)

The three-dimensional surface rising from the base quadrant K0L shows the output level fQ) corresponding to each possible combination of inputs K and L. Thus, combination (L_1,K_1) yields an output of Q_1 at point A on the production surface while (L_2,K_2) yields Q_2 at point B.

analysis of indifference curve as we have it ECO 201. That is, if we take the production surface of Figure 2.1 and cut it at various heights with planes parallel to the base plane, the result will be a contour map of the production surface that looks very much like a contour map of a hill. Each contour line on the map will represent a certain height (level of output or Q) as well as all of the combinations of K and L that will allow us to attain that height. This technique has been used in **Figure 2.2** where the points A and B from **Figure 2.1** are now shown to lie on two different contour lines or isoquants.

An isoquant is a contour line on a production surface. It shows all combinations of two inputs that will produce a given level of output per unit of time.

In Figure 2.2 isoquant I_1 corresponds to Q_1 of output and traces all combinations of K and L that will result in that level of output per time period. Isoquant I_2 plots all combinations of K and L that will result in an output of Q_2. Point C on the diagram shows that Q_2 of output can be produced with Kc of K and L of Lc, as well as with the original combination of inputs at point B. An infinite number of isoquants can be drawn for any given production function since there is one for every possible level of output.
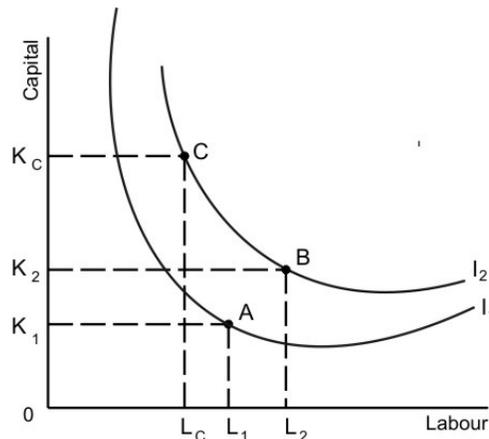
Figure 2.2: Two Isoquants of the Production Function Q = f(K,L)

Isoquant I₁ shows all combinations of K and L that will produce Q₁ units of output. Isoquant I₂, which is further from the origin shows all combinations of K and L that will yield Q₂ of output. Thus, either combination (L K) or combination (L2, K2) or any go C other combination of inputs on If can be employed to produce level Q of output.

Finally we can say four more things about the characteristics of isoquants:
1.   Isoquants will not intersect, since this would imply that a given isoquant is both higher and lower (in terms of output) than another.
2.   If output can be increased by increasing either K or L then isoquants that are further out from the origin will represent more output than those closer in.
3.   If output can be increased by increasing either K or L then isoquants will be downward sloping to the right.
4.   If K and L are imperfect substitutes for one another, isoquants will bend toward the origin (will be convex toward the origin) as in **Figure 2.2**.

The first two of the above characteristics are relatively easy to understand. Consider them in the order stated. First isoquants will not intersect one another since each one is defined as representing only one level of output. If two isoquants were to intersect it would imply that more than one level of output is represented by each one of them (or that one can be higher than, lower than and even equal to the other). This is an impossibility given their definition.

The second characteristic of isoquants (that those further out from the origin represent higher levels of output when both K and L have a positive effect on output) follows because moving outward from the origin implies an increase in K, L or both. If increased input use results in greater output, isoquants representing successively greater levels of output will also represent successively larger amounts of K and L inputs. Thus, they will have to be located further out from the origin, which is the point where both K and L equal zero.

The last two of the four isoquant characteristics stated above are not easily explained without further examination of the production function. In particular, they rear on the nature of the marginal effect of changes in inputs on the level of output produced. In the next unit that follows, we introduce a new concept marginal product that will prove helpful in analysing the remaining characteristics of isoquants and will continue to be important in our discussion of the theory of production.

SELF ASSESSMENT EXERCISE 1: Distinguish between isoquant and indifference curve.

3.4   Isoquants and the Total Product Curve

In Figure 2.3 capital is constant at level K_1, and labour is increased from $L = 1$ to $L = 6$. Panel (a) shows how output per week varies in the isoquant diagram as K_1 of capital is combined with different amounts of labour along the horizontal line K_1S. Note that some levels of output (10, 40) can be produced in plant K_1 only with input combinations where isoquants slope upward to the right. This means that in the short run with plant size K there is no alternative but to produce certain outputs where the marginal product of one of the two inputs is negative. Since L is variable the outputs 10 and 40 should be produced at points A and B respectively. Producing these same outputs at points H and J would not be rational.

Panel (b) of **Figure 2.3** shows a total product curve (TP_L), which relates output (Q) to labour use (L).
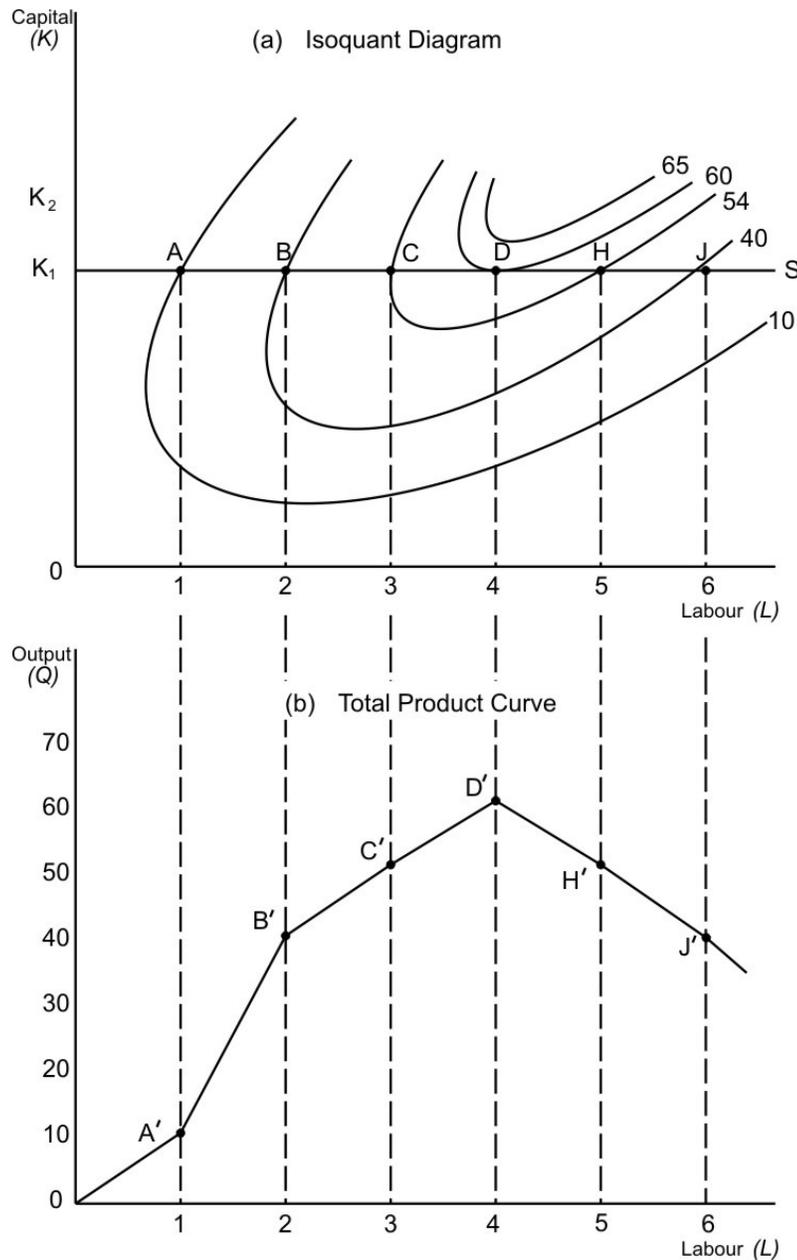
Figure 2.3: Short-Run Production with Capital Fixed at K$_1$

In panel (a), capital is fixed at K$_1$, and output is increased along line K$_1$S by increasing L only. The maximum output attainable in plant K$_1$ is 60 units, at point D. Beyond point D, MP$_L$ is less than zero. Panel (b) shows the total product curve for L with K fixed at K$_1$. The total product curve is a plot of the combination of labour use and output level from panel (a). Thus, points A', B' C', D' E', and J' in the lower diagram correspond to A, B, C, D, E, and J in the upper one.

3.5   Relationship between Marginal Product and Isoquants

Marginal product has an important connection with the isoquant diagram. First

of all, if the marginal product of an input is greater than zero, it must be true that an increase in the use of that input will cause output to rise. This means that a higher isoquant will be reached. **In Figure 2.3**, at point A, both MP_K and MP_L are greater than zero, since a small change in either input K or input L will increase output from isoquant I_3 to isoquant I_4.
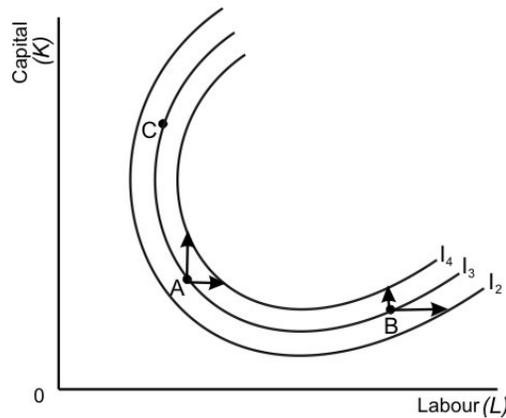
Figure 2.4:
Relation of Isoquant slope to marginal products of inputs.
In the neighbourhood of point A, where isoquants are sloping downward to the right output can be increased by increasing either K or L. However, with upward-sloping isoquants, in the neighbourhood of points such as B and C only one of the two inputs has a positive marginal product. At B MP_L is less than zero while at C MP_K is less than zero.

However, at point B in the same diagram, an increase in K will cause output to rise, while an increase in L will cause output to fall. We must conclude that although $MP_K > 0$ at point B $MP_L < 0$. This phenomenon relates to our earlier statement that isoquants will be downward sloping when both MP_K and MP_L are greater than zero. (It is the reason for the third characteristic of isoquants listed in unit 1 of this module). Upward-sloping isoquants imply a negative marginal product of one of the two inputs. If you check point C in **Figure 2.4**, you should be able to determine that it lies in a region where $MP_L > 0$ but $MP_K < 0$.

It is certainly possible for production functions to contain regions of negative marginal product. What occurs in such regions is that there is just too much of one of the inputs being used relative to the other. Think about a small passenger jet with 120 Seats as an example. It is certainly possible for an airline to employ ten cabin attendants on such a plane instead of the usual three or four. However those extra attendants would probably reduce output because they would get in each other's way and also take up valuable passenger space. It would not be rational for the airline to choose to employ additional attendants when their marginal product is negative; but the combination, drone small plane and ten cabin attendants does exist on its production function for

the route being flown.

Although it is clear that a firm will avoid using so much of a variable input (like labour) that the input has negative marginal product the same cannot be said for short-run fixed inputs. For example, consider the case of an airline that is using too large a plane on a given route. If it has no other aircraft available for the route it may, in the short run choose to operate where the marginal product of capital (the airplane) is negative. This would mean it could actually serve the same number of passengers with less fuel and a smaller crew if it had a smaller plane. However, having committed itself to a certain array of capital equipment in the short run the airline has no alternative but to use the excessively large plane. Of course, if such a situation persisted in the long run, the airline would sell its large plane and replace it with a smaller one.

Were it not for the existence of the short run we could simply rule out any points on the production function where the marginal product of an input is negative. However, it is entirely possible for a firm to get stuck with too much of a fixed input in the short run.

3.6   Ridge lines and the Relevant Region

As result of the short-run problem we will draw our isoquant diagrams with isoquants that bend around and become upward sloping at both ends. This will allow us to divide the diagram into three regions: One where both MP_K and MP_L are positive; one where is negative but MP_L is positive; and one where MP_K is negative but MP_L is positive. Such is the case in Figure 2.5, where we have added a new concept ridge lines, to the isoquant diagram.

Ridge lines form the boundaries of the region of the isoquant diagram within which the marginal product of both inputs is positive.

In **Figure 2.5**, the ridge lines are 0F and 0G. Above ridge line 0F isoquants are upward sloping and $MP_K<0$. Since isoquants are downward sloping immediately below 0F but upward sloping immediately above it, this ridge line goes through all points where isoquants are vertical. Similarly, ridge line 0G passes through all points where isoquants are horizontal. Below 0G MP_L is negative. The shaded area inside the two ridge' lines is known as the relevant region. Assuming both inputs are variable (long run), a firm will never choose to operate at any point outside the relevant region.
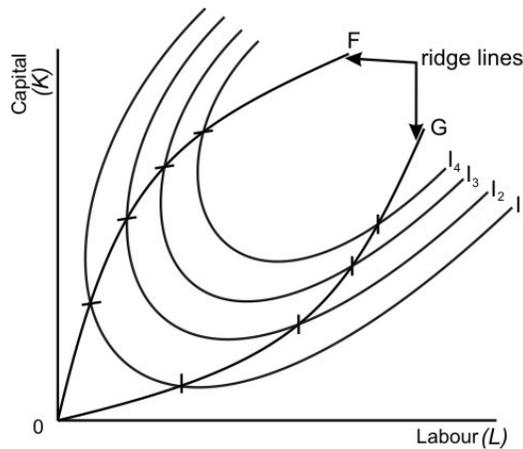
Figure 2.5

The "relevant region" of the isoquant diagram is where isoquants are downward sloping to the right and convex (bowed) toward the origin. In the relevant region, MP_L and MP_K are greater than zero. Ridge line 0F passes through all points where isoquants are vertical while 0G passes through all points where isoquants are horizontal. Along 0F, $MP_K = 0$, and along 0G, $MP_L = 0$.

SELF-ASSESSMENT EXERCISE 2:

Explain why a movement down an isoquant (within the ridge lines) implies that the MPL is declining

3.7   Marginal Rate of Technical Substitution

There is one additional connection between isoquants and the marginal products of inputs that is important to our analysis. It is the marginal rate of technical substitution (MRTS), which tells how much of one input can be substituted for the other while keeping output constant. Along an isoquant in the K0L quadrant, the MRTS is equal to $-\dfrac{\Delta K}{\Delta L}$, or the negative of the slope of the isoquant.

The Marginal Rate of Technical Substitution (MRTS) is the rate at which one input can be substituted for another, while output remains constant.

In **Figure 2.6** we examine the marginal rate of technical substitution of labour for capital $MRTS_{KL}$, along isoquant I_1. Moving down the isoquant from point A through points B, C and D, we have set the diagram up so that the use of input L is increased by the same amount (one unit) between each of these points. Note however, that the use of input K can be reduced only by successively smaller amounts in order to remain on the isoquant and keep output constant. Between points A and B, a unit of L will substitute for two units of K. However

the MRTS falls to $-\dfrac{\Delta K}{\Delta L}$ = 1 between points B and C and to 1 2 between points C and D.
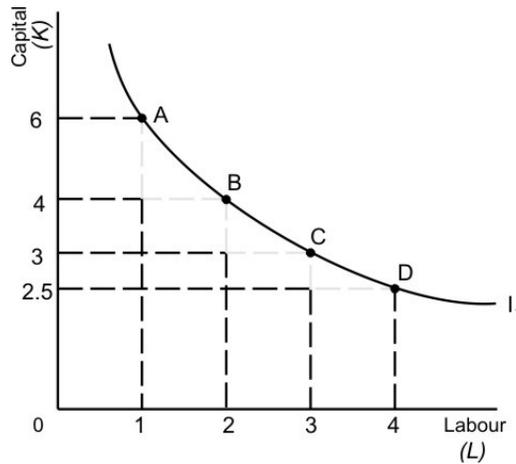
Figure 2.6 diminishing MRTS$_{KL}$ Along an Isoquant

The MRTS$_{KL}$, that is, $-\dfrac{\Delta K}{\Delta L}$, falls along the isoquant from point A through point D. Between A and B, the MRTS$_{KL}$, is $-(-\dfrac{2}{1})$ = 2. Between B and C, it is $-(-\dfrac{1}{1}) = 1$, and between C and D it is $-(-.5) = .5$. The MRTS$_{KL}$, falls because it becomes increasingly difficult to substitute labour for capital as the quality of capital that labour has available to work with reduced.

The economic reason for the falling MRTS along an isoquant is that inputs are not perfect substitutes for one another. Thus as we first try to substitute labour for capital it works quite well because there is plenty of capital for the labour to work with. However, as we continue to attempt this substitution, it becomes increasingly difficult for labour to do the job of capital, and very little capital can be removed per unit of labour added.

4.0   CONCLUSION
We simplify the production function in this unit by assuming that firm's depends on only two inputs and might be examined. The amount by which one input can be reduced when one more unit of another   input is added while holding output constant is referred to as marginal rate of technical substitution. The various combinations of inputs that yield the same level of output is called isoquant. We established the relationship between total product, marginal product and isoquant.

5.0   SUMMARY

In this unit we were able to discuss the concept of production, production function, long run and short run and the way they are related in a firm setting. Moreover, you also learnt about isoquant and its various features. Nature of Production

6.0   TUTOR MARKED ASSIGNMENT

1.   Explain how, from an isoquant map, we can derive (a) the TPL and (b) the TPK. (c) What type ofisoquant map is implied by a TP function like the one figure 2.4

2.   In what ways are firms' isoquant maps and individuals' indifference curve maps based   on the same idea? What are the most important ways in which these concepts differ?

7. 0   REFERENCES /FURTHER READINGS

Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing Company, Minnesota, USA.

Karl E.C. and Line C. F (2007):*Principles of Microeconomics*, Pearson Education International, New Jersey, USA.

Umo J.U.(1986): *Economics, African Perspective*; John West publications Limited, Lagos.

O'Sullivan A. and Sheffrin S.M. (2002):*Microeconomics: Principles And Tools:* Pearson Education, New Jersey, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 3: THEORY OF PRODUCTION III

CONTENTS

1.0 INTRODUCTION

In the last unit we considered the basic needful that you should know about production theory both in the short run and the long run. The concept of marginal product, economic reason for expansion of a firm and its implications shall be dealt with. This unit explains marginal rate of technical substitution with the help of isoquant and isocost approach.

2.0 OBJECTIVES

At the end of this unit student should be able to:
1.   State the economic relationship that exit between marginal product and isoquant
2.   Describe the concept of marginal rate of technical substitution using isoquant approach.
3.   Explain the implication of input prices and firm's budget

3.0 MAIN CONTENT
3.1 Relationship between MRTS and Marginal Products

Surely, the rate at which one input can be substituted for another must have something to do with the marginal products of the two inputs. Indeed it does, for, logically, labour's MP will be higher the more capital it has to work with up to a point, and the same could be said for capital. But how is all of this related to the marginal rate of technical substitution?
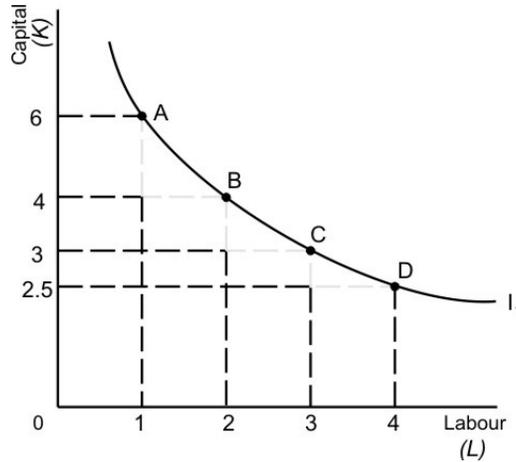
Figure 3.1: Diminishing MRTS$_{KL}$ Along an Isoquant

As we move along an isoquant from a point like A to one like B in **Figure 3-1**, $\Delta Q = 0$, since output does not change. However, K has changed by ΔK, and L has changed by ΔL. Each of these changes will affect output through the marginal product of the respective input. Thus the total change in output will be

$$\Delta K(MP_K) + \Delta L(MP_L) = 0,$$

since the number of units of K removed times its marginal product per unit will just be offset by the number of units of L added times the marginal product of a unit of L.

If we subtract $\Delta K(MP_K)$ from both sides of equation the following expression results:

$$\Delta L(MP_L) = \Delta K(MP_K).$$

Dividing both sides of the above by $\Delta L(MP_K)$ yields

$$\frac{MP_L}{MP_K} = -\frac{\Delta K}{\Delta L} = MRTS_{KL}$$

Thus, it follows that the MRTS at a point on an isoquant is equal to the ratio of the marginal products of the two inputs at that same point.

Note: *The definition for MRTS given above is an arc formula. We can derive the point formula for the MRTS as follows. We have already noted that along an isoquant the change in the quantity of output must be zero. Thus along an isoquant the total differential of the production function is equal to*

$$dQ = \frac{\partial Q}{\partial K} dK + \frac{\partial Q}{\partial L} dL = 0 \qquad\qquad (1)$$

lf we subtract $\frac{\partial Q}{\partial K} dK$ from the two left-hand sides of equation 1, we obtain

$$\frac{\partial Q}{\partial L} dL = -\frac{\partial Q}{\partial K} dK \qquad (2)$$

Dividing both sides of the above by dL and $-\frac{\partial Q}{\partial K}$, we get

$$\frac{\frac{\delta Q}{\delta L}}{\frac{\delta Q}{\delta K}} = -\frac{dK}{dL} \qquad (eq.\ 3)$$

However, since we know that $\frac{\delta Q}{\delta L} = MP_L$ and $\frac{\delta Q}{\delta K} = MP_K$, we have

$$\frac{MP_L}{MP_K} = -\frac{dK}{dL}, \qquad (eq.\ 4)$$

The point formula for $MRTS_{KL}$

3.2   MRTS and Input Substitutability

It is the diminishing MRTS that accounts for the curvature of isoquants in the relevant region. Thus, as long as inputs are not perfect substitutes for one another isoquants will be convex toward the origin as we have generally drawn them. This occurs because a falling MRTS means that the isoquant's slope will become less and less steep as L is substituted for K.

There are two cases in which isoquants will not be convex toward the origin in the relevant region. The first is the case of perfect substitutes. Here isoquants are straight lines; and the MRTS is a constant. Such a case is shown in panel (a) of **Figure 3.2**, where two units of L always substitute for one unit of K; and the MRTS is constant and equal to one-half. Panel (b) of **Figure 3.2** shows another special case in which K and L cannot be substituted at all. Typewriters and typists would fit such a case since during any given workday or shift each typist must have one typewriter to work with. Thus, the relevant region consists only of points such as A B, and C; and isoquants are right angled to show' that increasing the amount of one of the inputs without increasing that of the other will not add to output . It follows that anywhere off the diagonal line A, B, C, the marginal product of one of the two inputs is zero.

3.3   MRTS and Ridge Lines

We can make one final observation using the notion. of the MRTS.
Since the $MRTS_{KL} = \frac{MP_L}{MP_K} = -\frac{\Delta K}{\Delta L}$ and is, therefore, equal to (-1) times the slope

of an isoquant where an isoquant is vertical (along ridge line 0F in **Figure 2.4 unit 2**), it must be true that $MP_L = \infty$ since the slope of a vertical line is infinite. For the slope to be infinite, MP_K must be zero since we know that MP_L is positive both in the relevant region and in the region above 0F. Thus, when isoquants are vertical (along 0F)

$MP_K = 0$.

Along the lower ridge line (0G in Figure 2-4), the slope of an isoquant is zero since this is where isoquants are horizontal. Here, $\dfrac{MP_L}{MP_K} = 0$

since MP_L is zero. (Remember that MP_L is positive to the left of OG but negative to the right of 0G. Thus it passes through zero along OG.)
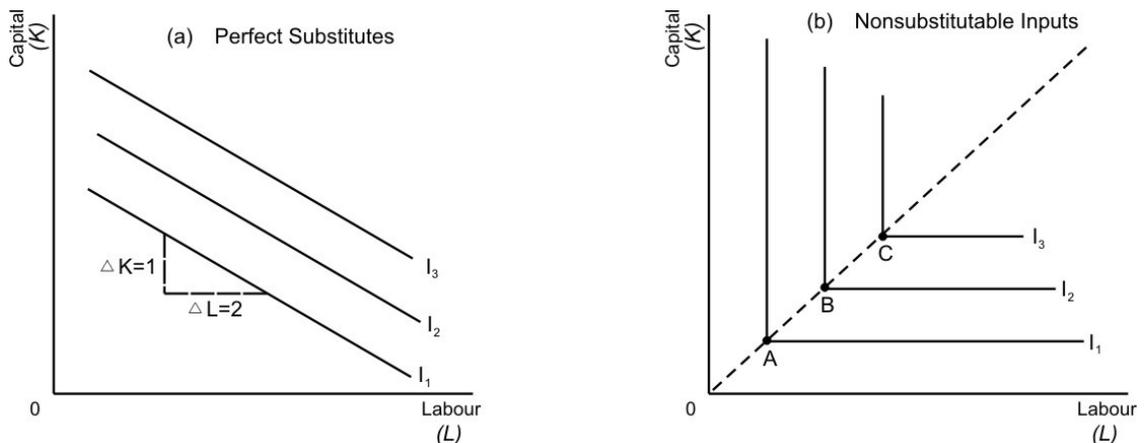
Figure 3.2. Two Special Types of Isoquants

In panel (a), the straight-line isoquants indicate that L can be substituted for K at a constant rate $(-\dfrac{\Delta K}{\Delta L} = \dfrac{1}{2})$*. Thus, the two inputs are perfect substitutes.*
In panel (b) the right-angled isoquants indicate that K and L cannot be substituted for one another at all. Thus, the only relevant input combinations occur at points such as A, B, and C.

3.4   The Isocost Line

The above analysis of the production function and isoquants has given us a very complete description of the input-output combinations available to the firm. Our next step is to devise a way of determining which input combinations result in the production of each level of output at the lowest possible cost in either of the two principal production periods (long run and short run). To do this we need a way to determine the cost of each input combination that the firm can buy. Subsequently we shall develop an algebraic and a graphical method for describing input cost.

3.5   Input Prices and the Budget

The firm's costs arise from its expenditure on inputs. For example, if a firm hires two workers for a day and the wage rate is N40 per day, these workers will add N80 to its cost. When the price of an input is given (such as the N40 daily wage just mentioned) the firm's total expenditure on that input will equal the number of units of the input employed times its price per unit. If L is the number of workers employed and P_L is the price (daily wage) of a worker then expenditure on labour will equal $L(P_L)$. In the preceding example, **$L(P_L) = 2(N40) = N80.$**

Assuming all input prices are given (true when the firm cannot negotiate these prices but must accept them as established) the expenditure of a firm with only two inputs, K and L will be equal to the number of units of K employed times its price (P_K) plus the number of units of L employed times the price of L which we can call P_L. If we call the firm's total expenditure by the name "Total Cost" (TC) we can write

$$TC = K(P_K) + L(P_L).$$

Furthermore, if there were more than two inputs used by the firm, we could generalize this expression to:

$$TC = K(P_K) + L(P_L) + ... + N(P_N)$$

For any number of inputs employed. The above equations are called the budget equation of the firm.

The budget equation *of a firm expresses the firm's total cost as a function of its expenditure on inputs. Its general form is $TC = K(P_K) + L(P_L) + ... + N(P_N)$.*

3.6   Plotting the Budget Equation

The budget equation for the two-input case can be plotted in the K0L quadrant- the same quadrant in which we drew production isoquants. In fact, it plots as a straight line called an isocost line.
An isocost line *is a plot of the budget equation for the two-input case. It shows all combinations of two inputs that can be bought with a given budget at given inputprices.*

To see why the budget equation plots as a straight line, assume that $P_K = N10$, $P_L = N2$, and the firm is spending N100 on inputs. The budget equation will be

$$TC = K(10) + L(2) = 100.$$

Rearranging terms, we can write

$$K(10) = 100 - L(2)$$

$$K = 10 - \frac{2}{10}L$$

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

is that of a straight line with a K intercept of 10 and a negative slope of $-\frac{1}{5}$.

Note that the absolute value of the slope is $\frac{2}{10} = \frac{P_L}{P_K}$. The isocost line for TC = 100, given $P_K = N10$ and $P_L = N2$, is shown in Figure 2-7.

To find the ends [K and L axis intercepts] of any isocost line $K(P_K) + L(P_L) =$ TC just let the amount of one input equal zero and ask how much of the other one can be bought for a budget of TC naira. For example, if we let K = 0 in equation. We have

$$L(P_L) = TC$$

$$L = \frac{TC}{P_L}.$$
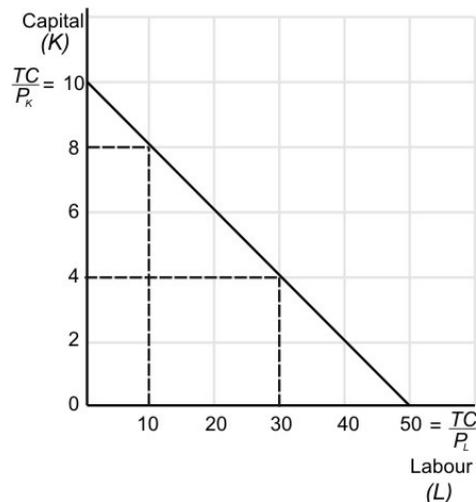
Figure 3.3:Isocost line for the Equation TC = K(10) + L(2) = 100

The isocost line shows all combinations of two inputs that can be bought for a given budget and a given set of prices. If the bud et is N100, P_K = N10, and P_L = N2, the straight line with intercepts TC/P_K = 10 and TC/P_L = 50 describes all such input combinations.

Thus, the L axis intercept of the isocost line is $\frac{TC}{P_L}$. Similarly, the K axis

intercept is $\dfrac{TC}{P_K}$. For the equation K(10) + L(2) = 100, the L axis $\dfrac{N100}{N2} = 50$,

and the K axis intercept is $\dfrac{N100}{N10} = 10$. Note that 10 is also the K axis intercept

term.

Along isocost line lies all input combinations that the firm can buy when it spends every bit of a budget of N100, given P_K and P_L. It can also buy combinations below the isocost line but for these it would spend less than N100 and have some money left over. Thus, the isocost line is a ***constraint***, since the firm cannot buy any combination lying to the right of it for N100 or less. Clearly, an isocost line is very much like a consumer's budget line since it says what inputs the firm can ***buy*** with a given budget or total cost but it leaves open the question of what combination the firm will actually decide to buy.

SELF-ASSESSMENT EXERCISE 1:

Assume that a firm's PK = $1, PL $2, and total Cost = $16. (a) What is the slope of the isocost? (b) Write the equation for the isocost. (c) What do you means by PL/ PK?

3.7   Shifts in Isocost Lines

For our two-input case, we have seen that the slope of the isocost line is $\dfrac{P_L}{P_K}$

.Thus, as long as input prices do not change, it follows that the slope of the isocost line will not change. With fixed input prices, if the firm increases its budget, the isocost line will shift outward in parallel manner as shown in panel (a) of Figure 2-8. Here, $C_1C'_1$ is the original isocost line from Figure 2-7 (TC = N100, P_K = N10, P_L = N2). The isocost line will shift to $C_2C'_2$ if the firm increases its budget to TC = N140. In panel (b) of Figure 2-8, the isocost line shifts inward from $C_1C'_1$ to $C_0C'_0$ as the budget is reduced from N100 to N50.

A price change in one of the inputs will shift the isocost line in nonparallel fashion. For example, if P_L falls, the "foot" of the isocost line will shift

rightward for any given total cost. This is so because $\dfrac{TC}{P'_L}$ will be greater than

$\dfrac{TC}{P_L}$ anytime that $P'_L < P_L$ (see Figure 2-9). In plain English, a given budget will

allow the firm to buy a larger maximum quantity of L when P_L falls. You should be able to verify for yourself that a rise in P_L will shift the foot of the isocost line inward and that changes in put will have similar effects on the K axis intercept or Otto's of the isocost line if P_K and TC remain constant.
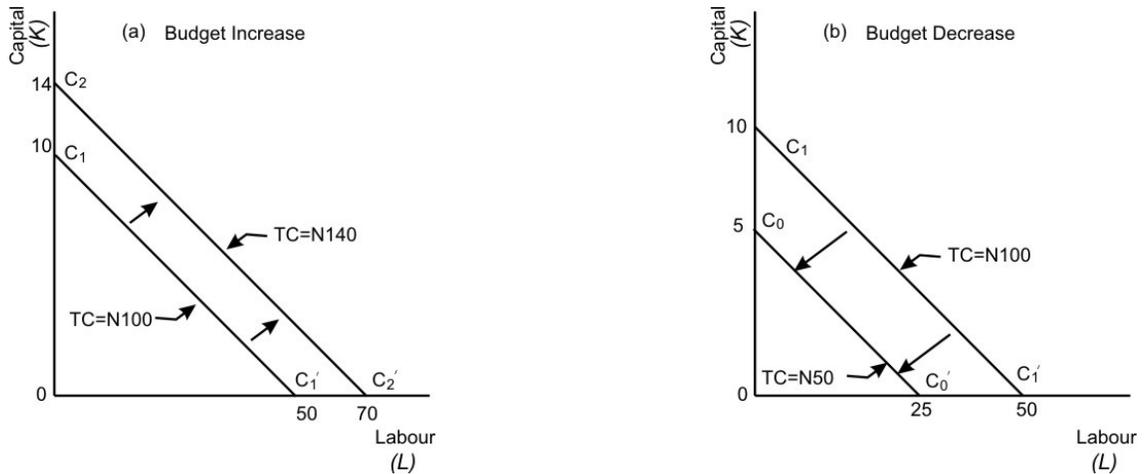
Figure 3.4 How budget changes affect the Isocost Line

With given input prices, a budget increase shifts the isocost line outward in parallel fashion [panel (a)], while a budget decrease shifts the isocost line inward in parallel fashion [panel (b)].
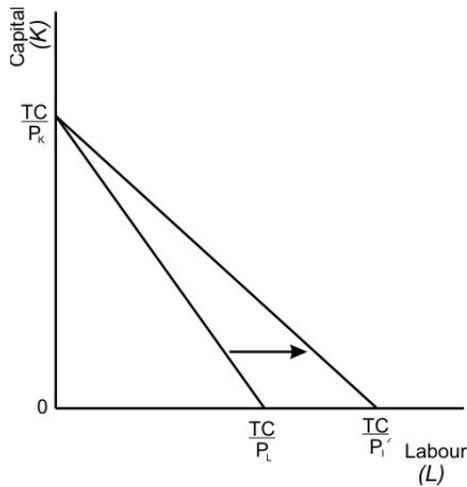
Figure 3.5. How an Input Price Change affects the Isocost line

A decrease in P_L (the price of a unit of labour) will shift the "foot" of the isocost line outward since $\dfrac{TC}{P'_L}$ is greater than $\dfrac{TC}{P_L}$. However, the K intercept of the line will not change, since neither TC nor P_K has changed.

4.0   CONCLUSION

The production function is a mathematical statement of the way output changes as the physical amounts of productive inputs are changed. If technology changes, the equation of the production function would change.

An isoquant includes (is the locus of) all the technically efficient methods (or

all the combinations of factors of productions for producing a given level of output. The production isoquant may assume various shapes depending on the degree of substitutability of factors. You learnt about isocost line which explains the cost/ firm outlay on inputs for production.

5.0   SUMMARY

This unit explains production function using isoquant approach and how the firm determines the least cost combination of input using labour and capital. The ridge lines define the regions of isoquants that is possible for efficiency to be achieved.

6.0   TUTOR MARKED ASSIGNMENT
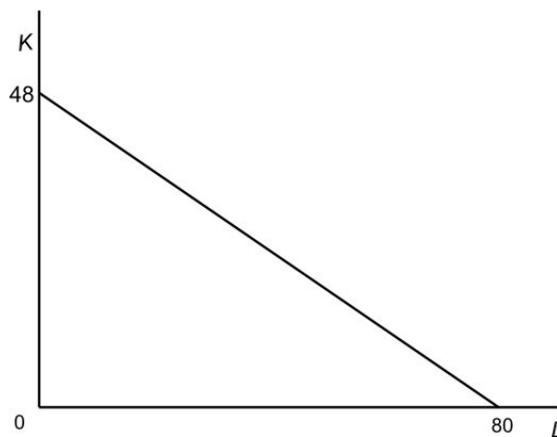
1.   The above is an isocost line for a budget of TC = N1,840. Answer the following questions about it.
a.   What is the slope of the isocost line?
b.   What are the prices per unit of K and L?
c.   If the price of L changed to N32 per unit, how would the isocost line for TC = N1840 change?
2.   Mrs BIGGS are produced according to the production function

$$Q = 2K + L$$

where:
Q = Output of Frisbees per hour
K = Capital input per hour
L = Labor input per hour
a.   If K = 10, how much L is needed to produce 100 Frisbees per hour?
b.   If K = 25, how much L is needed to produce 100 Frisbees per hour?

7. 0   REFERENCES /FURTHER READINGS

Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing Company, Minnesota, USA.

Karl E.C. and Line C. F (2007):*Principles of Microeconomics*, Pearson Education International, New Jersey, USA.

Umo J.U.(1986): *Economics, African Perspective*; John West publications Limited, Lagos.

Nicholson W. and Snyder C. (2010): Intermediate Microeconomics 11Ed., South-Western Cengage Learning, Mason, USA

O'Sullivan A. and Sheffrin S.M. (2002):*Microeconomics: Principles And Tools:* Pearson Education, New Jersey, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 4:   PRODUCTION THEORY IV

CONTENTS
1.0   Introduction
2.0   Objectives
3.0   Main content
4.0   Conclusion
5.0   Summary
6.0   Tutor Marked Assignment
7.0   References /Further Readings

1.0   INTRODUCTION

This unit is just the continuation of unit 3 especially the concept of isocost we ended the unit with. The attainement of equilibrium by the producer, it also demonstrate how a change in price of any of the inputs affect the budget equation and input substitution strategy of the firm. We will look at the long run least cost condition and output maximization of the firm as a way achieving profitability.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Explain with numerical values and graphical details the least cost combinations
2.   Explain and illustrate the effect of an input price change
3.   Describe expansion path and its conditions

3.0   MAIN CONTENT
3.1   Cost Minimization in the Long Run

A LeastCost Combination of Inputs is that combination of inputs that will enable a firm to produce a given level of output at the lowest possible cost.
In the two-input case we have developed, the long-run least cost combination of inputs for any given output will occur *when no substitution of **capital** for **Labour**or L for K will cause a reduction in total cost*. This will be true

whenever the output produced per naira spent on an additional unit of K is equal to the output produced per naira spent on an additional unit of L. It will not pay the firm to switch its expenditure from K to L if a naira spent on L increases output by the same amount as a naira spent on K. For example, if a naira spent on either K or L yields two units of output. buying one naira's worth more of L at the expense of one naira's worth of K will have a net effect of + 2 - 2 = 0.

3.2   PRODUCER EQUILIBRIUM

How can we determine the number of units of output produced per naira spent on additional K or L? The answer is found in the relation of each input's marginal product to its price per unit. For examples suppose $MP_K = 100$. If the firm hires an additional unit of K, output will increase by 100. Now suppose P_K = N50. (It costs N50 to increase K by one unit.) If the firm spends the N50 to get one more unit of K, output will increase by 100 and the marginal product per naira spent on additional K will be $\dfrac{100}{N50} = 2$ per N1. In other words, since N50 was spent to get 100 units of output, the marginal product per naira spent on K was 2 units of output per naira. Note that this can be expressed as $MP_K \div$ price of K, or $\dfrac{MP_K}{P_K}$ = marginal product per naira spent on K.

The marginal product per naira spent on L can be written as $\dfrac{MP_L}{P_L}$. Suppose a unit of labour costs N20 and $MP_L = 40$. The marginal product per naira spent on L would be $\dfrac{40}{N20} = 2$ units per N1. If the firm were producing some given level of output, say,

Q = l00, and it were employing K and L in a combination such that $\dfrac{MP_K}{P_K} =$ $\dfrac{MP_L}{P_L} = 2$ units per N1, it would not be able to reduce cost by switching expenditure from one input to the other since moving 1% of expenditure from K to L would have a net effect of + 2 - 2 = 0 on output.

However, if MP$_L$ were 80 instead of 40 we would have $\dfrac{MP_L}{P_L} = 80/20 = 4$ unit per N1, and $\dfrac{MP_K}{P_K} < \dfrac{MP_L}{P_L}$, $\dfrac{100}{50} < \dfrac{80}{20}$. The firm could reduce its cost by switching expenditure from K to L since N 1 more spent on L would increase output by 4 units. This action would allow N2 less to be spent on K, while maintaining output at Q = 100 since the net effect on output of spending N1 more on L and N2 *less* on K would be + 4 - 4 = 0. Further, it would make sense to continue

substituting L for K as long as $\dfrac{MP_L}{P_L} = \dfrac{MP_K}{P_K}$

3.3   Long-Run Least Cost Condition

The only time that substitution of one input for the other would not yield a cost reduction would be when $\dfrac{MP_L}{P_L} = \dfrac{MP_K}{P_K}$. Thus, the condition for obtaining a least cost combination of inputs is to arrive at a point where the marginal product per naira spent on one input is equal to the marginal product per naira spent on any other input.

The least-cost condition can be generalized for any number of variable inputs. In other words, it is applicable to all inputs in the long run and all variable inputs in the short run. If a firm has **n** inputs in the long run, we can state the least cost condition as follows:

The long-run least cost condition is met when, for n inputs, $\dfrac{MP_1}{P_1} = \dfrac{MP_2}{P_2} = \ldots =$

$\dfrac{MP_n}{P_n}$.

As indicated in the preceding example, any inequality in the ratio of marginal products to input prices means that the firm has not attained a least cost combination of inputs. In such a situation, the firm will be able to reduce costs by substituting inputs with higher marginal products per naira for those with lower marginal produces per naira.

3.4   Limits to Input Substitution

Suppose for the moment that a firm is producing at an input combination where $\dfrac{MP_K}{P_K} < \dfrac{MP_L}{P_L}$. Will the firm continue to substitute for K indefinitely? The answer is no because as the amount of K is reduced and that of L is increased, we can expect MP_K to rise while MP_L falls. This will happen because each labour unit will have successively less and less capital to work with as the substitution takes place. Thus, it will become more and more difficult to obtain additional output by adding labour, while the effect on output of increasing capital (MP_K) will become greater. There will be a tendency for $\dfrac{MP_K}{P_K}$ to rise and for $\dfrac{MP_L}{P_L}$ to fall. This is exactly what is needed to arrive at the least cost condition, or the input combination where $\dfrac{MP_K}{P_K} = \dfrac{MP_L}{P_L}$.

The marginal product changes just described are, of course, related to the concept of the diminishing marginal rate of technical substitution along an isoquant. In the next section cost minimization in the isoquant diagram is examined, and we show you that the least-cost condition is fulfilled when the MRTS is equal to the input price ratio, $\dfrac{P_L}{P_K}$.

3.5   Isoquants and Cost Minimization

In the isoquant diagram with two inputs K and L that are variable in the long run, cost minimization can be viewed as attaining the lowest possible isocost line for any output (isoquant) the firm chooses to produce. Cost minimization is illustrated in **Figure 2.4.** Here, it is assumed that P_K, = N5, while P_L = N2. Points A and D represent combinations of K and L that will produce I_1 = 50 units of output along isocost line C_2C_2'. Isocost line C_2C_2' represents a total cost of N50, however; and point B shows that 50 units of output can be produced with a budget as low K as N40 on isocost line C_1C_1'.

Since C_1C_1' is just *tangent* to isoquant I_1 , it is the *lowest* isocost line that touches I_1 = 50 units of output. The combination of inputs at point B, K_bL_b, is the least cost combination of inputs for the ratio of input prices represented by the slopes of the isocost lines C_1C_1' , and C_2C_2' . Along isoquant I_1 , any input combination other than that at point B could be attained only with a higher isocost line than C_1C_1' , and it would therefore require a larger budget to produce the *same* 50 unit level of output.

3.6   Relation to Least-Cost Condition

At point B in Figure 2-10 tangency of isocost line C_1C_1' to isoquant I_1 indicates that the input price ratio (absolute value of slope of C_1C_1'), $\dfrac{P_L}{P_K}$, is equal to the MRTS$_{KL}$ on isoquant I_1 (absolute value of slope of I_1 at point B). Algebraically, we can state

$$\frac{P_L}{P_K}, = -\frac{\Delta K}{\Delta L} .$$
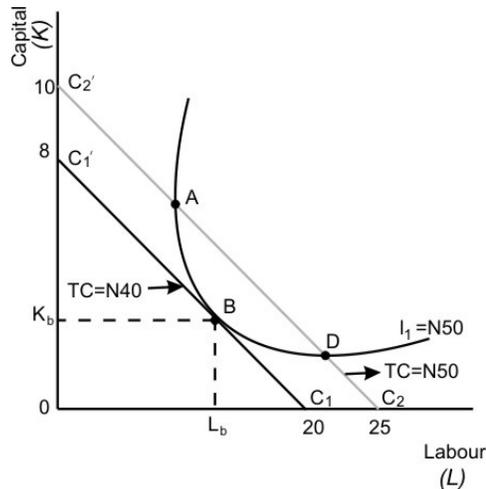
Figure 4.1 Cost Minimization for an Output of 50 Units

With a given production function given input prices, and a desired output of 50 units cost is minimized at point B where the isocost line for TC = N40 is just tangent to isoquant I_1. Points A and D also lie on the so-unit isoquant, but the input combinations at these points cost N50 instead of N40.

However, from equation above, given previously, we know that the MRTS_{LK} is also equal to $\dfrac{MP_L}{MP_K}$. Thus, we have $\dfrac{P_L}{P_K}, = \dfrac{MP_L}{MP_K}$.

If both sides of equation 2-9 are multiplied by a common term, MP_K/P_L, the following is obtained:

$$\frac{MP_K}{P_L} \cdot \frac{P_L}{P_K} = \frac{MP_L}{MP_K} \cdot \frac{MP_K}{P_L},$$

or

$$\frac{MP_K}{P_K} \cdot \frac{MP_L}{P_L}$$

Thus we must conclude that tangency of an isocost line to an isoquant is completely consistent with the general condition for optimum use of variable inputs at given input prices.

SELF-ASSESSMENT EXERCISE 2:

Isoquant can be convex, linear, or L-shaped. What does each of these shapes tell you about the nature of the production? What does each of these shapes tell you about MRTS?

3.7   Maximization of Output

The isoquant diagram of Figure 4.1above provides a convenient medium for showing that the condition for maximization of output from a given budget is

the same as that for cost minimization. Consider point B again. Suppose our problem had been to maximize output for a budget of N40, rather than to minimize cost for an output of 50 units. Since isocost line C_1C_1' cannot reach any isoquant higher than $I_1 = 50$, the maximum output that can be attained with a budget of N40 and the given input prices is 50 units. To accomplish this, the firm would have to use K_b of capital and L_b of labour at point B. Any other combination of K and L on isocost line C_1C_1' would correspond to being on some isoquant lower than I_1. Further, such points would be intersections between isoquants and $C_1C_1`$ and not tangency points like point B. It follows that when output is not maximized for a budget of N40, $\frac{P_L}{P_K} = \frac{MP_L}{MP_K}$, and $\frac{MP_K}{P_K} = \frac{MP_L}{P_L}$. At point B of course, both of these ratios are equal.

With input prices given we can conclude that tangency of an isocost line to an isoquant can be used to represent either (1) cost minimization for a given level of outputs or (2) output maximization for a given budget. No matter which is the case, the general condition for a least cost combination of variable inputs will hold at the point of tangency.

Note:*Mathematically, the least-cost combination of inputs is found by solving a constrained minimization problem as follows:*

$$Minimize \ TC = K(P_K) + L(P_L),$$
$$Subject \ to \ Q = f(K,L) = Q_O,$$

Where Q_O is a given level of output.

Using Lagrange's undetermined multiplier method, we form the Lagrangian function $H = K(P_K) + L(P_L) - \lambda[f(K,L) - Q_O]$, where λ is the undetermined multiplier. To solve for the optimal levels of K and L, the first-order partial derivatives of the above function are set equal to zero, yielding a system of three equations in three unknowns, or

$$\frac{\delta H}{\delta K} = P_K - \lambda f_K = 0$$
$$\frac{\delta H}{\delta L} = P_L - \lambda f_K = 0$$
$$\frac{\delta H}{\delta \lambda} = -f(K,L) + Q_o = 0$$

Restating the first two of the above partials.

$$\frac{\delta H}{\delta K} = P_K - \lambda MP_K = 0$$

$$\frac{\delta H}{\delta L} = P_L - MP_L = 0 \, ;$$

therefore,

$P_K = \lambda MP_K$

$P_L = \lambda MP_{L,}$ and

$\dfrac{P_K}{P_L} = \dfrac{MP_K}{MP_L}$

Multiplying both sides of the last expression by $\dfrac{MP_L}{P_K}$,

$$\frac{MP_L}{P_K} \cdot \frac{P_K}{P_L} = \frac{MP_K}{MP_L} \cdot \frac{MP_L}{P_K}, \text{ or } \frac{MP_L}{P_K}, \text{ or } \frac{MP_L}{P_L} = \frac{MP_K}{P_K},$$

which is the least-cost condition. In a constrained minimization problem such as the above, the undetermined multiplier, λ, represents marginal cost, since

$\dfrac{\delta H}{\delta Q_O} = \lambda$

If the problem is to obtain the highest output for a given budget, we have then maximize Q = f(K,L) subject to a total cost constraint. Using Lagrange's method again, we have

Maximize Q = f(K,L)
Subject to TC = K(P_K) +L(P_L) = TC_O,

whereTCo is a given level of total cost or budget. The Lagrangian function is

$$J = f(K,L) - \lambda[K(P_K) + L(P_L) - TC_O]$$

Setting the first-order partial derivatives equal to zero, we have

$$\frac{\delta J}{\delta K} = f_K - \lambda P_K = 0$$

$$\frac{\delta J}{\delta L} = f_L - \lambda P_L = 0$$

$$\frac{\delta J}{\delta \lambda} = -K(P_K) - L(P_L) + TC_O = 0$$

Restating the first two of the above partials.

$MP_K - \lambda P_K = 0$,
$MP_L - \lambda P_L = 0$, and
$\dfrac{MP_K}{MP_L} = \dfrac{P_K}{P_L}$

Multiplying both sides of the above expression by $\dfrac{MP_L}{P_K}$ yields

$$\frac{MP_K}{P_K} = \frac{MP_L}{P_L}$$

In this case λ is interpreted as the marginal product per naira spent on additional inputs, since $\frac{\delta J}{\delta TC} = \lambda$.

3.8   Effect of an Input Price Change

A change in the price of one of the two inputs will lead to substitution off the input that has be- come relatively cheaper for the one that has be- come relatively more expensive. For example if the price of labour rises capital will become cheaper relative to labour and will be substituted for it**. In Figure 4.1**, a large increase in the price off labour is used to illustrate such a substitution. Initially, the firm is at point A where isocost line C_1C_1' is tangent to isoquant I_1. A large increase in the price of labour shifts the foot of the isocost line inward to C_1". The isotope line is now C_1C_1", and the budget is not sufficient to produce I_1 of output. The firm must increase the budget so that the isocost line shifts from C_1C_1" to C_2C_2' if output is to continue to be at level I_1.
However, because of the change in the input price ratio (slope of the isocost line) the combination of inputs at point B will now be the least cost combination. Capital use will be increased and the use of labour will be reduced.

Something similar to the preceding example has occurred in the Nigeria Banking industry in recent years. As wage rates have risen it has become increasingly attractive to substitute robot-type machinery (ATM) for human labour. Actually two forces have been operating in this case. Not only have wage rates risen but technological change has made it possible to serve more customers relatively cheap. Both of these input price changes would tend to increase the slope of the isocost line as in Figure 4-1.
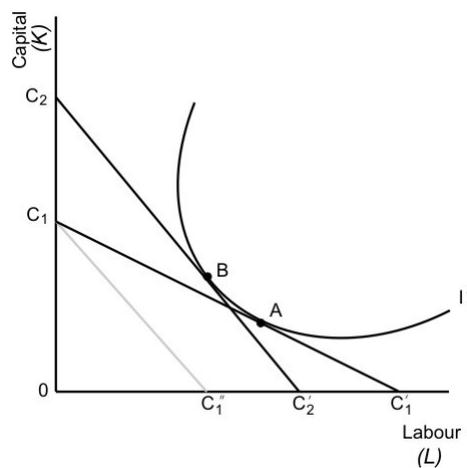
Figure 4.2: Capital-Labour Substitution in Response to Input Price Change

If the firm is initially at point A and the price of a unit of labour (P_L) rises, in the long run it will be rational to substitute capital for labour and move to point B on isocost line C_2C_2'. Since C_2 is greater than C_1 and P_K has not changed more is spent to produce I_1 at B than at the original cost-minimization point, A.

3.9   The Expansion Path

If input prices are given and do not change, it is possible to trace a path of least-cost input combinations in the isoquant diagram. This path, called the expansion path, can be obtained by moving the isocost line outward in parallel fashion and locating points of tangency with successively higher isoquants.

*The **Expansion Path** is the path of tangencies between isoquants and isocost lines for a given input price ratio. It shows how the firm would expand in the long run.*

Figure 4.3 shows an isoquant diagram with ridge lines (0F and 0G) and an expansion path. The expansion path, ABCDE, is developed by increasing the firm's budget from C_1 through C_5 and locating the tangencies of successive parallel isocost lines with isoquants I_1 through I_5. The path ABCDE is the expansion path for the ratio of input prices reflected by the slope of the isocost lines shown in the diagram.

If the input price ratio were to change a new expansion path would result. You can easily prove this fact for yourself by passing a straightedge (notecard or pencil) through the diagram in Figure 2-12 and keeping its slope constant but different from that of the given isocost lines. You will develop a path of tangencies that is different than the path ABCDE.

3.10   Relationship of the Expansion Path to Long-Run Cost

The relationship between the firm's cost data and production analysis is thoroughly discussed in the next module- Theory of Cost. For the long run, all of the information needed to describe the way the firm's cost varies as output is increased can be obtained from the isoquant diagram. That is with input prices given each combination of output level and total cost that the rational firm will produce corresponds to a point on the expansion path.

For example, in Figure 4.2, if I_1 = 100 units of output and C_1C_1' is the isocost line for a budget of N1,000, point A tells us that it will cost the firm N1,000 to produce 100 units of product. Its per unit or ***average*** cost of production will be $\frac{N1000}{100} = N10$. In other words, the 100 units of output will cost N10 each to produce. How the firm's total and per unit costs change as it increases its output in the long run will depend on the nature of the cost-output

combinations at other points, such as B,C,D, and E, that lie further out on the expansion path. For example if at point D, C_4C_4' represents a budget of N4,000 and $I_4 = 250$, the firm's per unit cost would be higher at the 250-unit level of output than at the 100-unit level, since N4,000/250 = N16.
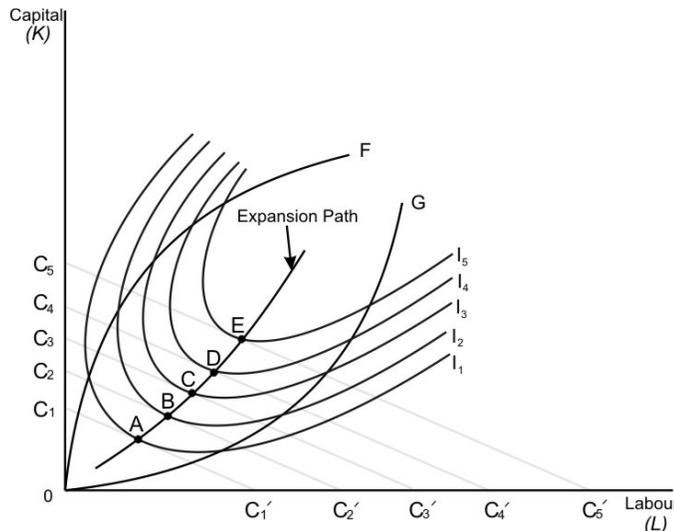
Figure 4.3. Derivation of the Firm's Expansion Path

For a given production function and given input prices the firm's expansion path is derived by finding all points of tangency between successive parallel isocost lines and the isoquants. Thus the line connecting points A, B, C, D, and E is an expansion path. It shows all least cost input combinations in the long run, given a specific input price ratio, $\dfrac{P_L}{P_K}$.

The precise behaviour of long-run total and per unit cost as output increases along the expansion path will depend on the mathematical properties of the firm's production function. These properties are best discussed in the context of the long-run cost curves of the firm, a subject to be taken up in Theory of Firm Cost. At this point it is sufficient to know that the data which describe the relationship between a firm's output and its production cost in the long run are obtained from points on the firm's expansion path.

SELF-ASSESSMENT EXERCISE 1:

Explain how short run expansion path differs from a long run expansion path.

4.0   CONCLUSION

The condition for long-run cost minimization or output maximization in the two input case is $\dfrac{MP_L}{P_L} = \dfrac{MP_K}{P_K}$. This states that the marginal product of one naira's worth of labour is equal to that of one naira's worth of capital. When

this condition holds at a point of tangency between an isocost line (budget line) and an isoquant, the firm will not be able to reduce cost by substituting one input for the other. Conversely, it will not be able to increase output without spending more money on inputs.

For a given input price ratio $\dfrac{P_L}{P_K}$, the path of tangency points between isocost line and isoquants is called an expansion path. The firm's long-run cost data are generated from points on this path.

In the two-input case, capital (K) is the short-run fixed input. The firm can increase output only by adding more of the variable input, labour (L) to the fixed amount of capital.

5.0   SUMMARY

In this unit you have learnt about Cost Minimization in the Long Run and how to determine Marginal Product Per Naira Spent on input. The concept of Long-Run Least Cost Condition, limits to input substitution were well examined. You also learnt the use of isoquants to describe cost minimization position of a firm. The effect of an input price change and relationship of the Expansion Path to Long-Run Cost were discussed with the use of graph for better understanding.

6.0   TUTOR MARKED ASSIGNMENT

1. What is the relation between the firm's expansion path and its long-run total cost curve?
2. Analyse the effect of an improvement in technology on (a) the isoquant map (b) the expansion path

7. 0   REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited,   Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson
        Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc., New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill
        Companies, Inc. USA

MODULE III: THEORY OFCOST

UNIT 1: THEORY OF COST- INTRODUCTION

CONTENTS
1.0   Introduction
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3.0   Main content
     3.1   Nature of Costs
     3.2   Explicit Costs
     3.3   Implicit Costs
     3.4   Opportunity Cost
     3.5   Private vs. Social Cost
     3.6   Fixed vs. Variable Cost
     3.7   Sunk Cost
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1.0   INTRODUCTION

The economists refer to cost as something other than money in the course of obtaining a value. The option sacrificed in obtaining any value. The option sacrificed may or may not be quantified in monetary which is different from the way an accountant looks at it.

Cost theory is related to production theory, they are often used together. However, the question is usually how much to produce, as opposed to which inputs to use. That is, assume that we use production theory to choose the optimal ratio of inputs (e.g. 2 fewer engineers than technicians), how much should we produce in order to minimize costs and/or maximize profits? We can also learn a lot about what kinds of costs matter for decisions made by managers, and what kinds of costs do not.

This module is also about how production cost varies with the size of the production input and the quantity of output in a given firm. For instance, a state government decides whether to build one or two new schools; it should take a careful look at the cost of providing hospital services in a large and small hospital. Similarly, a firm builds a computer chips factory; it should compare the production per chip in a large factory to the cost per chip in a small one. However, in this unit we shall look at concept cost and various types of costs- economic cost, accounting cost, private cost, social cost, fixed cost, variable cost, and sunk cost.

2.0   OBJECTIVES
At the end of this unit student should be able to:
1.   To differentiate between implicit and explicit cost
2.   To differentiate between private and social cost and;
3.   To describe the following terms:
        a.   fixed cost
        b.   variable cost
        c.   sunk cost

3.0   MAIN CONTENT

It should be apparent from the production analysis that a business firm's costs derive from the amounts it pays for inputs (factors of production) in order to produce any given level of output. Thus, a general statement of total cost for a firm that uses N inputs in its production function is simply the budget equation
$TC = K(P_K) + L(P_K) + \ldots + N(P_N)$

The budget equation, however, expresses cost as a function of the level of use of inputs. Firms are often interested in a different kind of cost relationship that between various levels of output and cost of production. Much of this module will deal with the way certain kinds of cost concepts behave as the firm changes its output, but first it is important to define costs and show how the cost figures normally used by managers and accountants are related to economists' notions of cost.

3.1   Nature of Costs

The accounting statements of business firms generally do not report all of the costs that firms actually incur in order to produce goods or services. This is because accounting methods focus on historical costs that record a firm's actual payments to suppliers of inputs, but pay little attention to costs that do not involve payments to persons or organizations outside the firm. Economists would say that the firm's account books tend to accurately reflect its explicit costs but largely ignore its implicit costs.

3.2   Explicit Costs

The firm's explicit costs are easy to identify, since they include what everyone usually thinks of when the word "cost" is used-expenditures for labour, raw materials, fuel, and so forth. All of these cost items have one thing in common. They can be counted up by keeping track of payments by the firm to the supplier of the input.
Explicit costs are those costs of production that involve a payment by the firm to some person, group, or organization outside the firm. In other words, it is the firm's actual cash payments for its inputs. However, the process of production usually involves more than explicit costs.

3.3   Implicit Costs

A firm often uses resources it owns as inputs in its production function. In general, their use does not involve a payment to any outside supplier. Suppose a firm owns a warehouse building that is quite useful but fully depreciated on its books. If it uses the building to store materials, its accounting records will not show any cost for this use. Yet, it is certainly true that the use of the building involves a cost to the firm, since it would be possible to rent the building to some other firm or individual. The cost to the firm, therefore, is the foregone rent. It is an opportunity cost, measured by the value of the rental opportunity that is foregone. Typically, the firm's implicit costs are of this nature. *The value of all inputs to a firm's production in their most valuable alternative use.*

Implicit costs are the costs of using firm-owned resources. They are opportunity costs which cannot be accounted for by payments to outsiders. Or the opportunity cost of non-purchased inputs.

In the preceding example, the warehouse building was said to be fully depreciated. The reason for this qualification is that depreciation, which does appear in accounting statements, is an implicit cost item meant to record the firm's using up of its capital goods (buildings and equipment). However, depreciation standards generally are determined by to laws and cannot be expected to be a good measure of the opportunity costs of using renowned capital goods.

An important implicit cost that accounting statements do not include in any way is what economists call ***normal profit (total revenue less total explicit and total implicit cost)***.

A normal profit is the return to entrepreneurs (owners, investors) that is necessary to keep the firm in operation over the long run.

Why is normal profit a cost? The reason is that people who invest in a firm expect to get some return on their investment. They have incurred an opportunity cost to invest in the firm rather than in some other alternative investment (other firms, bonds, etc.). If the firm proves to be less profitable than alternative investments, the investors will want to liquidate it and move to the alternatives. Thus, output will not be produced over the long run unless a normal profit is received by investors. The normal profit is compensation for the investors' or entrepreneurs' input .into the firm and is, therefore, a cost of production in the same sense that compensation for other inputs is a cost of production.

3.4   Opportunity Cost

Opportunity cost to firm in using any input is what the input could earn in its best alternative use (outside the firm). This is true for inputs bought or hired by the firm as well as for inputs owned and used by the firm in its own production. For example consider a firm that owns a building and therefore pays no rent for office space .this forgone rent is the opportunity cost of utilizing the office space and should be included as part of the economic cost of doing business.

SELF-ASSESSMENT EXERCISE 1:

An executive chef for stomach matter chain resigns his N40000/year position. He uses his life savings N50000 to purchase a small rural Inn. At the end of the first year of operation, his accountant provides him with the following information on revenues and explicit cost:

Revenue: N150000
Expenses:
Food   N40000
Labour   N70000
Utilities   N10000
Miscellaneous   N20000

Net Income: N10000

Did the entrepreneur make a profit of N10000 for a year?

3.5   Private vs. Social Cost

Note that the remaining part of this module and in later analyses our attention will be on the private economic costs of the firm.

The private economic costs of the firm include all the costs of resource use by the firm which must bear to produce its output.

For each possible level of output, the private economic cost will consist of all explicit and implicit costs borne by the firm. However, we should recognize that the private economic cost of production may not include all costs associated with a particular output. The reason is that the firm may shift some costs to parties who are not compensated for bearing them. For example, if a firm's production activities cause air pollution, real costs will be borne by those who are harmed by the polluted air. The output will have a social cost that is higher than its private cost to the firm.

The total social cost of a given activity is equal to its private cost plus all third-party costs borne by those who do not participate in the activity.

Thus, the private cost of a rock concert consists of the explicit and implicit costs of the organizers and performers as well as the implicit costs of the audience (they chose to expose their ears to possible damage). However, ear damage to persons who are neither sellers nor buyers of the concert is clearly a social cost.

Although it is important to recognize the existence of social costs and to develop means to compensate those who bear them, it is clear that the firm's decision makers will generally base their actions on private economic cost. Thus, we leave the issue of social costs at this point in order to fully develop our analysis of the firm.

SELF ASSESSMENT EXERCISE 2: Explain with example the meaning of normal profit

3.6   Fixed vs. Variable Cost

In the production analysis of preceding module, the ***short run*** was defined *as a period of time in which at least one input in the firm's production function is fixed*. What this means in terms of cost is that the short run is characterized by the existence of some production costs that are fixed. If we view the short-run fixed inputs as plant and equipment, the firm's ***fixed costs****are those associated with having the plant and equipment, whether or not any output is produced.*

In the two-input production function, $Q = f(K, L)$, if the price of capital is given as P_K, then fixed cost in the short run is just $K (P_K)$. In the real world, fixed cost is more complex but still readily identifiable. A firm's total fixed cost will be made up of items such as rent, property tax payments, depreciation, interest payments on long-term loans, and portions of its expenditures for numerous other inputs. The essential characteristic of fixed cost items is that they will not change as the quantity of output changes in the short run. Thus, if a firm has a mortgage on its building, the mortgage payment will be the same size no matter whether output is zero or some positive number of units per month.

The firm's ***variable costs****are all costs that do change with its level of output. This means that they are the costs of using variable inputs*. In the production function $Q = f (K, L)$, the short-run variable input would be labour (L). Of course, most firms have an array of inputs that are variable in the short run, including not only labour but also raw materials, fuel, and various kinds of producers' goods (parts, intermediate goods, and even some types of capital equipment). All of these 'inputs will change in amount as output changes in the short run and, therefore, will be components of the firm's short-run total variable cost.
In the long run, as we noted in the concept of production theory, all of the inputs of the production function are variable. This means that all costs are

variable. Thus, when analyzing the long run, the distinction between fixed and variable cost does not apply.

Example:
3.   Assume that capital constitutes a fixed input. The price of capital W_K is N5 per unit; the price of labour W_L is N10/unit. Multiplying W_K and W_L by the amounts of capital and labour, respectively, given in the production schedule, we obtain the fixed and variable cost schedules. Adding the fixed and variable costs for each output gives the total cost schedule.

Production schedules

Capital	Labour	Output
10	0	0
10	1	5
10	2	12
10	3	18
10	4	23
10	5	27
10	6	30
10	7	32
10	8	33

Cost schedules

Fixed(capital)	Variable (Labour)	Total
50	0	50
50	10	60
50	20	70
50	30	80
50	40	90
50	50	100
50	60	110
50	70	120
50	80	130

(a)

TVC

=N=/Unit

Slope =

60

50

40

30

20 ── A

10

0   10   20   30   Unit/t
             Output

=N=/Unit

(b)

3

2 ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─   **AVC**

1

0   10   20   30   Unit/t
             Output

Figure 1.1: Average variable costs will eventually rise, according to the law of diminishing returns. (TVC=total variable costs; AVC= average variable costs.)

3.7   Sunk Cost

***Sunk costs** are costs that have been incurred and cannot be reversed.*
Any costs incurred in the past, or indeed any fixed cost for which payment must be made regardless of the decision is irrelevant for any managerial decision. Suppose you hire an executive with a N1,000,000 signing bonus, plus N2,000,000 salary. After hiring, you may find the executive does not live up to expectations. However, if the executive's marginal revenue product is N2,000,001, the executive still generates N1,000 in profits relative to his salary and therefore should be retained. But if his Marginal Revenue Product (MRP) is N1,999,999, the firm loses an extra N1,000 each year they keep him, so he should be let go. The bonus is a sunk cost and does not affect the retention decision.

The principle of sunk costs is equivalent to the saying "don't throw good money afterbad." Sometimes a decision can be made to recover part of a fixed cost. Perhaps one could sell a factory and recover part of the fixed costs. Then

only the difference is sunk. For example, if we can sell a building for which we paid N500,000 for N300,000, then only N200,000 is sunk.

Sunk costs are perhaps one of the most psychologically difficult things to ignore.

Examples:
1.   Finance. Studies show investors let sunk costs enter their decision making. What price the stock was purchased at is sunk and therefore irrelevant. What matters is only whether or not this stock offers the best return for the risk. Yet, investors are reluctant to sell stocks whose price has gone down.

2.   Capital investment. I watched the world series of betters. In one instance, the odds of drawing a flush (and almost for sure winning the hand) was 1 in 5. The stake was about N200,000. So the player should call any bet less than or equal to N40,000. Yet the commentator advised that the player should call regardless of the bet, because he already had so much money in the stake (sunk costs).

3.   Cut your losses? Consider the war against Niger Delta Militants. We have sunk billions, but what alternative available for the government to avoid waste. So government came up with Amnesty programme to reverse the cost of fight and vandalism.

4.   Pricing in high rent eye-brow area. Consider restaurants in a high rent district (say an airport). Should they take the rent into account when setting prices? No. In fact, prices are high not because of the rent, but typically because of the lack of competitors.

SELF ASSESSMENT EXERCISE 3: Briefly explain the difference between fixed cost and sunk cost

4.0   CONCLUSION

This unit provides a discussion of the firm's costs. The firm's explicit costs represent outright payments to factors of production for their services. Implicit costs are costs incurred by the firm because it has used resources in one way, thereby giving up the opportunity to use them in other ways. A normal profit is the return to entrepreneurs that is necessary to keep the firm in operation over the long run. The private economic costs of the firm include all the costs of resource use that the firm must bear to produce its output. The social cost of a given activity is equal to its private cost plus all third-party costs borne by those who do not participate in the activity.

The firm's fixed costs are those that do not vary in the short run, whether or not

any output is produced. The firm's variable costs are costs that do change with its level of output.

5.0   SUMMARY

You have been introduced to the basic concepts of cost theory which basis had been laid in the production theory of firm. Here you have learnt that economic cost and accounting cost concept are different because of implicit cost (opportunity cost). The private cost and social cost (neighbourhood cost and private cost) are clearly explained. Fixed cost , variable cost and sunk cost are treated with examples which are practical for easy understanding of their peculiarities.

6.0   TUTOR MARKED ASSIGNMENT

1.   What are implicit costs of production? Can any portion of profit be viewed as a cost of production? Why or why not?

2.   Which of these are likely to be fixed costs when business just started?
    a.   monthly rent for the warehouse
    b.   payments to suppliers of raw materials
    c.   properties taxes
    d.   director salary

7. 0   REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc., New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 2:   THEORY COST II

CONTENTS

1.0   INTRODUCTION
The firm, in the short run has at least one fixed input. Generally, we view the short run as a period of time during which output can be changed using existing capacity (plant and equipment), but a period too short to change the size of the firm's physical plant. There are fixed inputs in the short run, there will also be fixed costs. As in production analysis, the analysis of short-run cost will be much simplified if we use the two-input case as a model which this unit begins with.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Describe the conditions attached to short-run period of a firm
2.   Establish the relationship among these cost concepts given labour and capital as inputs: fixed cost, variable cost and marginal cost
3.   Calculate total cost, average total cost, and marginal cost and represent each of them on a graph

3.0   MAIN CONTENT
3.1   Costs in the Two-Input Case

If we continue with the two-input production function, $Q = f(K, L)$, it will be relatively easy to relate the behaviour of short-run cost to that of total product, average product, and marginal product of the variable input. However, it is just necessary to make some observations about fixed cost.

3.2   Total Cost

In the short run, some inputs are fixed and some variables; this leads to fixed and variable costs. Total fixed costs (TFC) are the total obligations of the firm per time period for all fixed inputs. These fixed or sunk costs include payments for renting the plant and equipment, most kinds of insurance, property taxes, and some salaries (such as those of top management). While total variable cost (TVC) are the total obligations of the firm per time period for all the variable inputs of the firm. Each of these would be discussed in detail using graphs and table.

3.2.1   Fixed Cost Concepts

In the two-input case, if the amount of capital (K) is fixed at some number of units, then total fixed cost will be equal to K multiplied by the price per unit of capital. We can write

Total Fixed Cost = TFC = K(P$_K$),

where P$_K$ is the unit price of capital. Of course, K(P$_K$) will be constant if the number of units of capital is fixed and P$_K$ is given.

A plot of TFC as output changes will be a straight horizontal line, as in Figure 2.1, since TFC will not vary with output. The TFC curve will be a horizontal line no matter how many fixed inputs the firm has in the short run, although a change in the price of a fixed input would cause the curve to shift upward (price increase) or downward (price decrease).
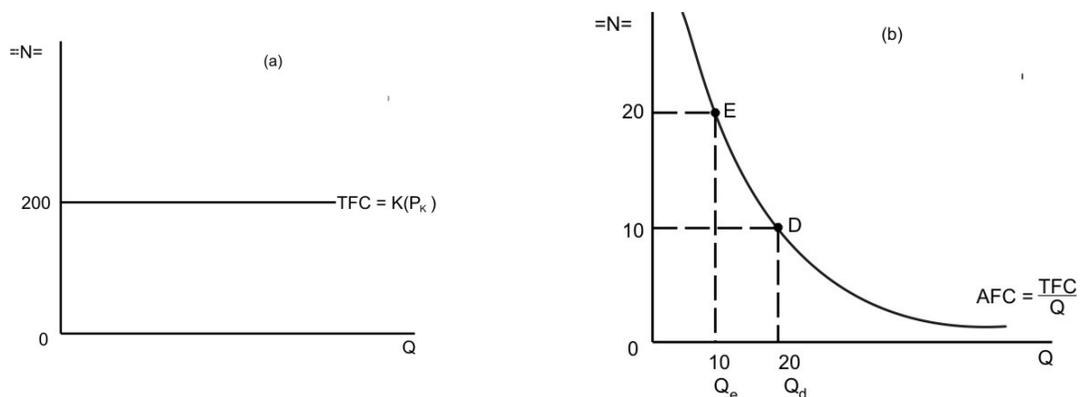
Figure 2.1 Total Fixed Cost and Average Fixed Cost

Total fixed cost (TFC) always plots as a horizontal line as in panel (a), since it does not change when the quantity of output (Q) changes. Average fixed cost (AFC) is total fixed cost divided by Q. As Q increases in panel (b), AFC falls.

Total Fixed Cost (TFC) is the private economic cost of the firm's fixed inputs

in the short run. The TFC curve is a horizontal line.

It is also useful to know what happens to fixed cost per unit of output as the quantity of output changes. This concept, known as Average Fixed Cost (AFC), behaves in a very predictable way given that TFC is a constant.

Average fixed cost (AFC) is fixed cost per unit of output produced in the short run.

Thus, average fixed cost is just TFC divided by quantity of output (Q), or

$$\text{Average fixed cost} = AFC = \frac{TFC}{Q}$$

As Q gets larger and larger, AFC will decline, since the numerator in $\frac{TFC}{Q}$ does not change. An AFC curve is shown in panel (b) of Figure 2.1. AFC will always be shaped like this curve because any rectangle formed by the axes and the coordinates of a point on the curve will have an area equal to TFC. That is if AFC = TFC/Q, then AFC (Q) = TFC. Any rectangle such as $0AFQ_eQ_e$ or $0AFC_dDQ_d$ in Figure 2.1 (b) will have an area equal to TFC.

The curves of TFC and AFC will be a horizontal line and a rectangular hyperbola, respectively, no matter how many fixed inputs the firm has. For example, if there were three fixed inputs, K, M, and N, and each had a fixed price *(P_K, P_M, and P_N),* total fixed cost would be *$TFC = K(P_K) + L(P_M) + M(P_N)$,* but it would still sum to a constant naira value. Thus, what we have developed from using K as the only fixed input is a pair of fixed-cost concepts (TFC and AFC) that can be regarded as completely general descriptions of the firm's fixed-cost curves.

3.2.2 Variable Cost Concepts

There are five short-run variable cost concepts generally used in the analysis of firm behaviour.These are total variable cost, short-run total cost, short-run marginal cost, average variable cost, and short run average cost. In the sections below, each of these concepts will be defined and the two-input production function, Q = f(K,L), will be used to help describe their behaviour.

3.2.3 Total Variable Cost
The firm's short-run variable costs stem from its hiring of inputs that are variable over the short-run time period.

Total Variable Cost (TVC) is the sum of all private economic costs of the firm that vary with its short-run level of output.

If in the short run $Q = f(K,L)$ but K is fixed, the firm's variable costs will depend strictly on how much labour (L) it employs. In fact, for each level of output, total variable cost will be equal to the amount of L employed times the price per unit of L, which we have previously called P_L.

Thus,

Total Variable Cost = TVC = $L(P_L)$.

3.2   Short-Run Total Cost

Short-run total cost is the sum of total variable cost and total fixed cost. Short-run total cost (STC) consists of all private economic costs of the firm in the short run.

STC is obtained by simply adding a constant (TFC) to TVC. Thus, Short-run Total Cost (STC) = TVC + TFC.

The graphical effect of adding TFC to TVC is shown in Figure 2.2. The short-run total cost curve (STC) turns out to be identical in shape to the TVC curve, but it is located higher in the quadrant, since an amount equal to distance 0F has been added to TVC at every level of output. This means that distances AB and CD are also equal to 0F.

Since the shape of the short-run total cost curve is identical to that of the total variable cost curve, we can conclude that both represent the behaviour of the firm's total product curve for the variable input in the short run. The nature of this connection should become clearer when we look at our next variable cost concept, marginal cost.
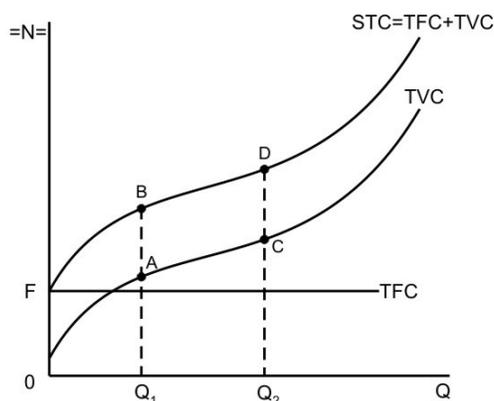
Figure 2.2: Relationship of Short-Run Total Cost to Total Variable Cost and Total Fixed Cost

Short-run Total Cost (STC) is obtained by adding total fixed cost to total variable cost at each level of output (Q). Thus, STC is just TVC "slipped

upward" by distance 0F. The vertical distance between TVC and STC is always equal to 0F, so that AB = CD = 0F.

Example:

Assume that capital constitutes a fixed input. The price of capital W_K is N5 per unit; the price of labour W_L is N10/unit. Multiplying W_K and W_L by the amounts of capital and labour, respectively, given in the production schedule, we obtain the fixed and variable cost schedules. Adding the fixed and variable costs for each output gives the total cost schedule.

Production schedules

Capital	Labour	Output
10	0	0
10	1	5
10	2	12
10	3	18
10	4	23
10	5	27
10	6	30
10	7	32
10	8	33

Cost schedules

Fixed (capital)	Variable (Labour)	Total
50	0	50
50	10	60
50	20	70
50	30	80
50	40	90
50	50	100
50	60	110
50	70	120
50	80	130

Average variable costs will eventually rise, according to the law of diminishing returns. (TVC=total variable costs; AVC= average variable costs.)

3.3   Short-Run Marginal Cost

It is important for a firm to know how sharply/slowly costs rise as it increases its use of short-run variable inputs. Short-run marginal cost is the concept that provides such information. The positively sloped portion of the short run marginal cost curve (SMC) results from diminishing returns

Short-run Marginal Cost (SMC) *is the rate of change of either total variable cost or short-run total cost as output changes from a given size plant. .*
Thus, we can write

Short-run Marginal Cost = $SMC = \dfrac{\Delta TVC}{\Delta Q} = \dfrac{\Delta STC}{\Delta Q}$

The method of tangents can be used to deter- mine the behaviour of short-run marginal cost from the slope of the TVC curve. In Figure 2.3, the tangents to

TVC show $\dfrac{\Delta TVC}{\Delta Q}$ or SMC as indicated by the triangle constructed below the tangent to point C. Tangents to the curve will fall as Q is increased, until point B is reached. After point B, tangents will become steeper as Q is larger. Thus, marginal cost first falls and then rises and point B is an inflection point showing where TVC has its lowest slope. This means that SMC falls as output is increased up to Q_b but thereafter rises, as shown in the lower panel of Figure 2.3.

In Figure 2.4, STC and TVC are shown to have the same slope at any given level of output. This is in keeping with our earlier finding that STC is TVC shifted upward by a constant equal to TFC. Since the rate of change of TFC as Q changes is zero, adding TFC to TVC has no effect on marginal cost, which is the slope of either TVC or STC.

It is helpful also to know the relationship of short-run marginal cost to the marginal product of the firm's short-run variable inputs). In the two-input case, Q = f (K, L), we have seen that TVC = L (P_L). Since SMC is equal to the rate of

Note

The calculus or point definition of short-run marginal cost is

$$SMC = SMC = \frac{dTVC}{dQ} = \frac{dSTC}{dQ}$$

change of TVC as output changes, we can write
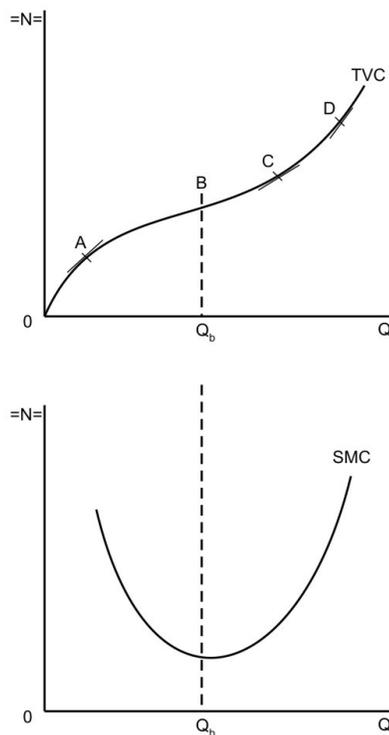
Figure 2.3. Relation of Total Variable Cost to Short-Run Marginal Cost *Short-run Marginal Cost (SMC) is the rate of change of total variable cost as output changes. Thus, tangents to TVC measure SMC. In the upper diagram, the slopes of the tangents decrease up to point B (an inflection point), but thereafter increase. It follows that SMC will fall until output level Q_b is reached but rise beyond Q_b.*

$$SMC = \frac{\Delta LTC}{\Delta Q} = \frac{\Delta L(P_L)}{\Delta Q}.$$

Since P_L is a constant, we have

$$SMC = \frac{\Delta L}{\Delta Q}(P_L) = \frac{\frac{1}{\Delta Q}(P_L)}{\Delta L}.$$

However, $\Delta Q / \Delta L$ is the marginal product of L..
Therefore,

$$SMC = \frac{1}{MP_L}(P_L)$$

and we find that short-run marginal cost is the reciprocal of the marginal product of labour multiplied by a constant, P_L. Since the law of diminishing returns says that MP_L will eventually fall, its reciprocal, $\dfrac{1}{MP_L}$, must eventually rise. Thus, SMC must eventually rise.
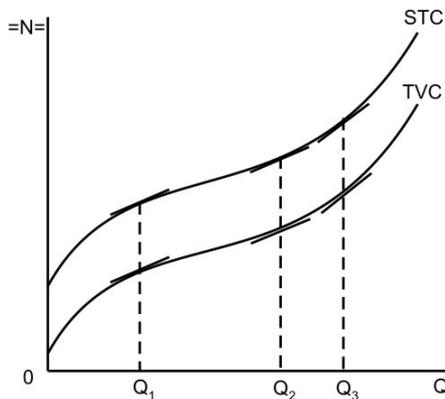
Figure2.4. Tangents Show that Short-Run Marginal Cost Is the Slope of eitherTotal Variable Cost or Short-Run Total Cost

For any level of output such as Q1, Q2, or Q3, the slope of TVC measures marginal cost. Since STC differs from TVC only by a constant (the amount of total fixed cost), both curves will have the same slope at any given output. That is why the pairs of tangents at Q1, Q2, and Q3 are parallel lines.

3.2.3 Average Variable Cost
The productivity of the firm's variable inputs will also have a specific relationship to its per- unit variable costs.

Average variable cost (AVC) is variable cost per unit of output produced.

Therefore, we can write

Average variable cost (AVC) = $\dfrac{TVC}{Q}$

In the two-input case, Q = f(K,L), with K fixed, TVC = L (P_L). Thus,

$$AVC = \frac{L(P_L)}{Q} = \frac{\frac{1}{Q}}{L(P_L)}$$

Since Q/L is the average product of labour, it follows that

$$AVC = \frac{1}{AP_L(P_L)},$$

or that AVC is the reciprocal of AP_L multiplied by a constant, P_L. You know that AP_L is a curve that initially rises but eventually falls, assuming total product (TP_L) is a curve with an inflection point and a maximum. Thus, the reciprocal of AP_L can be expected to first fall but eventually rise as output increases. This means that average variable cost will be a U-shaped curve.
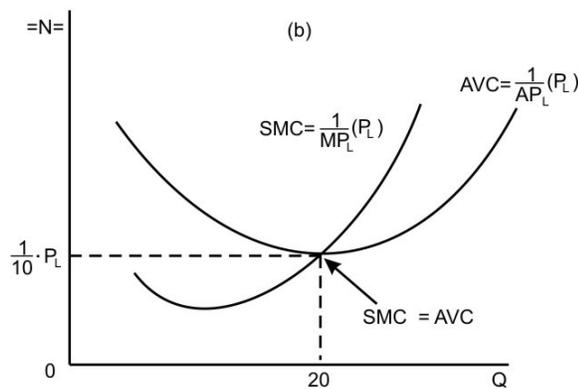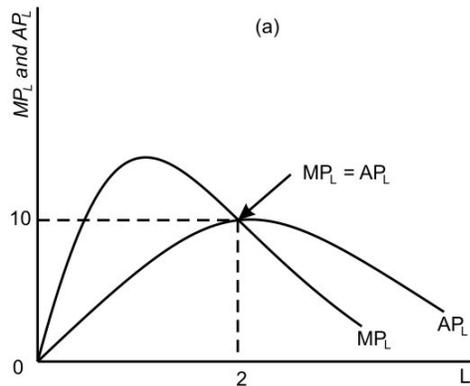
Figure 2.5: Relation of Marginal and Average Product to Marginal and Average Variable Cost

When there is only one variable input, SMC is the reciprocal of that Input's marginal product multiplied by the input's price. Similarly, AVC is the reciprocal of the input's average product multiplied by the same input price. That is why the curves in panel (b) display a relation that is inversed to those in panel (a). Here, AP_L is at a maximum where L = 2 and Q = AP_L (2) = 20. Accordingly, AVC = $1/AP_L$ (P_L) is at its minimum point where Q = 20.

Figure 2.5 shows how AVC is related to AP_L as well as how SMC is related to MP_L in the two input case. Note that the cost curve values in panel (b) are the reciprocals of the product curve values in panel (a), each multiplied by the same constant, P_L. It follows that where MP_L = AP_L, the SMC will equal AVC. In other words, the minimum point of the AVC curve occurs at the level of output corresponding to the maximum point of the average product of labour curve. In Figure 2.4 the AP_L maximum occurs where L = 2 and AP_L = 10 or at a total output of 2(10) = 20. At Q = 20 in panel (b) AVC is at a minimum and equal to SMC, and both are equal to 1/10(P_L). If the price of labour were N75 per unit, we could calculate AVC to be 1/10(N75) = N7.50 at its minimum point.

3.2.3 Short-Run Average Cost
To complete the set of short-run cost concepts, it is necessary only to consider the total cost per unit of output produced.

Short-run Average Cost (SAC) is total cost divided by the number of units of output produced.

Since short-run total cost was earlier labelled STC, we can write

$$SAC = \frac{STC}{Q}$$

There is another way to define SAC, however, and this second definition is more useful for analyzing the firm's SAC curve. SAC must also be the sum of the firm's per-unit axed cost and its per-unit variable cost. Thus,

SAC = AFC + AVC.
The short run average total cost curve is U-shaped because of the conflicting effects of (a) fixed costs being spread over a larger quantity of output and (b) diminishing returns.
From the preceding two sections we know that the AFC curve is a rectangular hyperbola and that the AVC curve can be expected to be U-shaped. The result of adding these two curves together is shown in Figure 2.6 below. SAC, like AVC, will be a U-shaped curve. Since AFC falls as output increases, the vertical distance between AVC and SAC will become smaller at higher levels

of output. Another result of adding the two curves is that the minimum of SAC will occur at a higher level of output than that corresponding to minimum AVC. The latter is easier to understand if we consider the relation of the two average curves to short-run marginal cost.

In Figure 2.6 marginal cost is shows along with AVC and SAC. As marginal cost rises, it must pass through the minimum points of both AVC and SAC, because of the average-marginal relationship. It follows that the minimum of SAC will be to the right of the minimum of AVC, since SMC, after it passes through the latter, will continue to be upward sloping.
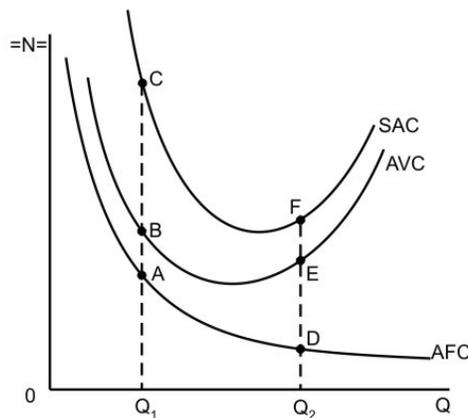
Figure 2.6: Average Fixed Cost Is Added to Average Variable Cost to Obtain the Curve of Short-Run Average Cost

The firm's short-run average cost curve (SAC) is obtained by adding average fixed cost to average variable cost at each level of output. Since AFC always falls as output increases, SAC and AVC will converge to the right. At Q_1, distance Q_1A equals distance BC, while at Q_2, distance Q_2D equals distance EF.
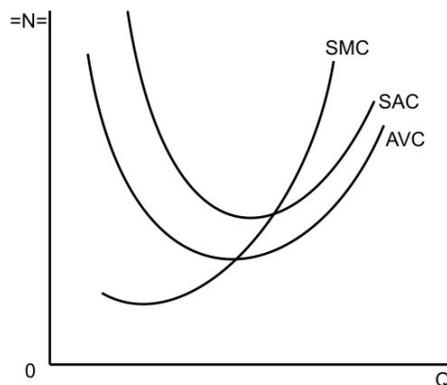
Figure 2.7: Relation of Short-Run Marginal Cost to Average Variable Cost and Short-Run Average Cost
Because of the average-marginal relationship, as SMC rises it will pass through the minimum points of AVC and SAC. This relationship and the

presence of fixed cost means that the minimum point of SAC will occur at a greater output than that consistent with minimum AVC.

SELF ASSESSMENT EXERCISE 1:
Consider a firm with the following short run costs:

Quantity	Variable	Total cost
1	30	90
2	50	110
3	90	150
4	140	200
5	200	260

a.   What is the firm's fixed cost?
b.   Compute short run marginal cost, short run average cost, and short run average total cost for the different quantities output
c.   Draw the three cost curves. Explain the relationship between the SMC curve and the SATC /SAC curve and the relationship between the SAVC curve and the SATC curve.

4.0   CONCLUSION

Total cost is the private economic cost of the firm's axed inputs in the short run. TheTFC curve is a horizontal line. Average fixed cost is the fixed cost per unit of output.

$AFC = \dfrac{TFC}{Q}$ The average fixed cost curve is a rectangular hyperbola.

Total variable cost is the sum of all private economic costs of the firm that vary withits short-run level of output. Average variable cost is variable cost per unit of output.

$AVC = \dfrac{TVC}{Q}$.

Short-run total cost consists of all private economic costs of the firm in the short-run.

Short-run average cost is cost per unit of output in the short run. $SAC = \dfrac{STC}{Q}$.

Short-run marginal cost is the rate of change of either total variable cost or short run total cost as output changes from a given size plant. $SMC = \dfrac{\Delta STC}{\Delta Q} = \dfrac{\Delta TVC}{\Delta Q}$.

The SMC curve intersects the AVC and the SAC curves at their respective minimum points.

5.0   SUMMARY

In this unit, we looked at the cost side of a firm, explaining the shapes of the firm's short run cost curves and long run cost curves. Here, you learnt about short run costs concept and curves. The relationships that exist among them were described and illustrated with appropriate graphs. Note also that law of diminishing returns is related to short run period while the economies of scale is long run concept as earlier discussed in the preceding unit. Attempt was made to set questions that bothers on calculations so as help achieve the unit objectives. We concluded the unit with explanation on the link that exist between the short run average cost and long run average cost.

6.0   TUTOR MARKED ASSIGNMENT

1.   According to the supervisor in your company, the short run marginal cost of tables is less than the short run average cost. If you increase your output of tables, will your short run average cost increase or decrease?

2.   Consider a firm that has a fixed cost of N60 per minute. Complete the following table.

Output	FC	TVC	STC	SMC	AFC	SAVC	SATC
1		10					
2		18					
3		30					
4		45					
5		65					
6		90					

7. 0   REFERENCES /FURTHER READINGS

Truet L.J and Truet D.B. (1984): *Intermediate Economics*; West Publishing Company, Minnesota, USA.

Karl E.C. and Ray C. F (2007):*Principles of Microeconomics*, Pearson Education International, New Jersey, USA.

Umo J.U.(1986): *Economics, African Perspective*; John West publications Limited, Lagos.

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc., New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 3: THEORY COST III

CONTENTS

1.0   INTRODUCTION

To fully understand how long-run cost changes as the firm's output changes it is necessary to return to the concepts of the production function and the expansion path. As demonstrated in the production theory as treated, the expansion path traces the cost- minimizing input combinations for each output level the firm can produce in the long run. Thus, it provides the necessary information to describe how minimum cost changes as output changes, subject to the provision that input prices remain constant.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Explain how the long-run total cost, and average cost are derived
2.   Describe the factors that lead to internal economies scale and diseconomies scale
3.   Describe increasing return to scale, constant increasing and decreasing return scale with the use production function

3.0   MAIN CONTENT
3.1   A Numerical Example of Short-Run Cost

Using the two-input production function, $Q = f(K,L)$, it is easy to illustrate the connection between short-run cost and the short-run productivity of the variable input using tabular data. For example, in table 3.1it is assumed that capital (K) is fixed at 10 units and that the amount of labour can be increased from one to nine workers per day, after which capacity is reached and no further increase in output can be obtained. The price of a unit of capital (P_K) is N100, while that of a unit of labour (P_L) is N80.

As the table shows, marginal cost falls as long as MPL is rising, but thereafter, marginal cost rises. Likewise, average variable cost falls when AP_L is rising but

rises once APL falls. Finally, neither AVC nor SAC will rise until exceeded by SMC.

Table 3.1

Labour Input (L)	Output (Q)	MP_L	AP_L	TFC	AFC	TVC= $L(P_L)$	SMC= $(1/MP_L)(P_L)$	STC	AVC= $(1/AP_L)(P_L)$	SAC
0	0		-	₦1,000	-	₦ 0		₦1,000	-	-
		10					₦8.00			
1	10		10	1,000	₦100.00	80		1,080	₦ 8.00	₦108.00
		40					2.00			
2	50		25	1,000	20.00	160		1,160	3.20	23.20
		46					1.74			
3	96		32	1,000	10.42	240		1,240	2.50	12.92
		36					2.22			
4	132		33	1,000	7.58	320		1,320	2.42	10.00
		33					2.42			
5	165		33	1,000	6.06	400		1,400	2.42	8.48
		27					2.95			
6	192		32	1,000	5.21	480		1,480	2.50	7.71
		25					3.20			
7	217		31	1,000	4.61	560		1,560	2.58	7.19
		23					3.48			
8	240		30	1,000	4.16	640		1,640	2.67	6.83
		21					3.81			
9	261		29	1,000	3.83	720		1,720	2.76	6.59
		0					∞			
10	261		26.1	1,000	3.83	800		1,800	3.07	6.90

3.2   How Short-Run and Long-Run Cost Are related

For a given production function there is a definite relation between short-run and long-run cost. In the long run with given input prices, the firm chooses the level of fixed inputs (plant size) that will minimize cost for its anticipated level of output; Once it has built its plant, the plant will be capable of producing output levels other than the anticipated one, although it may not be able to produce those outputs as cheaply as some other size plant could.

The isoquant diagram can be quite helpful for comparing long-run and short-run cost. In panel (a) of Figure 3.1, we assume that the production function is non-homogeneous and that moving out the expansion path ABCD would produce a U-shaped, long-run average cost curve (LAC). Plant K_3 is the right size for output level 300, since at point C anisocost line is tangent to the 300 isoquant. It follows that short-run cost in plant K_3 for an output of 300 is identical to long-run cost. This cannot be said for any other level of output produced in plant K_3, given the input price ratio represented by the isocost line in the diagram. Why? Consider isoquant 100. The long-run, cost-minimizing input combination for this isoquant occurs at point A, where an isocost line would be tangent to the isoquant. To produce the same output in plant K_3, the isocost line would have to be further out, so that it would intersect isoquant 100 at point H. In fact, for every output level other than 300, production in plant K_3 would result in $MP_K/P_K = MP_L/P_L$,
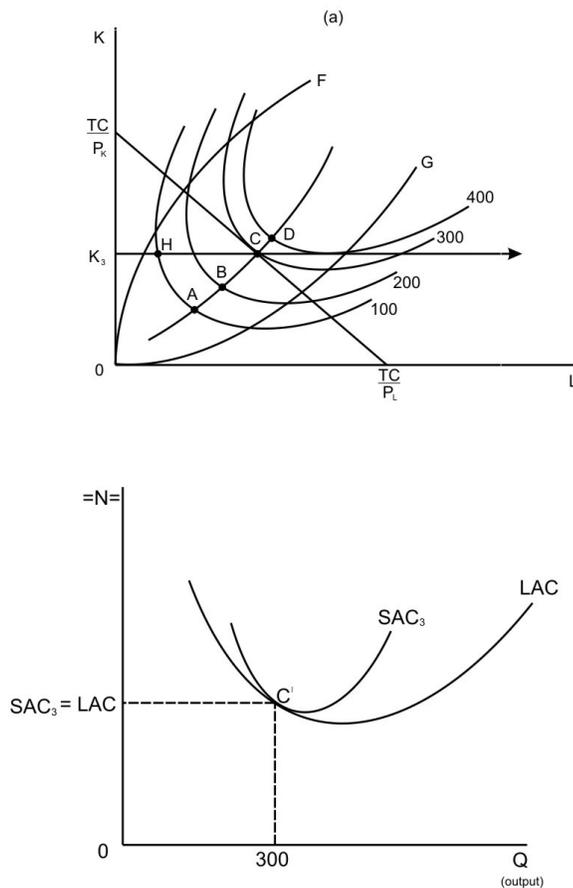
Figure3.1. Relation of Isoquant Diagram to Short-Run and Long-Run Average Cost

Given the production function and input price ratio shown in panel (a), data for the firm's long-run average cost would be obtained from the expansion path, ABCD. However, with plant size K₃, short-run average cost would be obtained from points on the horizontal arrow. Only at point C and output level 300 will LAC and SAC be equal. Accordingly, in panel (b), SAC₃ is tangent to LAC when Q = 300.

since an isocost line for the given set of input prices would intersect the isoquant rather than being tangent to it. Thus, all plant K_3 output levels other than 300 would be produced at something greater than their long- run cost of production.

If we now consider the relation between the long-run average cost curve and the short-run average cost curve for plant K_3, a cost point corresponding to point C' in the isoquant diagram of Figure 3.1, panel (a), can be defined. In Figure 3.1, panel (b), the LAC curve represents the average cost of production that would be obtained from points along the expansion path ABCD of the

above isoquant diagram. The curve SAC_3 is the SAC for plant K_3, and C' corresponds to point C in the isoquant diagram, where long-run cost and the short-run cost attainable in plant K_3 are the same for the 300 level of output.

Turning back to the isoquant diagram figure 3.2, it follows that for every plant size other than K_3, a different SAC can be developed. For example, this is done in panel (a) of Figure 3.2for six different plant sizes. Note that each plant size defines a short-run path (horizontal arrow) through the production function that intersects the expansion path ABCDJK only once. Each of these points corresponds to a tangency between a short-run average cost curve and the LAC, as shown in panel (b) of the figure.

SELF-ASSESSMENT EXERCISE 1:
The short run marginal cost curve will have an increasingly steeper slope because (a) the law of diminishing returns implies increasing marginal costs (b) total costs increase as output increases (c) total fixed costs are positive in the short run (d) all of the above

3.3   LAC as an Envelope Curve

If K, or size of plant, is infinitely divisible, there will be an infinite number of short-run average cost curves, each of which touches the LAC curve only once. This would make the LAC a smooth curve that forms an envelope around all of the possible SACs. In fact, the LAC curve is often called an "envelope curve" because of the way it wraps around the SACs.[7]
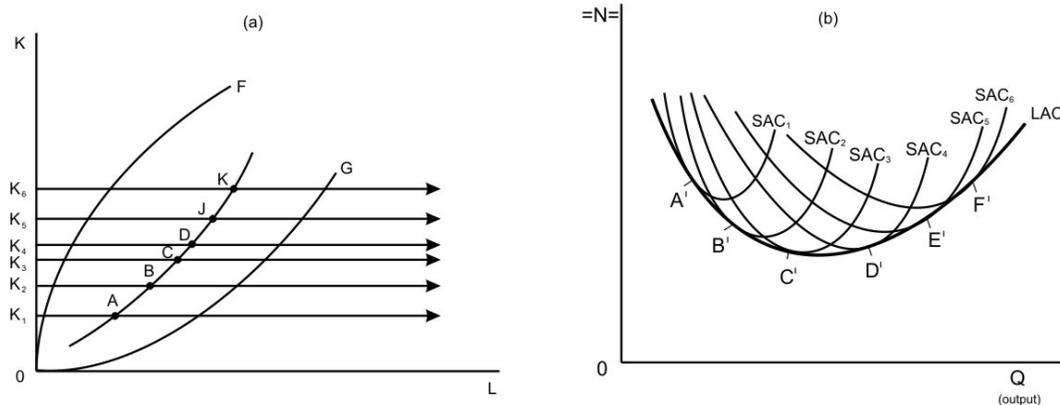
Figure 3.2 Relation between Plant Size, the expansion Path, and the Long-Run Average Cost "Envelope Curve"

Each plant size (horizontal arrow) in panel (a) corresponds to an SAC curve in panel (b). Further, each SAC curve is tangent to the LAC at the output level where its corresponding K value crosses expansion path ABCDJK, and the A', B', etc., points in panel (b) correspond to the A, B, etc., points in panel (a). The LAC curve is an "envelope curve" that wraps around all of the SAC curves.

The LAC envelope will not be smooth if there is no infinite number of possible plants. For example, if only three plant sizes are possible, the LAC curve might look like that in Figure 3.3. (This kind of thing could occur in many industries, because capital equipment is available only in certain standard sizes.) The important point to note about this, or any other situation where the number of plant sizes is limited, is that LAC always traces the least average cost of production for the possible output levels. Thus, in Figure 3.3, it is the bold, outer curve and indicates that least-cost production for outputs between zero and Q_1 occurs in plant SAC_1, while plant SAC_2 will be least cost for output levels between Q_1 and Q_2. For outputs greater than Q_2, plant SAC attains the least cost of production.
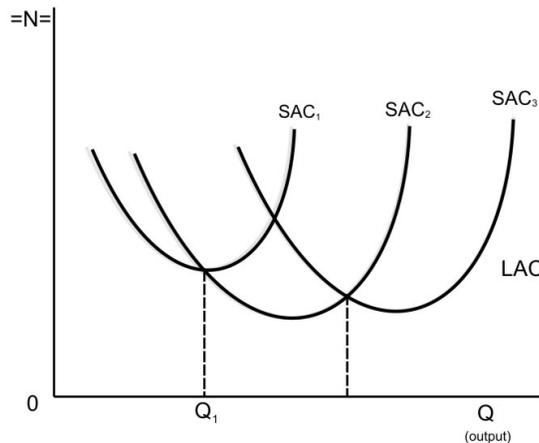
Figure 3.3: The LAC Curve When Plant Sizes Are Limited

When only a few plant sizes are feasible, the LAC curve will trace the least average cost of production from all possible plants. Here, it consists of SAC_1, up to Q_1, SAC_2 from Q_1 to Q_2, and SAC_3 beyond Q_2.

3.4   Optimum Size Plant

The plant that can attain the lowest average cost of production in the long run is frequently called the optimum size plant.

The optimum size plant is the plant that has its SAC curve tangent to the LAC envelope curve at the minimum point of LAC.

In Figure 3.2, the optimum size plant would be plant K_4, which corresponds to short-run average cost curve SAC_4. (Note that SAC_4 is tangent to LAC at the lowest point on the latter) A priori, there is no reason for the firm to choose to build an optimum size plant, since, as we have seen, that plant can produce only one of the many possible output levels at least long-run cost. If the firm's anticipated output is smaller than that at D' in panel (b) of Figure 3.2, it would choose to build a less-than-optimum size plant and operate on the falling portion of the plant's SAC curve (like plant SAC_3 in Figure 3.2, for example).

However, for output levels to the right of D', the firm would choose a plant larger than the optimum size and operate it on the rising portion of its SAC. This occurs with plants SAC_5 and SAC_6 in Figure 3.2 at points J' and K'. In the preceding module- production theory, it will be shown that firms that survive in the long run under perfect competition do tend to build optimum size plants. However, there is no such automatic tendency in other market structures.

.4.0 CONCLUSION

The firm's long-run average cost curve is an envelope curve that describes points of tangency between itself and an infinite number of SAC curves for possible sizes of plant. (This assumes plant size is infinitely divisible). If plant sizes are limited, the LAC curve consists of those segments of the possible SAC curves that describe the least possible cost of production for each output level.

For a given set of input prices, the plant that can attain the minimum possible long-run average cost of production is called the optimum size plant. The optimum size plant is not the least-cost plant for output levels other than the one corresponding to the minimum of the U-shaped LAC curve.

5.0 SUMMARY

In this unit attempt was made to set questions that bother on calculations so as help you achieve the unit objectives. We concluded the unit with explanation on the link that exist between the short run average cost and long run average cost. You also read about the concept of optimum size of a firm.

6.0 TUTOR MARKED ASSIGNMENT
1.   Average cost schedules for three plant sizes are given. Plot the corresponding average cost curves and construct a LRAC curve from the results. (Note that plant sizes are not infinitely divisible here)

PLANT A   **PLANT B**   **PLANT C**

Output	AVC
1	14
2	12
3	10
4	12
5	14
6	16

Output	AVC
4	11
5	10
6	9
7	8
8	9
9	10

Output	AVC
8	13
9	12
10	11
11	10
12	11
13	12

2. Do you agree that the long run average cost curve is 'planning' curve?

7. 0 REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc., New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT4: THEORY COST IV

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1.0   INTRODUCTION

To fully understand how long-run cost changes as the firm's output changes it is necessary to return to the concepts of the production function and the expansion path. As demonstrated in the production theory as treated, the expansion path traces the cost- minimizing input combinations for each output level the firm can produce in the long run. Thus, it provides the necessary information to describe how minimum cost changes as output changes, subject to the provision that input prices remain constant.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Explain how the long-run total cost, and average cost are derived
2.   Describe the factors that lead to internal economies scale and diseconomies scale
3.   Describe increasing return to scale, constant increasing and decreasing return scale with the use production function

3.0   MAIN CONTENT
3.1   Derivation of Long-Run Total Cost

In the following analysis, the isoquant diagram is similar to the one that appeared as module 2 (theory of production) of the preceding module.

However, here, in panel (a) of Figure 4.1, a numerical value has been assigned to each isocost line and each isoquant. The points A through D on the expansion path identify the least-cost combinations of inputs for each of the output levels on the isoquants. The budget values for each isocost line (given input prices) identify the lowest total cost of producing each of the output levels. Since the isocost lines are just tangent to each isoquant along the expansion path, there is no possibility of producing any of the outputs at a lower cost than that shown for the isocost line that touches the corresponding isoquant.

In panel (b) of Figure 4.1, the output levels from the upper diagram are measured on the horizontal axis. The cost values from the isocost lines are measured on the vertical axis. A plot of the combinations of cost and output from points A, B, C, D and E on the expansion path yields points A ' , B ' , C ' , D ' and E ' on the long- run total cost curve of the firm (LTC). Thus, the long-run total cost curve shows the least long- run total cost of production for each level of output, given input prices.
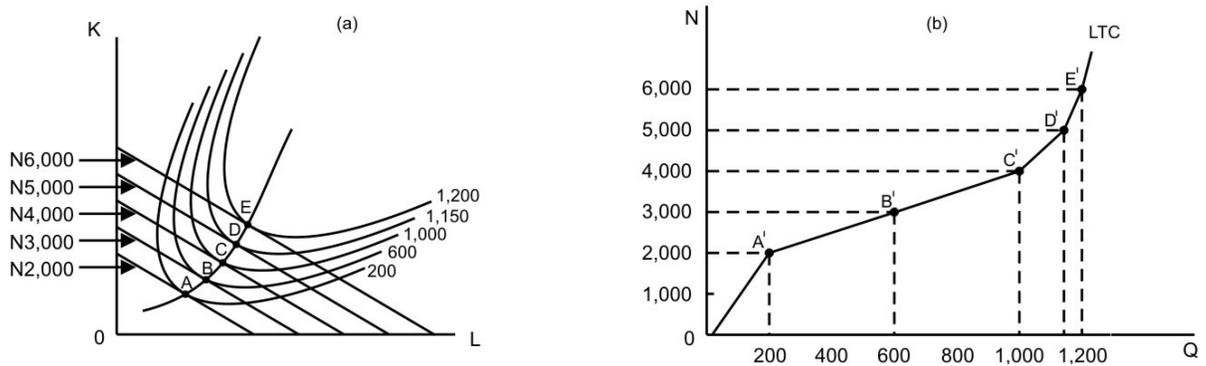
Figure 4.1. The Firm's Expansion Path and Derivation of Its Long-Run Total Cost Curve (LTC)

Each point (A, B, C, D, E) on the expansion path in panel (a) has a corresponding (A', B', C', D', E') on the long-run total cost curve in panel (b). The LTC is a plot of the minimum cost of production of each level of output, given the isoquant and isocost lines of panel (a). The isocost lines in panel (a) assume constant Input prices.

Long-run total cost is the minimum economic cost of producing each possible level of output *when the time period is sufficiently long to change all inputs of the firm's production function*.

Any change in input prices would generate a different LTC curve than the one in panel (b). For example, a doubling of the prices of both labour and capital would not change the least-cost input combinations or expansion path in panel (a) but would double the budget value associated with each isocost line.

Therefore, in panel (b), the LTC curve would rotate upward. In general, any increase in an input price will rotate LTC upward, while a decrease in an input price will rotate it downward.

If the firm's production function has more than two inputs, the nature of the relation between long-run total cost and the least-cost combination of inputs for each level of output is still conceptually the same as in the two-input case. That is, the LTC still describes the least cost of production for each output, given input prices. It follows that at each point on the LTC curve, the ratio of marginal products to input prices is equal for all inputs, or

$$\frac{MP_K}{P_K} = \frac{MP_L}{P_L} = ... = \frac{MP_N}{P_N}$$

3.2   Long-Run Average Cost (LAC)

Long-run average cost is a measure of the cost per unit of output produced. If LTC = Long-run Total Cost, then long-run average cost (LAC) can be denied as follows:

$$LAC = \frac{LTC}{Q}$$

Where, Q is the number of units of output produced.

Long-run average cost (LAC) is equal to $\frac{LTC}{Q}$ and measures per unit cost when all inputs are variable.

The behaviour of long-run average cost, like that of total cost, depends on the properties of the firm's production function. In fact, the isoquant diagram and LTC curve in Figure 4.1 were purposely set up to produce a long-run average cost curve that is U-shaped. Panel (a) of Figure 4.2 reintroduces the LTC data from the preceding figure, but this time a smooth curve has been fitted through points A, B, C, D, and E. In panel (b)a points A' , B' , C' , D', and E ' show the value of LAC = $\frac{LTC}{Q}$ for each corresponding point on the long-run total cost curve.

Note
The word "rotate" is used to describe the change in LTC because it will continue to emerge from the origin. Thus, an increase in the price of an input would produce a counter- clockwise rotation as follows:
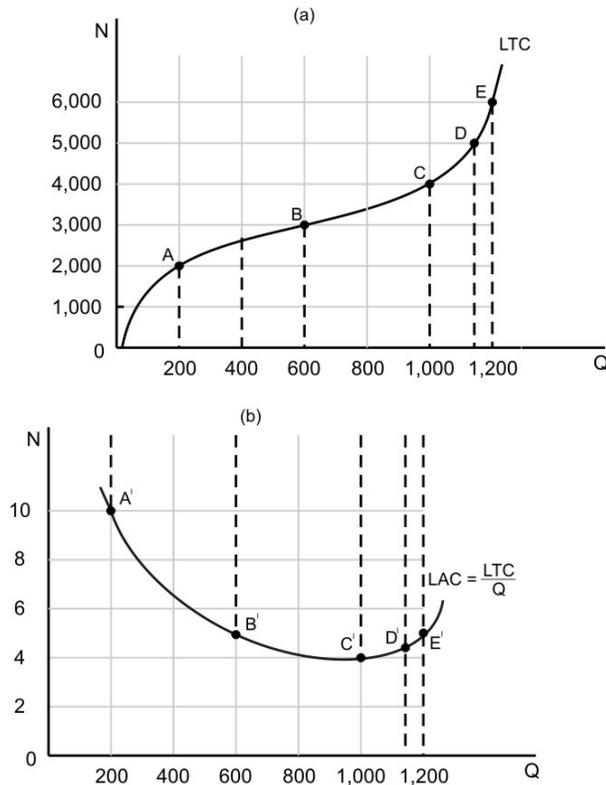
Figure 4.2: Relationship of Long-Run Total Cost to Long-Run Average Cost

Given the long-run total cost curve in panel (a), long-run average cost is obtained by dividing LTC by the number of units of output produced (Q). This has been done for points A, B, C, and D in panel (a) in order to obtain the LAC values for points A', B', C', D' and E' in panel (b).

A smooth curve lettered through the data of panel (b) traces LAC, the long-run average cost curve.

3.2.1 Internal Economies and Diseconomies

Why is the LAC curve of Figure 4.2 a U-shaped curve? It is because the data employed to derive the curve reject a specific assumption about the firm's production function. In particular, it is assumed that the firm encounters internal economies and diseconomies (sometimes called economies and diseconomies of scale) as output is increased along the firm's expansion path.

Internal economies *are technological and organizational advantages that accrue to the firm as output is expanded in the long run.*

An example of an internal economy is the use of larger size equipment to perform a given task when the level of output increases. This occurs in tasks as

simple as hole digging. The size of machine (backhoe, bulldozer, etc) chosen is often larger for digging a large hole than for digging a small hole. However, only one operator is needed for either size of machine. Putting the operator to work on a larger machine reduces the firm's cost per ton of excavation done.

Internal economies even arise from purely mathematical relationships. For example, consider two rectangular open-top storage bins, 170th four feet high. lf the smaller of the two bins is 10 feet long and 5 feet wide, it will be able to hold 10 ' x 5' x 4 ' = 200 cubic feet of material. It will have two wails 10 ' x 4 ' and two wails 5 ' x 4 ' as well as a floor panel that is 10' x 5 ' .

The surface area of its wall and floor will be 80 + 40 + 50 = 170 square feet. Suppose the second bin differs only in length and is 12 feet long. Its capacity will be 12' x 5 ' x 4 ' = 240 cubic feet, or 20 percent more than the first bin. However, its surface area will be 96 + 40 + 60 = 196 square feet. This is only 196/170 = 1.152 1 or about 15 percent larger than the first bin. Only 15 percent more material yields a bin with 20 percent greater holding capacity. Similar relationships between surface area and volume hold for all sorts of containers, pipelines, and tanks used in industry. Thus, internal economies are quite common. (Note, however, that larger containers and pipes frequently must have thicker walls, a fact that dampens, but does not eliminate, internal economies.)

Finally, we should add that internal economies may arise from more efficient organization as firms increase in size. For example, a firm may be able to increase the size of its output and workforce with very little increase in its clerical and administrative personnel. Furthermore, as it expands it may take advantage of internal economies from usage of more highly automated once procedures, including, perhaps, the use of computers and word processing systems.

Of course, increasing the size of a firm's operations could involve changes that tend to increase rather than reduce per unit production costs. If so, internal diseconomies are present.

Internal diseconomies are technological and organizational disadvantages that the firm encounters as output is expanded in the long run.

Internal diseconomies are conceivable but are *not* as frequently observed or documented as internal economies. Obviously, as a production system becomes larger, new transportation costs can arise because of the necessity of moving materials or components greater distances in larger plants. Larger plants might also present problems with excessive heat, noise, or power requirements that would yield disadvantages when compared with smaller plants. Finally, maintenance costs for large-size equipment might be much greater than for similar small- size equipment.

Organizational diseconomies are also a possible disadvantage of increasing the size of a firm's operations. These range from simply reaching a point where the size of the firm's workforce requires large increases in supervisory and management staff to the creation of a self-perpetuating and ever- expanding bureaucracy that burdens the firm with low-productivity personnel. The problem of supervising an excessively large workforce is not to be taken lightly since it involves not only the cost of the additional supervisors but also the opportunity cost of lost, or inefficiently utilized, effort of production workers. In fact, there are documented cases of workforce expanding to the point that supervisory personnel simply did not know where production workers were, let alone whether or not they were accomplishing any production!

Note
The notion that a bureaucracy will tend to expand whether or not there is any increase in work to be done is frequently called Parkinson's Law, after a British professor who claimed to have first discovered it

3.2.2   The U-shaped LAC

It is the net effect of internal economies and diseconomies that determines the shape of the firm's long-run cost curves. The result is easiest to describe in the case of the long-run average cost curve (LAC), as shown in Figure 4.2. The firm is likely to encounter both internal economies and internal diseconomies as it expands in the long run. Thus, it is the net effect of the two that determines the behaviour of long-run cost. The long-run average cost curve will be U-shaped, as in Figure 4.2, if the firm at the beginning encounters net internal economies but thereafter encounters net internal diseconomies as it expands.
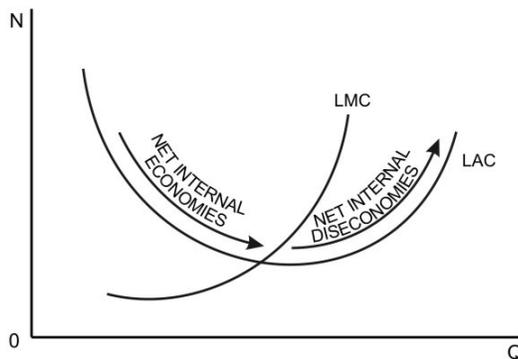
Figure 4.2: How the Stage of the LAC Curve Relates to Internal Economies and Diseconomies

Internal economies and diseconomies affect the shape of the firm's long-run average cost curve. If long-run expansion of output is first accompanied by net internal economies but later by net internal diseconomies, the LAC curve will be "U" shaped.

3.3   Long-Run Marginal Cost

Figure 4.2 also shows the firm's long-run marginal cost curve.
Long-run marginal cost (LMC) is the rate of change of long-run total cost as output changes.

since $LMC = \dfrac{\Delta LTC}{\Delta Q}$, *the increase in total cost that results from producing one more unit of output. Marginal costs reflect changes in variable cost in the long run.* It is the slope of the LTC curve; whenever internal economies and diseconomies produce a U-shaped LAC curve, the LTC curve will have the shape shown in Figure 4.2. This means LMC will first fall but eventually rise as output increases. Because of the average-marginal relationship, the rising LMC must pass through the minimum of LAC, as it does in Figure 4.2.

There are situations where LAC will not be U-shaped. For example, if as the firm expands, the internal economies outweigh diseconomies, but the reverse never occurs, the LAC will slope downward throughout its range. It is conceivable, of course, that expansion would be accompanied by net internal diseconomies but no range of net economies. In this case, the LAC would slope upward throughout its range.

Empirical studies of long-run cost in various industries have found ample evidence of net internal economies, but only limited evidence of net diseconomies. This suggests that for many the LAC curve is down- types of production, ward sloping throughout the range of existing sizes of firms.

3.4   Returns to Scale

The shapes of the firm's long-run cost curves depend on the properties of its production function. An important long-run property of any given production function is its returns to scale.

Note:
The calculus or point definition of long-run marginal data cost is $LMC = \dfrac{\Delta LTC}{\Delta Q}$
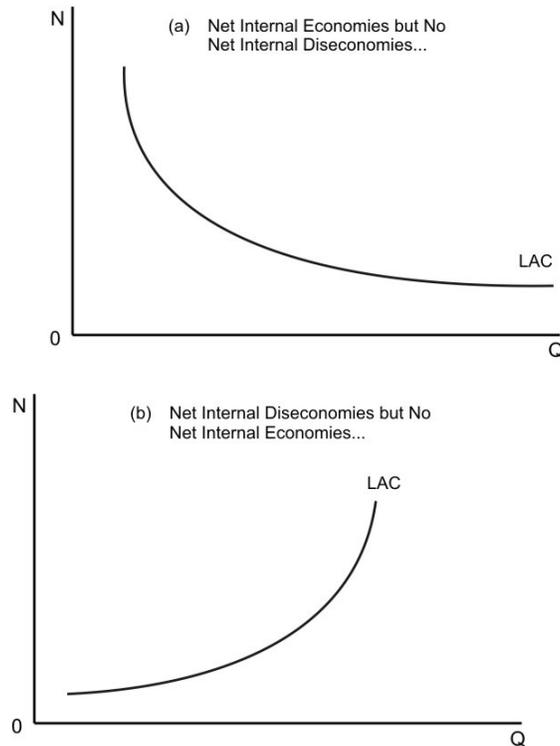
Figure 4.3: Examples of Long-Run Average Cost Curves That Are Not U-shaped

A firm that encounters net internal economies but no net internal diseconomies as it expands in the long run will have a falling LAC curve like that shown in panel (a). On the other hand, net internal diseconomies throughout the range of a firm's long- run expansion path will yield an upward-sloping LAC curve like that in panel (b).

The returns to scale of a production function describe how its output responds to proportional increases in all of its inputs.

The two-input case, $Q = f(K, L)$ can be used to illustrate the returns to scale concept. To determine the returns to scale of the production function over some range of input use, we can ask what will happen to output if the amounts of both K and L are doubled. If output doubles, the function is said to have constant returns to scale. In this case, it will be true that $f(2K, 2L) = 2f(K, L)$ or twice the original level of output.

If a production function has constant returns to scale at all input combinations, it will be true that $f(aK, aL) = af(K, L)$ where 'a' is any constant. A production function is said to have increasing returns to scale if $f(aK, aL) > af(K, L)$ or when a doubling of inputs more than doubles output. Finally, a production function has decreasing returns to scale if

$f(aK,aL) < af(K,L)$ or a doubling of inputs results in something less than a doubling of output.

3.4.1 Scale Changes in the Isoquant Diagram

For the production function $Q = f(K,L)$ returns to scale can be examined by passing a ray or vector from the origin through the isoquant map. Along such a vector, it will be true that K and L change by the same proportion. Figure 4.4 shows four possible patterns of returns to scale using a vector through the isoquant diagram for an input ratio of two units of capital to one of labour.

In panel (a), a doubling of both inputs from point R to point S causes output to double, since S lies on the 200 isoquant. Another doubling of inputs from point S to point T again doubles output to 400. Thus, the production function represented by the isoquants in panel (a) has constant returns to scale. In panel (b), the production function has increasing returns to scale, since a doubling of inputs more than doubles output along the vector 0RST. Panel (c) depicts decreasing returns to scale, since a doubling of inputs results in less than a doubling of output. Finally, in panel (d) returns to scale are variable, since a doubling of inputs causes more than a doubling of output from point R to point S, but less than a doubling of output from point S to point T.

3.4.2 Hypothetic and Homogeneous Production Functions

A production function is hypothetic if its expansion paths and ridge lines are straight lines. A hypothetic production function is also homogeneous if the following is true: $f(aK,aL) = a^n f(K,L)$ where 'a' is a constant and the exponent n is called the degree of homogeneity of the function. Since n can assume only one value for a given homogeneous function, homogeneous production functions cannot have variable returns to scale. More precisely, for a homogeneous production function, returns to scale will be constant if n = 1, increasing if n > 1, and decreasing if no 1.
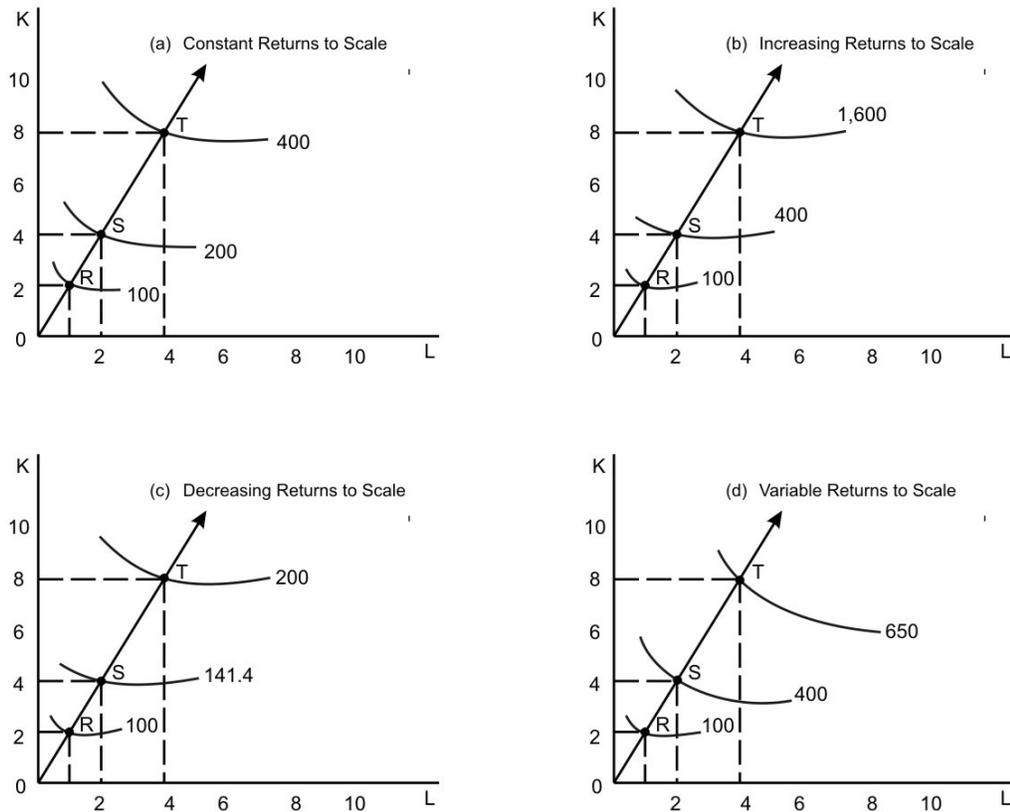
Figure 4.4: Isoquant Diagrams for Various Types of Returns to Scale

To examine returns to scale, we increase all of the firm's inputs by the same proportion. In these diagrams, the amounts of K and L employed are doubled, and then doubled again. With constant returns to scale, output also doubles-With increasing returns to scale, output more than doubles, and with decreasing returns to scale output increases but by less than doublet on previous level. Finally in panel (d) variable returns to scale yields more than a doubling of output from R to S but less than a doubling of output from S to T.

In Figure 4.4, panels (a), (b), and (c) employed isoquant values that are consistent with homogeneity of the production function. In fact, in panel (a), n = 1 , so that an = 2×1 = 2, and returns to scale are constant. In panel (b), n = 2, so that an = 2×2 = 4, and returns to scale are in- creasing (a doubling of both inputs quadruples output). In panel (c), n = 1/2, so that an = 21/2 = 1.414, and returns to scale are decreasing (a doubling of both inputs causes output to increase 1 .414 times.) Since the isoquants in panel (d) of Figure 4.5 show variable returns to scale, the production function it illustrates cannot be homogeneous.

3.4.3 Returns to Scale and LAC

If a production function is hypothetic, the expansion path for any given price ratio will be a vector and will provide basic data on 170th returns to scale and the behaviour of long-run average cost as output changes. In fact, LAC will be horizontal when returns to scale are constant, will slope downward when returns to scale are increasing, and will slope upward when returns to scale are decreasing. These relationships can be illustrated by again using the data from panels (a), (b), and (c) in Figure 4.4.

Suppose P_K = N400 per unit and P_L = N100 per unit. In panel (a) of Figure 3.5, if the firm is at first minimizing its long-run cost at point R (imagine an isocost line tangent at that point), its total cost (LTC) will be 2 (N400) + 1(N100) = N900. Its average cost will be LAC = LTC/Q = N900/100 = N9 per unit. Since the function is homogeneous, doubling cost will move the firm out a straight-line expansion path to point S, where LTC = ₦1800 LAC = N1800/200 = N9. a doubling of cost will double output, so LAC will be a constant. More generally, for a homogeneous production function with n = 1 (called linearly homogeneous or first-degree homogeneous) a^n = a and for any a, LAC = aLTC1/aQ1, where LTC1 and Q1 are the original levels of cost and output. Since the a's will always cancel, LAC will be a constant.

Table 4.1: Summarizes the relation between returns to scale and LAC for the homogeneous production functions of panels (a) through (c) of Figure 4.5. Note that increasing returns to scale yields falling average cost. Decreasing returns to scale, on the other hand, yields rising average cost.

Table 4.1: Relation between Returns to Scale and Long-Run Average Cost

Panel of fig. 3.5	Type of returns to scale	Level of output	LTC/Q = LAC
A	Constant	100	N900/100 = N9.00
		200	N1800/200 = N9.00
		400	N3600/400 = N9.00
B	Increasing	100	N900/100 = N9.00
		400	N1800/400 = N4.50
		1,600	N3600/160 = N2.25
C	Decreasing	100	N900/100 = N9.00
		141.4	N1800/141.4 = N12.73
		200	N3600/200 = N18.00

3.4.4 Variable Returns and LAC

The analysis of Table 4.1 does not include the variable returns to scale case because production functions with variable returns to scale may or may not have straight-line expansion paths. For these functions, minimizing long-run

cost may require that input proportions change as output is increased in the long run (even with constant input prices). This in fact was the case in Figures 4.1 and 4.2, where a U-shaped LAC was derived from a curved expansion path.

For a function with a curved expansion path, LAC cannot be obtained from vector data as in the cases of Table 4.1. In fact, in Figure 4.4, panel (d) is the only diagram where 0RST cannot be an expansion path. (If you draw an isocost line tangent to the l00 isoquant at point R, and then develop the expansion path for that input price ratio, it will not pass through points S and T.)

What can we say about the variable returns to scale case if the firm's expansion path is not a vector? We can say that if the production function exhibits first increasing returns to scale but later decreasing returns to scales the firm's LAC curve will be U-shaped. However, it is unlikely that the output corresponding to minimum LAC will be the same for all input price ratios Further, the firm may be able to benefit from net internal economies over some range of output by changing the proportions in which it uses its inputs, as well as the amounts of the inputs used. In any event, the cost data necessary to determine LAC will be found on the expansion path, regardless of whether that path is curved or straight. In general, we can expect the LAC to shift upward if an input price rises and downward if an input price falls.

3.5   Economies and Diseconomies of scale

Scale economies are property of long-run average costs indicating the change in the cost per unit as cost and plant size change. As output increases, the firm are cost of producing that output is likely to decline, at least to a point. This can happen for the following reasons:

1.   If the firm operates on a large a larger scale, workers can specialize in the activities at which they are most productive.

2.   Scale can provide flexibility. By varying the combination of inputs utilized to produce the firm's output, managers can organize the production process more effectively

3.   The firm may be able to acquire some production inputs at lower cost because it is buying them in large quantities and can therefore negotiate better price.

So, a firm enjoys *economies of scale* when it can double its output for less than twice the cost. Correspondingly, there are *diseconomies of scale* when a doubling of output requires more than twice the cost. The term economies of scale includes increasing returns to scale as a special case, but it is general because it reflects input proportions that change as the firm changes its level of production.

4.0   CONCLUSION

The long-run total cost is the minimum economic cost of producing each possible level of output when the time period is sufficiently long to change all of the inputs in the firm's production function. Long-run average cost is equal to long-run total cost divided by quantity of output. It is equal to cost per unit of output. Long-run marginal cost is the rate of change of long-run total cost with respect to changes in the quantity of output. LMC = ΔLTC/ΔQ. The LMC curve intersects the LAC curve at its minimum point.

Internal economies are technological and organizational advantages that accrue to the firm as output is expanded in the long run. Internal diseconomies are technological and organizational disadvantages that the firm encounters as output is expanded in the long run. Internal economies and diseconomies are responsible for the shape of a reshaped, long-run average cost curve.

The returns to scale of a production function describe how its output responds to proportional increases in all of its inputs. With constant returns to scale, increasing all inputs by a certain multiple will result in an increase in output of the same multiple.

With increasing returns to scale, increasing all inputs by a certain multiple will result in an increase in output of a larger multiple. When returns to scale are decreasing, increasing all inputs by a certain multiple will increase output by a smaller multiple.

5.0   SUMMARY

The unit takes you through the long-run concept of theory of cost which includes total cost, average cost and marginal cost and their relationships. You are also taught about the internal economies and diseconomies of scale, we went further to explain with graphical detail the concept of returns to scale and how its relations to long-run average cost.

6.0   TUTOR MARKED ASSIGNMENT

1.   What do you understand by returns to scale? If the firm's long-run total cost curve downward to the right, what kind of returns to scale does its production function?

2.   The production function $q = K^a L^b$

where $0 \leq a, b \leq 1$ is called a Cobb-Douglas production function. This function is widely used in economic research. Using the function above, show the following:

a.   The production function in Equation above is a special case of the Cobb-Douglas.

b.   If a + b = 1, a doubling of K and L will double q.

c.   If a + b < 1, a doubling of K and L will less than double q.

d.   If a + b > 1, a doubling of K and L will more than double q.

e.   Using the results from part b through part d, what can you say about the returns to scale exhibited by the Cobb-Douglas function

7. 0   REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc., New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

MODULE IV: GENERAL EQUILIBRIUM THEORY AND WELFARE ECONOMICS

UNIT 1: INTRODUCTION TO GENERAL EQUILIBRIUM CONCEPT

CONTENTS
1.0   Introduction
2.0   Objectives
3.0   Main content
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            3.1.1. Market Interactions
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      3.2   General Equilibrium in Production
            3.2.1   Edgeworth Box Diagram
            3.2.2. Transformation Curve
            3.2.3. Relationship between Contract Curve and Transformation Curve
4.0   Conclusion
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1.0   INTRODUCTION

In this module and the units that follows, our objective is to use the tools of macroeconomic analysis to develop a system-wide view of the allocation of resources and output in a market economy. The principal question to be approached is whether, in a competitive market economy, the individual actions of macroeconomic agents (consumers, firms) can result in a general, system-wide equilibrium such that all product and factor prices are consistent with equality between quantity demanded and quantity supplied in each separate market.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1   Differentiate between the concept of general equilibrium and partial equilibrium
2   To describe how *Pareto Optimum* is attained in production
3.   Explain with the aid of diagram the concept of contract curve

3.0   MAIN CONTENT
3.1   Partial and General Equilibrium Analysis

In earlier modules, when we considered one market at a time and assumed "other things being equal," we employed *partial equilibrium analysis.*Partial

equilibrium as the name suggests takes into consideration only a part of the market, ceteris paribus to attain equilibrium.

A partial equilibrium is one which is based on only a restricted range of data, a standard example is price of a single product, the prices of all other products being held fixed during the analysis. Partial equilibrium analysis examines the effects of policy action in creating equilibrium only in that particular sector or market which is directly affected, ignoring its effect in any other market or industry assuming that they being small will have little impact if any. Partial equilibrium model is an economic model of a single market. It is the study of the behaviour of individual decision-making units and of the workings of individual markets, viewed in isolation.

On the other hand, general equilibrium analysis studies the behaviour of all individual decision-making units and of all individual markets simultaneously. At this point, we turn to *general equilibrium analysis* to describe the operation of an economic system made up of many markets.

3.1.1. Market Interactions

General equilibrium analysis is a system-wide examination of prices and markets, focusing specifically on the interactions between the economic system's many product and resource markets.

Because of the many potential interactions among the markets for all the various products and resources in an economic system, general equilibrium analysis is necessarily complex. We can learn about the nature of a general equilibrium situation with the help of **Figure 1.1**below, which shows several interrelated markets.

In panel (a), the supply of petrol decreases because of an interruption in the supply of oil. The price of petrol rises to P'. Because of higher petrol prices, consumers drive less and try to make their old cars last longer. Thus, demand for autos declines from D to D', and automobile prices fall as manufacturers are forced to resort to *rebates* in order to sell cars. In panel (c), the demand for auto workers declines because of the decrease in the demand for cars. (This is a case of derived demand. That is, the demand for auto workers depends on, or is derived from, the demand for automobiles. In general, the demand for any factor of production is a derived demand.)

Continuing in Figure 1.1, we find that the auto workers who lose their jobs in panel (c) will seek other employment. This process may increase the supply of taxi drivers, thereby reducing the wage rate of taxi drivers, as in panel (d).
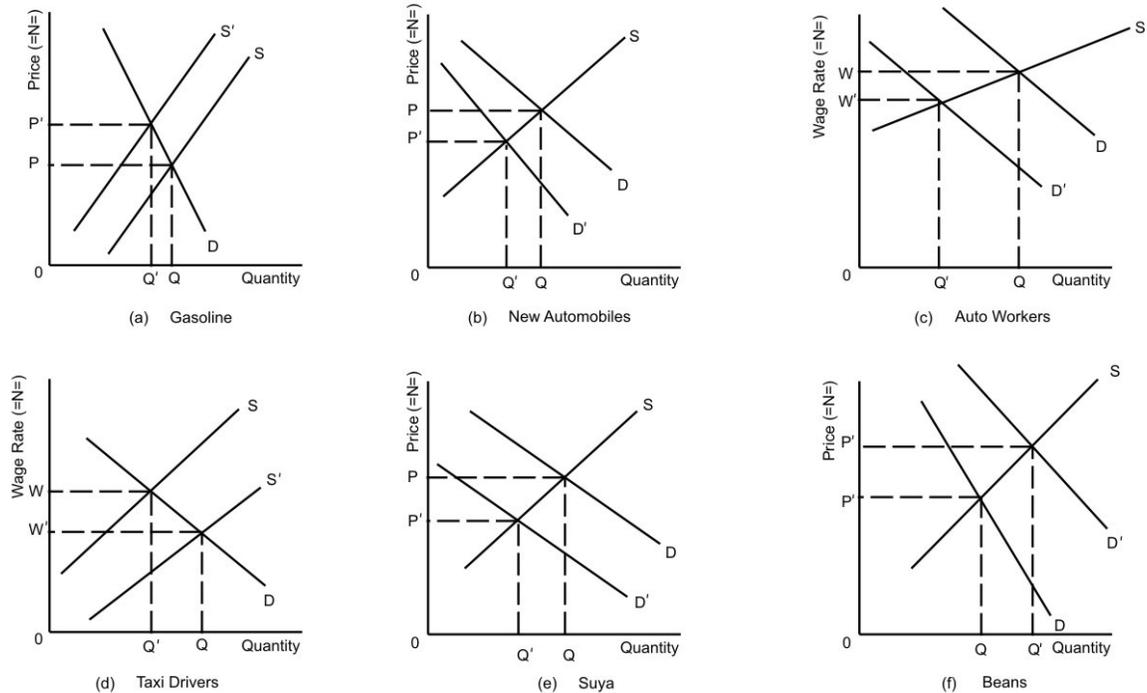
Figure 1.1 General Equilibrium Implications of a decrease in the Supply of Petrol

A decrease in the supply of petrol from S to S' in panel (a) leads to a decrease in the demand for new autos, a decrease in the demand for auto workers, an increase in the supply of taxi drivers, a decrease in the demand for meat, and an increase in the demand for fish. All of these resultant changes have price and quantity effects.

If there is reduced income for both auto workers and taxi drivers, the demand for meat, seen in panel (e) may fall. Both groups may have to eat more canned fish and less meat, which will lead to an increase in both the demand for and the price of canned fish.

Now, what about tin cans? Fish come in tin cans, so there must be some effect on the tin can market. Finally, if all these other markets are affected, won't this affect the demand for petrol (used to ship products and power taxis) back in panel (a)? It appears at this point that we are getting nowhere fast (or perhaps, somewhere very slowly).

This exercise has not been fruitless, for it has pointed out that (1) both the production of goods and the allocation of resources in a market economy depend on the decisions of consumers and producers in a large number of related markets and (2) changing one piece of data in one market may cause second, third, or even higher-order adjustments throughout the system. A full understanding of the system thus requires an examination of how such adjustments work themselves out.

SELF-ASSESSMENT EXERCISE 1:

1. In general equilibrium (a) all prices are assumed to be variable (b) some prices are assumed to be fixed or constant (c) most prices are assumed to constant (d) most prices are assumed to be variable

2. State the major difference between partial equilibrium and general equilibrium.

3.1.2 Historical Perspective

The need for a system-wide perspective on the of markets interrelatedness in the history of economic analysis. Indeed, Adam Smith's doctrine of the "invisible hand" was in effect a statement that perfect competition would somehow harmonize the activities of consumers, producers, and factor owners in all of the economy's many markets. However, Smith and his followers presented their analyses in verbal form and did not try to bring a great deal of logical or mathematical precision into their arguments. The latter was done in the late nineteenth century by the ('Lausanne School" of economists (Switzerland) which centred around two key figures, Leon Walras (1834-1910) and Vilfredo Pareto (1848-1923). Both of these men took advantage of mathematical analysis to describe the market economy using systems of equations relating to consumer and was recognized early producer behaviour. They succeeded in demonstrating that a general equilibrium of all markets can be reached in a perfectly competitive economy, but many years passed before economists fully explored the necessary and sufficient conditions for such a result. In fact, significant contributions to this area of macroeconomic theory have occurred in the period since World War II.

In the balance of this module, we will formulate a simple graphical model of general equilibrium under perfect competition. Our model is a scarcity model, based on limited availability of physical resources. We first describe general equilibrium in production and then take up the question of exchange between consumers. Finally, a full equilibrium in production and exchange is described.

3.2 General Equilibrium in Production

The simple model of two products and two factors of production can be used to illustrate the nature of general equilibrium in production. Suppose there are only two factors of productions, capital(K) and Labour(L), and that these factors can be used to produce only two kinds of products, X and Y. Assume that the input markets for K and L, are perfectly competitive and that there are given industry-level production functions for both X and Y.

If resources K and L, are available in limited quantities, the economy will only be able to produce certain combinations of products X and Y. If certain

amounts (but not all) of the two resources are used in the production of X, the remaining K and L, can be used to produce Y. The economy will be efficient if for any amount of X produced under cost minimization, the remaining resources are employed in a way that will yield the maximum possible amount of Y. As we shall see, perfect competition in the factor markets will ensure an efficient result.
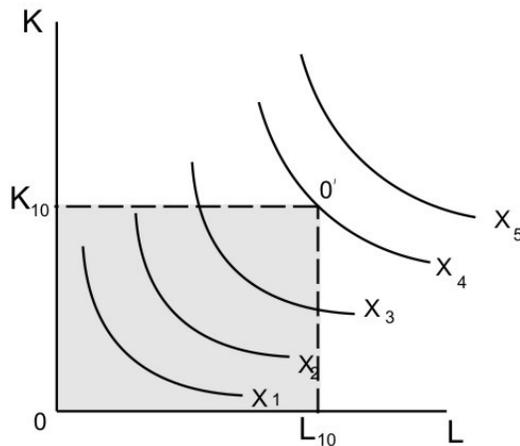
Figure 1.2. Isoquant Diagram for Product X

With only K_{10} and L_{10} of inputs available, the maximum amount of output that can be produced is the amount on isoquant X_4. All combinations of the two inputs that lie within the shaded box in this figure correspond to levels of X production that are smaller than X_4 and that do not use up all of the available K and L, .

SELF ASSESSMENT EXERCISE 2: Describe how the concept general equilibrium is different from partial equilibrium.

3.2.1 Edgeworth Box Diagram

To illustrate general equilibrium in production, a graphical device known as the Edgeworth box diagram is frequently employed: This diagram provides a means to relate the use of two factors of production to the amounts of two goods produced. It is constructed from the isoquant diagrams for the two kinds of output. One begins by considering the isoquant diagram for product X, as shown in **Figure 1.2**

If combination K_{10}, K_{10} represents the total amount of inputs K and L, available, allocation of all of these inputs to the production of X would make possible an output of X_4 at point 0' in the diagram. However, at any other point within the box $0_xL_{10}0'$ K_{10} output would be less than X_4, and not all of the available inputs would be used up to produce X.

In Figure 1.2, a similar isoquant diagram is shown for production of Good Y.

Again, the limited amount of resources available, K_{10}, L_{10}, determines that the maximum output of Y that could be produced is Y_5 (at point 0"). Notice that if the K and L, axes of Figure 1.2 are scaled the same as those in the preceding figure, box $0_y L_{10} 0"$ is identical in size to box $0_x L_{10} 0' K_{10}$. Of course, given the resource limitation, the two boxes are the only relevant parts of the isoquant diagrams in the two figures.

To construct the Edgeworth box diagram, the box of Figure 1.2 is "flipped-over" and placed on top of that in Figure 1.3, so that the origin, 0Y, falls precisely on point 0' of box $0_x L_{10} 0' K_{10}$. The result is shown in Figure 1.4. Note that the dimensions of the box are equal to the total amount of resources available, K_{10}, L_{10}.
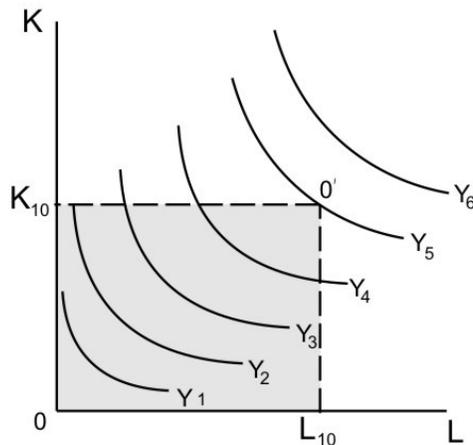
Figure 1.3: Isoquant Diagram for Product Y

As in the preceding figure, K_{10} and L_{10} represent the total amounts of inputs K and L, available. If all of these inputs are used to produce product Y, isoquant Y_5 can be attained. Within the shaded box lie combinations of the two inputs that correspond to levels of Y production smaller than Y_5 and that do not use up all of the available K and L, .

It is important to realize at this point that although our box diagram shows only a few representative isoquants for each of the two goods, every point in the diagram is either (1) an intersection of two isoquants, like point R, or (2) a point of tangency between two isoquants, like points S, T, and V. The path of tangencies $0_x STV0_y$ is called a contract curve. From any point off the contract curve, such as point R, it is possible to move to the contract curve and obtain a larger output of one of the two products without any reduction in the amount produced of the other. For example, from point R we could move to point T and increase Y production from Y_2 to Y_3 with no reduction in X production. Similarly, we could move from R to point V and increase output of X without decreasing that of Y. (Between points T and V on the contract curve, both X and Y production would be greater than at R.)

Points such as S, T, V, or any other point on the contract curve are called *Pareto Optimal Points.*

A Pareto optimum is a position that cannot be altered without making someone worse off.

For example, if X producers and Y producers are at point S in Figure 3-3, any change in the allocation of resources K and L, will cause at least one of the two groups to experience a reduction in output. Note that this is true no matter whether the change involves a movement along the contract curve or one to a point of the contract curve. In the box diagram, points that are not Pareto optimal are said to be inefficient, since, as shown above, it is possible to move away from such points and obtain an increase in the output of one good without decreasing the out- put of the other.
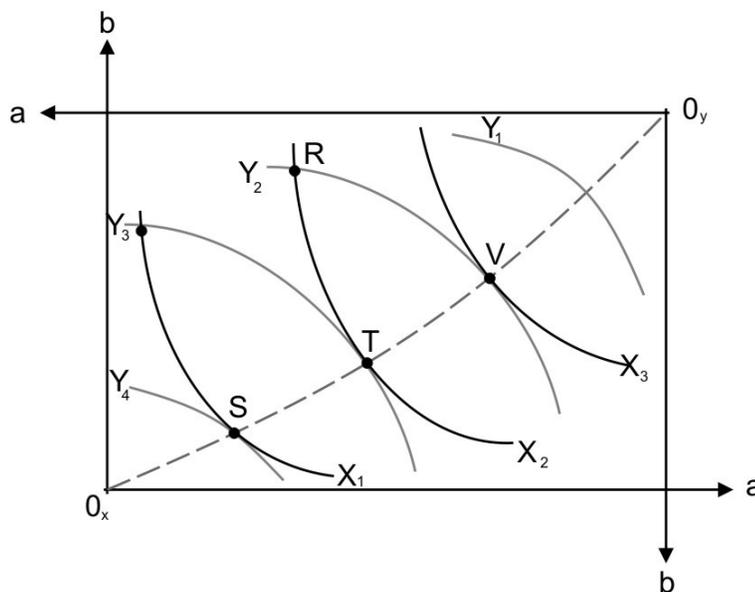
Figure 1.4.Edgeworth Box Diagram for Production of X and Y

All possible allocations of inputs K and L, between production of X and production of Y are contained within the Edgeworth box. Each point in the box is either an intersection of two isoquants, like point R, or a tangency point of two isoquants, like points S, T, and V. Tangency points are Pareto optimal, since it is impossible to move away from any one of them without reducing the output of one or both products. The broken line is the contract curve, which passes through all points where X and Y isoquants are tangent to each other.

Clearly, if the economy is to be efficient, it must move from any point like R in Figure 3-3 to a point on the contract curve, thus getting as much of X as possible given any level of Y production or vice versa.

The contract curve is the locus of Pareto optimal (efficient) points in an

Edgeworth Box diagram. Moving from a point off the contract curve to one that is on it leads to economic efficiency.

What force will cause producers to move to the contract curve? The answer is that perfect competition in the factor market will cause such a movement. Remember, under perfect competition there can be only one equilibrium market price for an input, and all purchasers of that input will end up paying that same price. However, the cost-minimizing producer will also be at a point where an isocost line is tangent to some isoquant of the production function for his or her product.

The problem at point R is that X producers and Y producers could not possibly be both cost- minimizing and paying the same prices for inputs K and L, since the slope of isoquant X_2 is not the same as that of isoquant Y_3. In fact, the only points where isoquants do have the same slopes for production of X and Y are points on the contract curve, since X and Y isoquants are tangent at all such points. Thus, the attainment of equilibrium in the factor markets for K and L.

where it is true that $\left(\dfrac{P_K}{P_L}\right)_X = \left(\dfrac{P_K}{P_L}\right)_Y$, or that both X producers and Y producers face the same relative prices for K or L, is the condition which will ensure that production takes place at points on the contract curve.

Once on the contract curve, the full general equilibrium of factor markets is obtained, and the prices of inputs K and L, will be stable. The general equilibrium condition for the factor market is $(MRTS_{KL})_X = (MRTS_{LK})_Y = \dfrac{P_K}{P_L}$ which states that the marginal rate of substitution of the factors of production will be equal in both industries and will in turn be equal to relative factor prices, $\dfrac{P_K}{P_L}$. This condition can be generalized for any number of factors, products, and factor prices and can also be expressed as

$$\left[\frac{MP_1}{P_1} = \frac{MP_2}{P_2} = \ldots = \frac{MP_M}{P_M}\right]_X$$
$$= \left[\frac{MP_1}{P_1} = \frac{MP_2}{P_2} = \ldots = \frac{MP_M}{P_M}\right]_Y = \left[\frac{MP_1}{P_1} = \frac{MP_2}{P_2} = \ldots = \frac{MP_M}{P_M}\right]_N =$$

Where:
M is the number of factors of production, and
N is the number of products.

SELF ASSESSMENT EXERCISE 3:

1.   What determine economic efficiency as described by VilfredoPareto.

2.   The dimensions of the production in the box in the Edgeworth geometric approach are determined by (a) the Production Possibility Frontier (b) the fixed quantities of inputs available (c) the state of technology (d) the quantities of goods produced

3.2.2. Transformation Curve

The existence of competitive general equilibrium in the factor markets ensures that the economy will be operating at a point on its production possibilities curve, also known as product transformation curve, or, simply, transformation curve.

The transformation curve shows all maximum combinations of two goods (or types of goods) that can be produced by an economy when its resources are fully and efficiently employed, given technology.

Resources are fully and efficiently employed when the output of one good cannot be in- creased without sacrificing some amount of another good. The transformation curve is usually shaped like the one shown in Figure 1.4.

The reason the transformation curve has a concave-toward-the-origin shape is an assumption that resources are not perfectly adaptable to alternative uses. Thus, in Figure 1.4, moving down the transformation curve from point Z to point Z' requires that successively larger amounts of Y be sacrificed in order to get a given increase in X. The reverse is true moving from Z' toward Z. The curve exhibits increasing opportunity costs of one good in terms of the amount of the other that must be given up to get a given increase in the first. Again, this happens because resources that are less and less suitable for X production are shifted into the X industry as output of X is increased while that of Y falls.

The absolute value of the slope of the transformation curve ($\frac{-\Delta Y}{\Delta X}$ in Figure 1.4) is called the marginal rate of transformation, MRT_{yx}. As the figure shows, the MRT_{yx} increases when goods are produced at increasing opportunity cost. *The MRT_{yx} can be viewed as the amount of Y that must be given up to obtain a one-unit increase in X production.*

3.2.3. Relationship between Contract Curve and Transformation Curve

Since the transformation curve shows the minimum amount of one of two goods that can be produced given the amount of the other, it has a very special relation to the contract curve in theEdgeworth box diagram. In particular, every point on the contract curve has a corresponding point on the transformation curve. This must be true, because in the Edgeworth box points off the contract curve are inefficient in the sense that output of one of the two goods can be increased with no reduction in output of the other. Further movements along

the contract curve require that the output of one of the two goods be reduced as that of the other increases. We can conclude that moving along the contract curve from 0_y to 0_x in Figure 1.4 is the same thing as moving along the transformation curve from point Z to point Z' in Figure 1.5. Production of X and Y at a point off the contract curve in Figure 1.4 will result in a goods combination lying inside the transformation curve of Figure 1.4.

In summary, perfect competition in factor markets will lead to a general equilibrium of those markets such that the economy will operate at some point on the transformation curve.
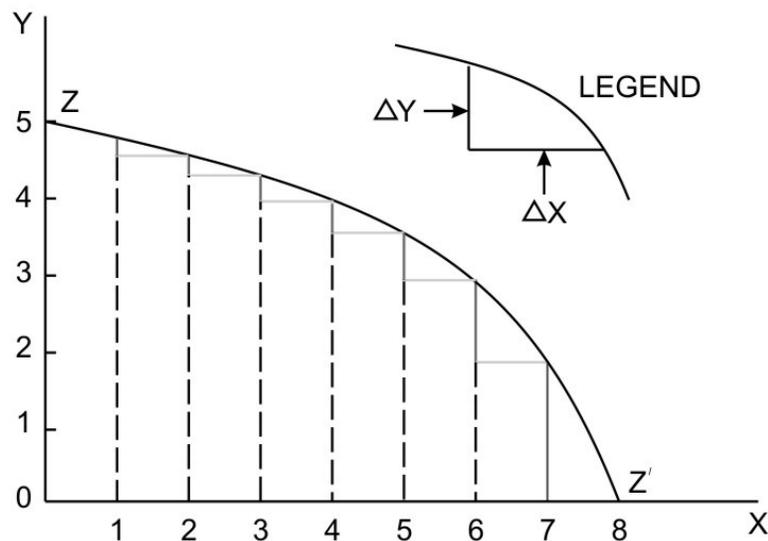
Figure 1.5. Transformation Curve for Production of X and Y

The transformation curve ZZ' in this figure is derived from the contract curve in the preceding diagram and shows all combinations of products X and Y consisted: with a Pareto optimal allocation of inputs K and L . At any point on the curve it is impossible to increase production of one of the two goods without decreasing that of the other. The absolute valve of the slope of the curve (-ΔY/ΔX, the marginal rate of transformation) increases as less of Y and more of X is produced, because resources are not perfectly substitutable between the X and Y Industries.

However, there is nothing in what we have done thus far that will identify which one of the infinite number of points on the transformation curve the economy will choose as its product mix.

4.0   Conclusion

General equilibrium analysis is an extensive study of a number of economic variables and elements, their interrelations and interdependences for understanding the working of the economic systems as a whole. But partial

equilibrium as earlier been studied is the study of the equilibrium position of an individual, a firm, an industry or a group of industries viewed in seclusion. The general equilibrium in production consider the economy will be efficient if for any amount of X produced under cost minimization, the remaining resources are employed in a way that will yield the maximum possible amount of Y. On the contract curve it is impossible (inefficient) to increase production of one of the two goods without decreasing that of the other. The absolute valve of the slope of the curve (-ΔY/ΔX, the marginal rate of transformation) increases as less of Y and more of X is produced, because resources are not perfectly substitutable between the X and Y industries**.**

5.0   Summary

In this unit of our study, we studied the concept of general equilibrium, we went ahead to illustrate in graphical term how markets are interrelated and attained efficiency. You also learnt about general equilibrium in production and relationship between contract curve and transformation curve/ production possibilities curve.

6.0   Tutor Marked Assignment

1.   With the aid of diagram explain the *Pareto optimum position.*

2.   Define production contract curve. Identify the points in the accompanying diagram that will be on the production transformation curve.

7. 0   REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.
Salvatore D. (2003): Microeconomics Harper Publishers Inc. New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 2:   GENERAL EQUILIBRIUM IN PRODUCTION AND EXCHANGE

CONTENTS

1.0   INTRODUCTION

In the last unit you learnt about the concept of general equilibrium as well as general equilibrium in production and transformation. In this unit therefore, we shall continue on the topic but on general equilibrium in exchange. Here completes the equilibrium, you will see how the entire economy is in the state of equilibrium that is all consumers, all firms, all industries and all factor services are in equilibrium simultaneously and they are linked through commodity and factor prices.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Explain what is meant by general equilibrium in exchange using difference curve
2.   Describe the relationship and connection that exist between marginal rate technical substitution and marginal rate of transformation

3.0   MAIN CONTENT
3.1   General Equilibrium in Exchange

Economists have long argued that people will trade goods with each other as long as they perceive that there are benefits to be had from trading them. Very simply, this principle means that a person trades because he or she will gain utility from Kunle the trade. This suggests that an equilibrium will exist in the exchange of two goods (X and Y) between any two consumers when it is not possible for both of them to gain from any modification in the terms of the exchange (more X for less Y, or vice versa). Such a proposition can be readily examined with an Edgeworth box diagram that is somewhat different from the one used to analyze equilibrium in production.

3.3.1 Exchange and the Edgeworth Box

To construct an Edgeworth box diagram illustrating exchange between two consumers, we begin with their individual indifference curve diagrams for two goods, X and Y. Figure 1.2 shows several indifference curves for Akin, who can consume either X or Y.
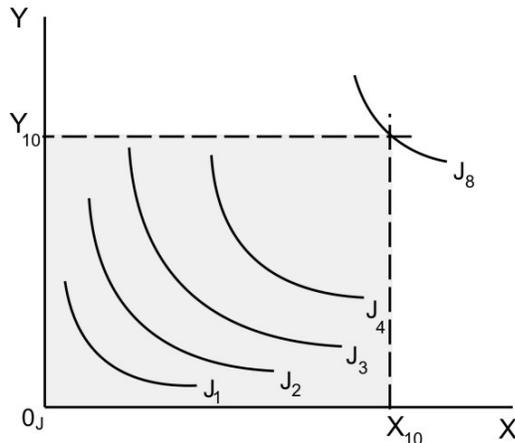
Figure 2.1 Consumer Akins' Indifference Curves for Goods X and Y

Product quantities X_{10} and Y_{10} are consistent with operation of the economy at a specific point on its transformation curve. If all of the economy's output were allocated to consumer Akin, Akin would be at the northeast corner of the shaded box and would attain indifference curve J_8. Any point within the box represents a lesser level of consumption by Akin.

Some indifference curves for Kunle, another consumer of X and Y, are shown in Figure 2.2. On the axes of the two diagrams, the quantities X_{10} and Y_{10} indicate the total amount of X and Y available to be somehow divided among the two consumers, given that the economy is at a specific point on the transformation curve. (This last qualification is necessary since the dimensions of the box diagram will be different for every combination of X and Y on the transformation curve.)

If we imagine flipping Figure 2.2 over on top of Figure 2.1 to construct an Edgeworth box of dimensions X_{10}, Y_{10}, the result is Figure 2.2. Note that any point in the box represents an allocation of the two goods between Akin and Kunle. However, points that are not on the contract curve, 0_J0_k are inefficient, since one of the two parties can be made better off without reducing the utility of the other. For example, a movement from point F to point G will increase Kunle's utility without reducing that of Akin. Similarly, moving from F to H will increase Akin' utility without reducing Kunle.

Will Akin and Kunle stay at point F if that is the initial distribution of X and Y between them? Not if they are free to trade. Since their indifference curves

intersect at point F, each person places a different relative valuation on X and Y than does the other. More formally, from indifference curve analysis it follows that at a point like F the marginal rate of substitution of X for Y (slope of the indifference curve in absolute value terms, or $\left[\dfrac{-\Delta Y}{\Delta X}\right]$ MRS$_{yx}$) is not the same for Akin as for Kunle. Specifically, as the tangents to the two indifference curves at point F show, Akin places a higher value on X than does Kunle, so that $(MRS_{yx})_J > (MRS_{yx})_K$. Thus, Akin will be willing to trade Y for X at a rate that would allow Kunle to reach an indifference curve higher than K_2.
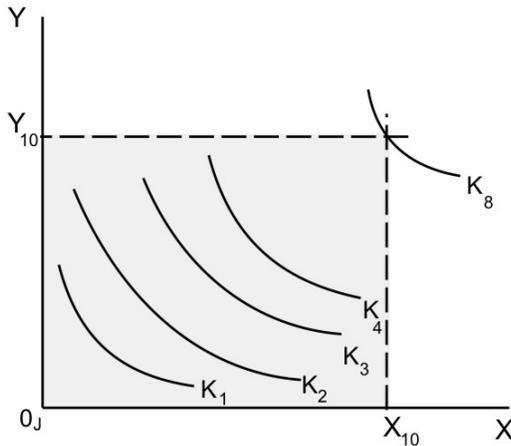
Figure 2.2. Consumer Kunle's Indifference Curves for Goods X and Y

The shaded area in transfinite hassle same dimensions as that in the preceding figure but contains indifference curves for Kunle instead of Akin. If all of the economy's output were allocated to Kunle, Kunle would reach indifference curve K_8. Otherwise, Kunle would be at some point within the shaded box and would attain a lower level of utility than K_8.

SELF ASSESSMENT EXERCISE 1:

In an economy of two individuals (A and B) and two commodities (X and Y), general equilibrium of exchange isreached when (a) MRTxy = MRSxy for A and B, (b) MRSxy= Px/Py, (c) (MRSxy)A = (MRSxy)B, or (d) all of theabove.

3.3.2 Incentive to Trade

A numerical example may help to explain why Akin and Kunle will not remain at point F in Figure 6-3 if they are free to engage in trade. We have already noted that the marginal rates of substitution of the two consumers differ at point F. Suppose $(MRS_{yx})_J \dfrac{\Delta Y}{\Delta X} = 4$, while $(MRS_{yx})_x = \left[\dfrac{-\Delta Y}{\Delta X}\right]_K = 2$ when the consumers are at point F. What does this say about the relative valuations of X and Y for Akin and Kunle? Since Akin at point F can move along indifference

curve J_3 and give up four units of Y for one of X without losing any utility, Akin will be willing to trade as much as four units of Y for one of X. Any exchange that gets Akin a unit of X for less than four units of Y will increase Akin' utility (move Akin to a point above indifference curve J_3).

Now consider Kunle. Given an MRS of 2 at point F, Kunle does not value X (in terms of Y) as highly as does Akin. If $\left[\dfrac{-\Delta Y}{\Delta X}\right]_K = 2$, then $\left[\dfrac{-\Delta X}{\Delta Y}\right]_K = \dfrac{1}{2}$.

Therefore, Kunle is willing to give up a unit of X for two or more units of Y. Suppose at F that Akin offers Kunle three units of Y for a unit of X. Does Kunle have an incentive to trade? Clearly, the answer is yes, since three units of Y for a one-unit reduction in X is more Y than Kunle needs to keep utility constant (remain on indifference curve K_2). From point F, Kunle will be able to move to a point above indifference curve K_2 if more than two units of Y are exchanged for one of X.

Would an exchange of 3 units of Y for one of X also be attractive to Akin? Again, the answer is yes, since Akin' MRS of 4 says that as much as 4 of Y can be given up for one unit of X while keeping Akin' utility constant. Thus, giving up less than four of Y for one unit of X will raise Akin' utility. We must conclude that whenever the marginal rates of substitution of two consumers differ, they will have an incentive to en gage in trade with one another. (Of course, this implies that when two consumers have the same MRS for two commodities, gain from trade will not be possible. Test yourself by assuming $(MRS_{yx})_J = (MRS_{yx})_k = 4$ at the beginning of the previous example. What kinds of offers will Akin and Kunle be willing to make each other? What do the identical MRSs say about their indifference curves'?)
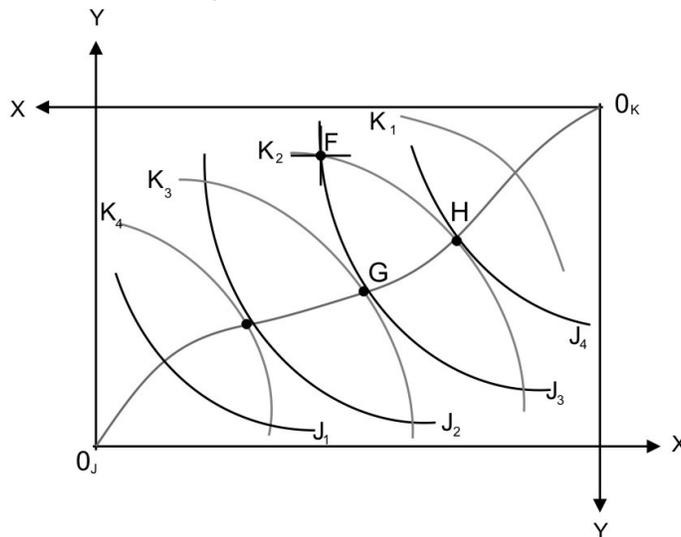

Figure 2.3.Edgeworth Box Diagram for Exchange Between Akin and Kunle

This Edgeworth box is similar to that in Figure 2.2, except that it represents

possible allocations of output between two consumers rather than allocations of inputs between industries. At points like in where two indifference curves intersect, Akin and Kunle place different relative valuations on goods X and Y and will have an incentive to trade. They will trade until they reach a point like G or H on the contract curve, where the distribution of goods will be Pareto optimal. Any point on the contract curve between G and H yields higher utility for both consumers than that originally attained at point F.

3.3.3 Attainment of Equilibrium

In Figure 2.3, the Edgeworth box for Akin and Kunle has been redrawn showing only their initial indifference curves (J_3 and K_2) and two that are higher ($J_{3.3}$ and $K_{2.2}$). The line TT' passes through point F and represents a rate of exchange of Y for X that is different from either MRS_J or MRS_k. Note that TT' also passes through point E on the contract curve. Given the nature of the Edgeworth box diagram, there will be an infinity of tangencies of A and K indifference curves between points G and H on the contract curve. Only at one of these tangencies will there be a line such as TT' that both represents the common MRS_{xy} of the two consumers and passes through their initial consumption point, F. Line TT' is called a terms outrace line and can be used to show what exchange of goods between the two consumers will lead them to equilibrium on the contract curve.

*A **terms of trade** line expresses a ratio of exchange between two goods at which two traders may choose to strike a bargain.*
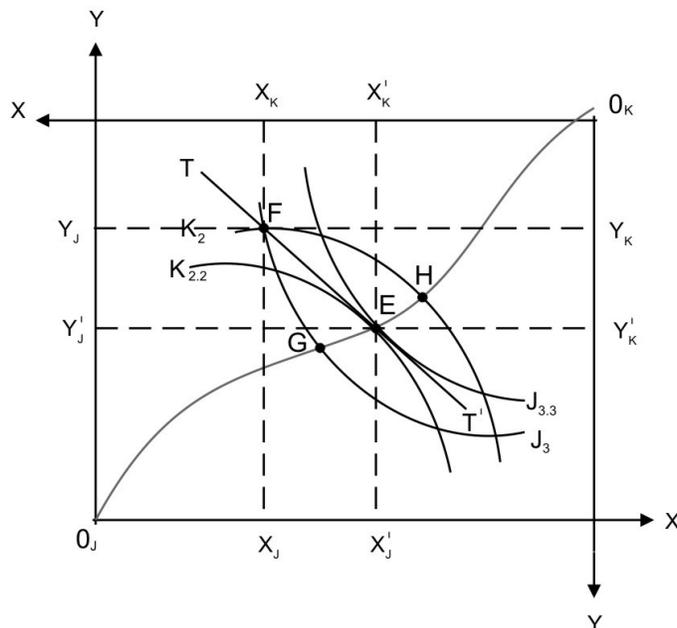

Figure 2.4Edgeworth Box Diagram Showing Terms of Trade

Given the initial allocation of goods at point F, free trade will lead Akin and Kunle to a point on the contract curve between G and H. There is only one

rate of exchange of Good Y for Good X that is consistent with both the initial allocations of goods and attainment of a Pareto optimal distribution on the contract curve. This is represented by the terms of trade line TT'. To get from point F to E, Akin trades ($Y_A – Y'_A$) of Y for ($X'_A - X_A$) of X, while Kunle does the opposite.

In Figure 2.4, Akin and Kunle end up at point E on the contract curve, because Akin is willing to offer an exchange of Y for X that will move Kunle to a point above indifference curve K_2 rather than along or below it. Likewise, the amount of X that Kunle is willing to give up to obtain an additional unit of Y will move Akin to a point above indifference curve J_3. Through bargaining, they will eventually reach point E, where Akin has given up ($Y_J – Y'_J$) of Y to obtain ($X_J – X_J$) of X. Kunle, on the other hand, has given up ($X_K - X_K$) of X to get ($Y'_K - Y_K$) of Y.

At point E, $(MRS_{YX})_J = (MRS_{YX})_K$, and both Akin and Kunle place the same relative valuations on the two goods (a unit of X is worth, in terms of Y, the same amount to Akin as to Kunle). Note that both Akin and Kunle are on an indifference curve higher than that at their pre-trade consumption point. Neither will wish to move away from point E. Why? The answer is that any such movement will make at least one of them worse off, and this is true no matter whether the movement is to a point on the contract curve or one off of it. In the exchange Edgeworth box, points on the contract curve are Pareto optimal, just as they were in the Edge- worth box for production. Thus, we do have an equilibrium in exchange at point E.

3.3.4 Nature of Equilibrium in Exchange

At point E in Figure 2.4, the tangency of indifference curves $J_{3.3}$ and $K_{2..2}$ ensures that $(MRS_{YX})_J = (MRS_{YX})_K$. This is a result consistent with utility maximization by both parties, since the terms of trade line TT' implies that a good's price ratio P_X/P_Y is also equal to the MRS_{YX} for either party. It follows that in perfectly competitive general equilibrium, market prices will be generated such that

$(MRS_{YX})_J = (MRS_{YX})_K = \dfrac{P_X}{P_Y}.$ (1)

However, the fact that the above ratios are equal also means that

$$\left(\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y} \right)_A = \left(\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y} \right)_K$$ (2)

If there are m products and t consumers in the economy, we can write the general equilibrium condition for exchange as

$$\left(\frac{MU_1}{P_1} = \frac{MU_2}{P_2} = \cdots = \frac{MU_M}{P_M}\right)_A =$$

$$\left(\frac{MU_1}{P_1} = \frac{MU_2}{P_2} = \cdots = \frac{MU_M}{P_M}\right)_K = \left(\frac{MU_1}{P_1} = \frac{MU_2}{P_2} = \cdots = \frac{MU_M}{P_M}\right)_T,$$

which states that all consumers are maximizing satisfaction subject to the market prices of the *M* goods and services.

3.4   General Equilibrium in Production and Exchange

Up to this point, we have found that general equilibrium in production requires that the marginal rate of technical substitution of inputs be equal for any pair of inputs over any number of goods. Similarly, general equilibrium in exchange requires that the marginal rate of substitution in consumption between any pair of goods be the same for any number of consumers. Our final task is to indicate when both conditions are fulfilled simultaneously, so that a general equilibrium of all markets (product and factor) exists. Given the kit of tools we have put together, we can return to the transformation curve and the consumers' Edgeworth box to complete our statement of equilibrium conditions.

In Figure 2.5, ZZ' is a transformation curve similar to that introduced above in Figure 2.4. Point E' on the transformation curve designates a special output mix of goods X and Y. The absolute value of the slope of the transformation curve at point E ' is the marginal rate of transformation, MRT. Inside the transformation curve, an Edgeworth box of dimensions X_{10}, Y_{10} is constructed for consumers Akin and Kunle. As in the preceding section, Akin and Kunle will attain equilibrium in exchange when they are at point E, where $(MRS_{YX})_J$ = $(MRS_{YX})_K$. The terms of the trade line, TT', implies a product price ratio of $\frac{P_X}{P_Y} = -\frac{\Delta Y}{\Delta X}$ which is in turn equal to the MRS_{YX} for either consumer. However, if firms are profit maximizers and there is perfect competition, it can be shown that MRS_{YX} will also have to be equal to the MRT, which means that line $T_1T'_1$ will be parallel to line TT' . The former is a term of trade line showing the rate at which the two goods can be exchanged for one another in production, while the latter expresses consumers' relative valuations of the goods. Since consumers can trade with producers, it must follow that the two ratios will be the same, so that MRS_{YX} will equal MRT. But more can be said than this.

Under perfect competition, firms maximize profit from sales of Good X where $MC_X = P_X$, since price is identical to marginal revenue. Likewise, perfect competition will ensure that $MC_Y = P_Y$. When the economy changes its output mix along the transformation curve, total cost remains constant. Thus,

$MC_X (\Delta X) + MC_Y (\Delta Y) = 0$, and   (3)
$MC_X (\Delta X) = -MC_Y (\Delta Y)$ (4)

Dividing both sides of equation (4) by $MC_Y (\Delta X)$ gives

$$\frac{MC_X}{MC_Y} = -\frac{\Delta Y}{\Delta X}$$

Note that the right-hand term immediately above, $-\frac{\Delta Y}{\Delta X}$, is the marginal rate of transformation, MRT. Thus, with perfect competition, we have
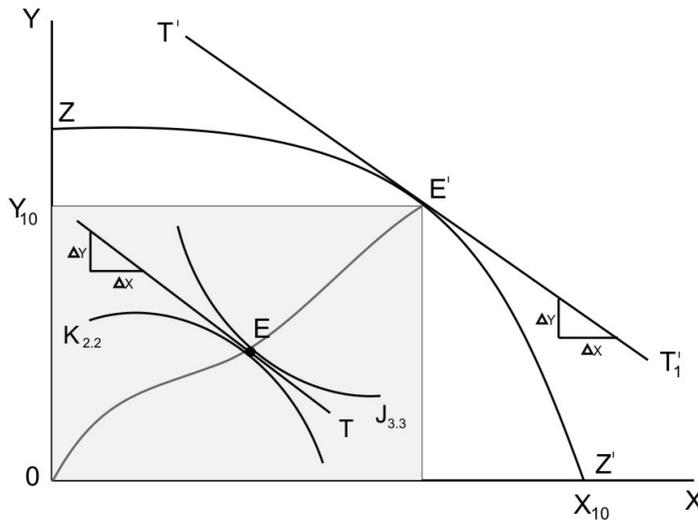
Figure 2.5. General Equilibrium for a Two-Good, Two-consumer Economy

If Pareto optimal production yields an output combination of X_{10}, Y_{10} as in the preceding two Edgeworth box diagrams, the Edgeworth box can be superimposed on the economy's transformation curve such that its northeast corner will be a point on the curve (point E'). With free trade and perfect competition, the marginal rate of substitution in consumption between goods X and Y for Akin and Kunle at point E will be the same as the marginal rate of transformation of the two goods in production at point E'. This follows because profit maximization ensures that $P_X = MC_X$ and $P_Y = MC_Y$. The result is that the two terms of trade lines, TT' and $T_1T'_1$ must be parallel.

$P_X = MC_X$, $P_Y = MC_Y$,

and $\dfrac{MC_X}{MC_Y} = -\dfrac{\Delta Y}{\Delta X} = \dfrac{P_X}{P_Y} = MRT$ (5)

and the absolute value of the slope of line $T_1T'_1$ in Figure 2.5 must equal the product price ratio. However, back in the consumers' Edgeworth box, the common MRS_{YX} for the two consumers must also equal P_X/P_Y. It follows that lines TT' and $T_1T'_1$ must be parallel, so that $MRS_{YX} = MRT$. Finally, when the foregoing is true, general equilibrium will obtain in production as well as in exchange, since all points on the transformation curve are consistent with $(MRTS_{ba})_X = (MRTS_{ba})_Y$.

SELF ASSESSMENT EXERCISE 2:

Explain why all of the points on a consumption contract curve are described as 'efficient'. Is any oneofthe points more efficient than another?

2. The distribution of two commodities between two individuals is said to be Pareto optimal if
   (a) one individual cannot be made better off without making the other worse off,
   (b) the individuals are on their consumption contract curve,
   (c) the individuals are on their utility-possibility curve, or
   (d) all of the above.

3.4.1 Welfare Implications of General Equilibrium

In this module, we have seen that there are three conditions that must be met in order to have general equilibrium in an economy where consumer and producer decisions are governed by the prices of goods and factors of production:

1. The marginal rate of technical substitution of any pair of factors must be the same in the production of all products;
2. The marginal rate of substitution in consumption of any pair of goods must be the same for all consumers; and
3. The marginal rate of transformation in production for any pair of goods will be equal to the marginal rate of substitution in consumption for that same pair of goods.

Perfect competition in all markets will ensure that the above conditions will be met. Further, the three conditions are consistent with Pareto optimality in production and consumption. No increase in the output of any product is possible without sacrificing some amount of some other product or products. Likewise, no change in the distribution of products can occur without making some consumer or consumers worse off.

If the principal "givens" in the general equilibrium system of the economy are the amounts of resources available, the production functions for various products, and the utility functions of individuals, there is no reason to believe that only one Pareto optimal solution to the system exists. In fact, there may be an inanity of Pareto optimal general equilibrium solutions. This means that there may be any number of product combinations along the transformation curve that are consistent with the three conditions stated above.

NOTE: *Arrow and Debreu have shown that the sufficient conditions for a perfectly competitive general equilibrium are that no firm has increasing returns to scale, at least one primary input is required to produce each good, no consumer supplies a greater amount of primary input than his or her initial*

stock of that input, each consumer is able to supply all primary inputs, and each consumer is insatiable and has a convex, ordinal utility function exhibiting convex indifference Curves.

Are some points on the better, from a social transformation curve welfare point of view, than others? Is there one product mix that is superior to all of the others and, therefore, that will maximize social welfare? General equilibrium analysis leaves us with a dilemma at this point. The most we can say based on the general equilibrium solution is that perfect competition, or some system that sets prices equivalent to those that would be established under perfect competition, will lead to an optimum result such that any change in the distribution of output (in- come) will cause some individuals to gain utility and others to lose. Whether some other out- come is in any sense better is a question ad- dressed by welfare economics, the subject of the following unit.

4.0   CONCLUSION

Given the tastes, preferences aims of the consumers in the economy, the quantity of each goods demanded depends not only on its price but also on the price of each other goods available in the market. Thus, each consumer maximizes his satisfaction relative to the prices ruling the market. Technical efficiency (MRT) is said to occur when the economy operates on the production possibilities curve. In this case, there are no unemployed and no underemployed resources. Economic efficiency is a more general concept that occurs when any change that benefits someone would result in harm for someone else (MRTS). Note that technical efficiency is a necessary condition for economic efficiency since a movement toward the production possibilities curve would benefit one or more individuals as shown in Figure 2.5.

5.0   SUMMARY

In the last unit we introduced you to the concept of general equilibrium as it related to production and transformation. Here, you learnt of our study, we studied the concept of marginal rate of substitution MRTS (consumption) and marginal rate technical efficiency MRT (production) as condition for the attainment of equilibrium, we illustrated these concepts with use of edgeworth box. At end the unit we clearly stated the three conditions that must be met for Pareto Optimum to be achieved to guarantee welfare.

6.0   TUTOR MARKED ASSIGNMENT

1.   Draw a transformation curve for the following efficient combinations of two goods A and B

Output A	Output B
100	0
80	50
60	80
40	100
20	110
0	115

Does your curve exhibit increasing opportunity cost? Explain how you can tell?

2.   Explain why you would expect a perfectly competitive market economy to be production and consumption-efficient and to have MRT = MRS

7. 0   REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc., New York, USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 3:   WELFARE ECONOMICS I

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1.0   INTRODUCTION

The discussion of general equilibrium theory in the preceding unit sets the stage for further system-wide analysis of the economy's performance in production and distribution of output. It is important to recall that an economy that is perfectly competitive in all factor and product markets will operate at a point on its transformation curve where both production and exchange is Pareto optimal. Thus, for the equilibrium product mix, there is no reallocation of goods that can increase the utility of a given consumer without decreasing the utility of some other consumer. However, as unit 1 and 2 showed, there is nothing in general equilibrium analysis that will allow us to say whether one of the economy's possible equilibrium positions is better or worse than another. To answer such a question, we must move into the realm of welfare economics.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1.   Make clear the elements that connects general equilibrium and welfare economics
2.   Relate the Grand Utility Possibilities Frontier to marginal rate technical efficiency

3.0   MAIN CONTENT
3.1   Nature of Welfare Economics

As the preceding paragraph suggests, welfare economics deals with comparing alternative states of the economy (product mixes and distributions output) in

order to determine which are better and which are worse. Of course, terms like "better" and "worse" generally involve ethical issues and, therefore, value judgments. The economist, who in other areas of his or her discipline is accustomed to predicting what *will* be if certain conditions occur, is faced in welfare economics with questions about what *ought to be.*

The classical economists, like Adam Smith and, especially, John Stuart Mill, did not shy away from questions about what ought to be in economic life. They were interested in, as Jeremy Bentham put it, "the greatest good for the greatest number". Generally, they argued that a self-directed market system would allow each individual to maximize utility and that the aggregate of such activity would result in maximum well-being for society. Although they prescribed remedies for various social ills (poverty, crime, illiteracy, etc.), they generally took it as obvious that these problems had to be solved in some rational manner and did not spend a lot of effort on the issue of whether their prescriptions were completely objective or scientific. It was as though they knew what the good society was and did not feel it was necessary to subject their preconceptions to any kind of rigorous scrutiny.

Modern welfare economics, on the other hand, was developed subsequent to the popularization of the notion of Pareto optimality. Its practitioners viewed economics as a scientific discipline, wherein policy analyses should be free of value Judgements. (Note that this point of view in itself constitutes a value judgment.) Thus, they strove mightily to develop methodologies that would allow comparison of various economic situations on a completely objective basis.

Although numerous criteria for welfare analysis were developed in the period from about 1935 to 1955, the same stumbling block always was encountered. This was the matter of inter-personal comparisons of utility. Since almost any change in the state of the economy caused by a policy adjustment will make some people better off and others worse off, the question of the net effect of such utility changes on society as a whole always rears its head. The plain truth is that there is no scientific way to compare a change in the utility of one person with a change in the utility of another. The more economists tried to get around this problem, the more they realized they could not. This does not mean that economists were unable to say anything about the implications of various economic alternatives, but it does mean that what they could say would have to be said with care, as the rest of this chapter will show.

3.2   The meaning of welfare economics

Welfare economics studies the conditions under which the solution to the general equilibrium model presented earlier in this module can be said to be optimal. It examines the conditions for economics efficiency in the production of output and in the exchange of commodities and equity in the distribution of

income.

The maximization of society's well-being requires the optimal allocation of inputs among commodities and the optimal allocation of commodities (i.e., distribution of income) among consumer. The conditions for the optimal allocation of inputs among commodities among consumers have already treated.

3.2.1 Elements of Welfare Maximization

What can economics say about the notion of making the whole of society as well off as possible? In the scarcity context of macroeconomics, it can examine (1) the utilization of resources, (2) the product mix, and (3) the distribution of output or income. A sample starting point for welfare economics is the one-person economy, such as the Island economy established in fiction by Robinson Crusoe. We will call this the "Crusoe Case."

3.2.2 Welfare Maximization in the Crusoe Case

Where the economy consists of only one person, macroeconomics provides us with a neat solution to the problem of welfare maximization. As long as Robinson Crusoe has an ordinal utility function that is "well behaved" (will exhibit downward-sloping indifference curves in the two-good case) it is easy to determine the state of his economy that is consistent with maximizing his utility (welfare). This can be done by simply stating the condition(s) under which no real-location of resources (change in the product mix) will result in an increase in Crusoe's total utility. Since Crusoe's only prices are opportunity costs, the condition must be stated in terms of his marginal rate of transformation in production and his marginal rate of substitution in consumption. The basic condition is just one - that the marginal rate of transformation be equal to the marginal rate of substitution for any pair of goods.

We can easily illustrate Crusoe's welfare- maximizing equilibrium in the two-good case by using a transformation curve along with his indifference curves for the goods. In Figure 3.1 Crusoe's transformation curve, TT', shows the combinations of capital goods and consumption goods that he can produce, given the amounts of resources at his disposal The curve has been drawn so that it exhibits increasing opportunity cost. The contour lines in the diagram (I_1, I_2, I_3) are Crusoe's indifference curves for consumption of the two types of goods. Clearly, Crusoe's welfare is maximized at point E, where indifference curve I_2 is tangent to the transformation curve. Crusoe can produce the combinations at points A and B, but these lie on a lower indifference curve and are inferior to combination E. Of course, a combination like C, which lies on a higher indifference curve than I_2, would make Crusoe happier than that at E; but it is unattainable since it lies outside the boundary of the transformation

curve.

The Crusoe case, then, has an obvious solution. In Figure 3.1, he must utilize his resources so that the marginal rate of transformation of capital goods for consumption goods (MRT_{vx}) equals his marginal rate of substitution in consumption (MRS_{YX}) at point E. Since MRT_{YX} is the absolute value of the slope of a transformation curve and MRS_{YX} is the absolute value of the slope of an indifference curve, the condition holds at E. Further, it will also be true that for any two inputs Crusoe uses to produce X and Y, such as capital (K) and labour (L), the marginal technical rate of substitution in the production of one good will be equal to that in the production of the other, or ($MRTS_{KL}$) x = ($MRTS_{KL}$)$_Y$ Otherwise, Crusoe would not be operating on the boundary of the transformation curve. It follows that a requirement for welfare maximization in the Crusoe case is that production be efficient in a Pareto optimal sense. (In Crusoe's Edgeworth box diagram for production of X and Y, an X isoquant would be tangent to a Y isoquant.)
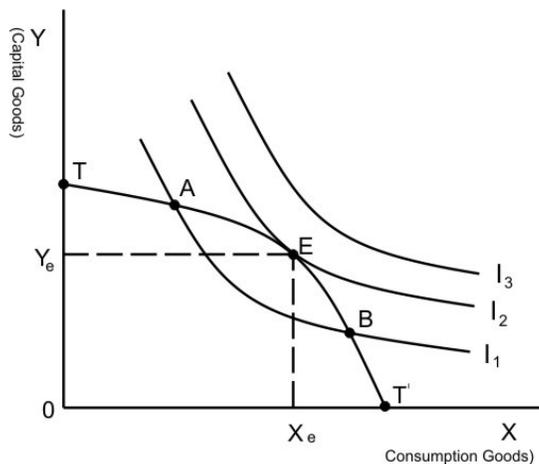
Figure 3.1. Welfare Maximization in the Crusoe Case

Robinson Crusoe's production possibilities for capital goods and consumption goods are shown on the transformation curve TT'. He maximizes his utility at point E, where the transformation curve is tangent to indifference curve I₂. Therefore, Crusoe will choose to produce combination (Xₑ,Yₑ) of the two kinds of goods.

3.3   Group Welfare and Interpersonal Comparisons of Utility

In the preceding section, the determination of the welfare maximum for Crusoe not only was very straightforward but also came up with a familiar result. That is, the condition that the MRS for any pair of goods equal the MRT for that same pair is the same condition that will hold when there is general equilibrium in a perfectly competitive economy. Can we then say that any perfectly competitive general equilibrium solution will lead to a welfare maximum? The

answer is no, and the reason is that the Crusoe economy had only one individual's utility function (that of Robinson Crusoe), while an economy made up of more than one consumer will be faced with the problem of reconciling the preferences of diverse individuals, each of whom has his or her own utility function.

Why does the existence of more than one individual's utility function cause a problem for welfare maximization? The answer is that people's *preferences differ*. In fact, a change in production or distribution of output that is desirable from the subjective point of view of one person in a society or group may be undesirable from someone else's point of view. Thus, one person's utility might be increased, while that of another falls. To determine whether society as a whole is better off from such a change, it would be necessary to compare the utility gain of the gainer with the utility loss of the loser. Given the subjective nature of utility (people's preferences, tastes, and feelings), it is just not practical to make interpersonal comparisons of utility (to compare the intensity of one person's gain with that of another's loss).

To make use of the approach introduced in Figure 3.1 for a multi-person society, we would have to substitute some sort of group preference function for Crusoe's indifference curves. One way to handle this is to resort to what are called "community indifference curves," which can be developed by aggregating the indifference curves of Individuals under some fairly restrictive assumptions about tastes, incomes, and the shape of individuals' indifference curves. Using community indifference curves, it is possible to develop contours such as I_1, I_2 and I_3 in Figure 3.1 and describe group equilibrium in much the same manner as in the one-person economy. This is an easy enough approach (and one that has been used frequently in international trade theory), but it is somewhat of a blind alley, since different distributions of income will yield different (and inconsistent) community indifference maps.

SELF -ASSESSMENT EXERCISE 1:

1.   What makes general equilibrium analysis objective while welfare economics is subjective?

2.   Why do market disequilibria lead to inefficiencies and non- Pareto optimum

3.4   Utility Possibilities

Another way of analyzing the problem of group welfare maximization is the utility possibilities approach. Here, a frontier similar to the product transformation curve is derived from an Edgeworth box for exchange by two consumers such a frontier is called a utility possibilities Curve.

*A **utility possibilities** curve shows optimal combinations of utility for two consumers, given the product mix of the economy.*

A utility possibilities curve for a given product mix is derived as follows. Figure 3.1.panel (a), shows an Edgeworth box for two consumers, Ade and Kunle, who can exchange two goods, X and Y. This Edgeworth box presupposes that the economy is at some point on its transformation curve, so that a given output of the two goods is available. As in the discussion in unit 2 of this module, we know that if the two persons are free to trade, equilibrium will occur somewhere on the contract curve. Also any point on the contract curve is *Pareto Optimal*, so that we cannot move away from without making one of the two parties worse off.

The utility possibilities curve is derived by moving along the contract curve from one corner of the box diagram to the other and plotting, in a separate quadrant, the resultant combinations of Ade's and Kunle's total utility. The result might be something like the curve in panel (b) of Figure 3.1. The curve shown in panel (b) is a utility possibilities curve. It shows the trade-off between Ade's utility and Kunle's utility, assuming one of the parties always maximizes utility given the level of the other party's utility. Note that this does not require cardinal utility measurement, because the scales on the axes of panel (b) could simply correspond to two different ordinal utility scales for the consumers. Since an increase in Ade's utility is always accompanied by a decrease in Kunle's, we know that the utility possibilities curve will slope downward to the right. However, we know nothing about the rate at which Ade's utility falls and Kunle's rises (or vice versa), and this is why the curve has been drawn with an irregular shape.

3.5   Interpersonal Comparisons

It may appear from Figure 3.1 that it is possible to compare Ade's gain in utility with Kunle's loss when the division of X and Y between them is changed from a point such as B to one like C in the Edgeworth box In fact, m panel (b) we show that the corresponding movement from B ' to C ' on the utility possibilities curve raises Ade's utility index by 40, while Kunle's drops by only 10. It is tempting to say that a net increase in utility would accompany such a redistribution of output, but we cannot do so, there is really no connection between the utility index on Ade's axis of panel (b) and that on Kunle's. All we can say is that a movement from B ' to C ' makes Ade better off and Kunle worse off.
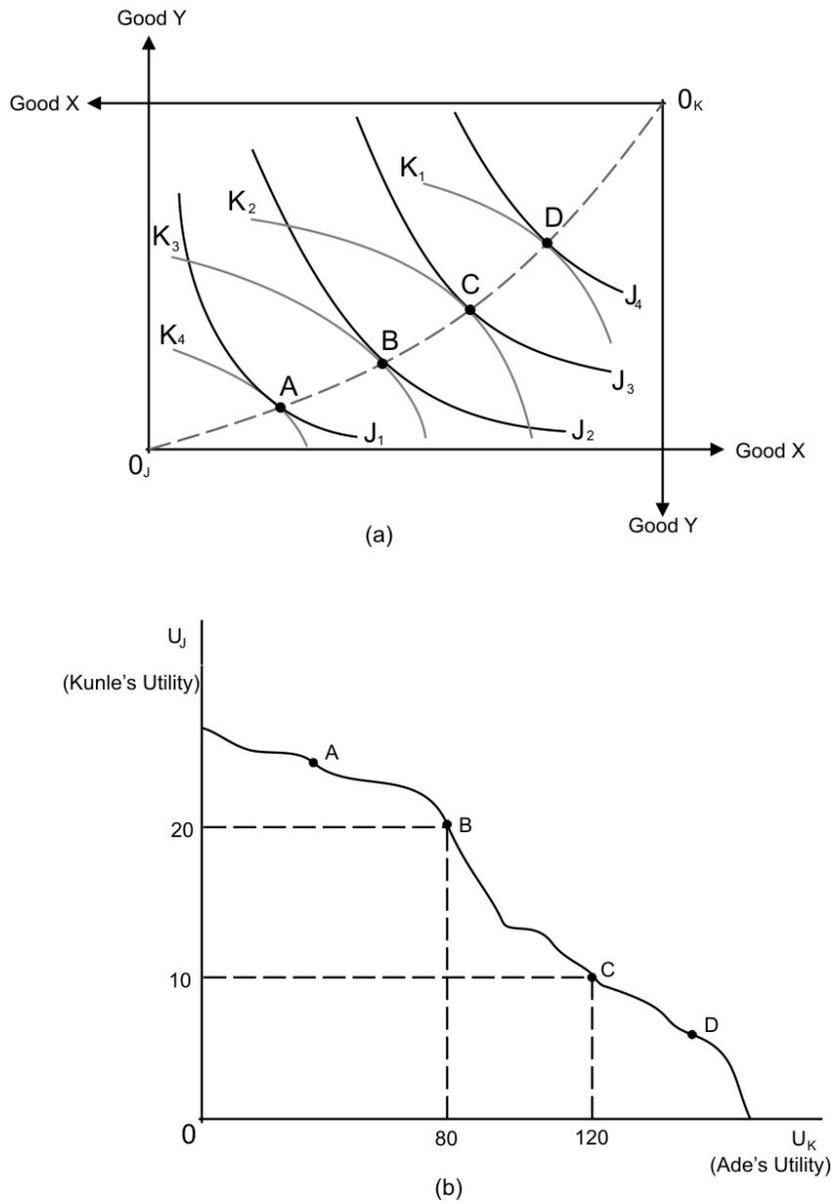
Figure 3.1: Relation of Edgeworth Box to Utility Possibilities Curve

In panel (a), the dimensions of the Edgeworth box assume that the economy is at some point on its transformation curve, so that production of X and Y is Pareto optimal. If the two consumers are free to trade, they will reach an equilibrium point that is somewhere along the contract curve ABCD. Panel (b) shows a utility possibilities curve with a scale of Kunle's utility on the vertical axis and Ade' on the horizontal axis. All points on the utility possibilities curve correspond to points of tangency between the two consumers' indifference curves in the Edgeworth box. Thus, it is impossible to increase one consumer's utility without reducing that of the other, if they are at a point on the utility possibilities curve.

Since utility is subjectively determined, there is just no way to compare Ade's gain with Kunle's loss. In fact, given the assumption of ordinality we cannot even say that in this example Kunle's utility fell by 50 percent, since the indexes do no more than identify which levels of utility are higher and which are lower. The "how much" question remains as impenetrable here as it was in the theory of consumer behaviour (ECO 201)

3.6   Grand Utility Possibilities Frontier

In Figure 3.1, a utility possibilities curve was derived from a single Edgeworth box diagram for two consumers, Ade and Kunle. No attempt was made to argue that any one point along the utility possibilities curve was in any way superior to any other such point. However, the discussion of general equilibrium in preceding unit 1 and 2 showed that the perfectly competitive economy would come to rest at one of the contract curve points which, of course, will correspond to a point on the utility possibilities curve for our given product mix.

Unfortunately, we also know from unit 1 and 2 that any number of Edgeworth box diagrams for two consumers can be drawn under the transformation curve for the economy. In the case we have been developing, this means that there is any number of utility possibilities curves for Ade and Kunle, each one corresponding to solve Edgeworth box for a possible combination of X and Y production.

In Figure 3.2, we show the relationship between the transformation curve and a set of utility possibilities curves. The utility possibilities curve HH ' in panel (b) corresponds to the contract curve 0_J0_K panel (a) Points F and G on the transformation curve denote the output combinations corresponding to two of the many additional Edgeworth boxes that could be drawn under the transformation curve. If these two boxes were sketched in and their contract curves developed, the utility possibilities curves FF ' and GG ' in panel (b) could be derived from them For each of the infinity of Edgeworth boxes we could develop under the transformation curve in panel (a), a utility possibilities curve can be derived in panel (b).

On each utility possibilities curve of panel (b), there is one point that is consistent with equality between the MRT_{YX} in production and the MRS_{YX} in consumption for the related Edgeworth box in panel (a). For the box 0_J Y_I 0_K X_1, this condition is true at Z (SS' is parallel to TT'), which corresponds to the point Z ' on utility possibilities curve HH' . Points R [on GG ' in panel (b)] and V (on FF') are meant to correspond to the contract curve points in the two other Edgeworth boxes where $MRT_{YX} = MRS_{YX}$. In Figure 3.3, the bold, outer curve that is tangent to all points like R, Z ', and V is called the grand utility possibilities frontier.
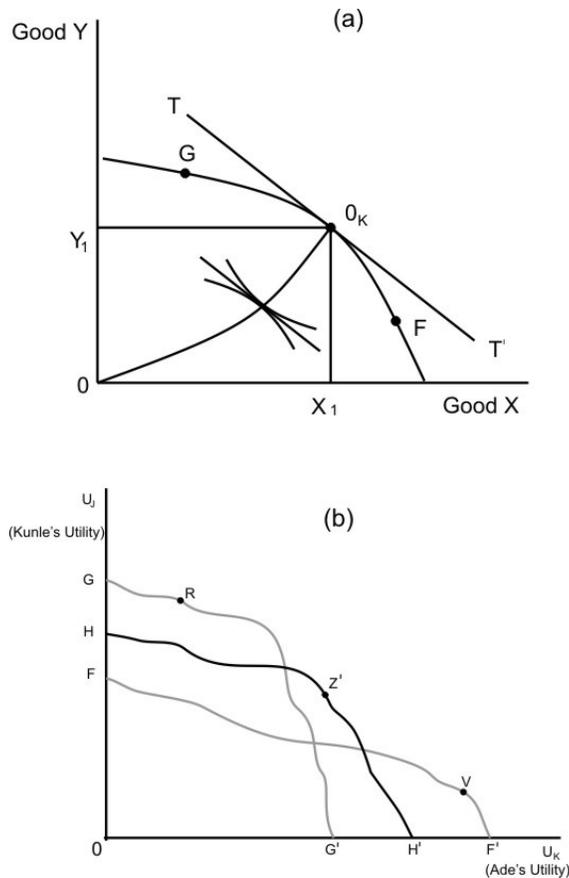
Figure 3.2. Relationship between Transformation Curve and Utility Possibilities Curves

If the economy is at point 0_K on its transformation curve in panel (a), efficiency in both production and exchange will be reached when $MRT_{YX} = MRS_{YX}$, or when its consumers are at point Z on the Edgeworth box for goods combination (X_1, Y_1). Since SS' is parallel to TT', the MRT equals the MRS. In panel (b), if HH' is the utility possibilities curve for goods combination (X_1, Y_1), point Z' corresponds to Z in the preceding panel. The two additional utility possibilities curves, GG' and FF' correspond to points G and F on the transformation curve in panel (a). R and V are the points on these two curves consistent with MRT = MRS.

*The **grand utility possibilities frontier** describes all possible combinations of utility for two consumers when the economy is efficient in both production and consumption $(MRT_{YX} = MRS_{YX})$.*

Any point inside the grand utility possibilities frontier is suboptimal, since one person can be made better off without harming the other by simply changing the product mix (moving to a new point on the economy's transformation
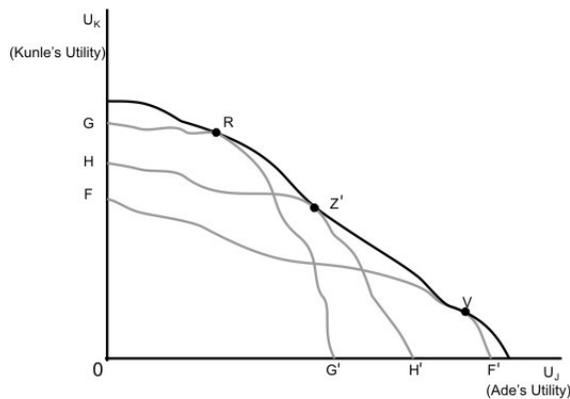
curve).

Figure 3.3: The Grand Utility Possibilities Frontier

There is a utility possibilities curve such as GG', HH' and FF' for each possible mix of goods the economy can produce. Further, there is a point corresponding to efficiency in both production and exchange on each utility possibilities curve. The grand utility possibilities curve (bold line) is an envelope curve tangent to all such points (R, Z', V, etc). If the two consumers are at a point on the grand utility possibilities curve, it is not possible to make one of them better off without making the other one worse off, given the economy's production possibilities.

Although the grand utility possibility frontier identifies all possible welfare optima for two consumers, it leaves us with a dilemma. We still do not know which of the points is best for our two-person world. Clearly, in Figure 3.3 movements from point Z toward point R make Kunle better off and Ade worse off, while movements toward V do the reverse. Some additional device is needed to ascertain how changes in the utility of individuals in society affect the well-being of society as a whole. The device commonly used to accomplish this feat (in theory) is the social welfare function.

4.0   CONCLUSION

Welfare economics deals with comparing alternative states of the economy (product mixes and distributions of output) to identify situations or changes that benefit society as a whole. Because welfare economics is concerned with the distribution of well-being among individuals, its application always raises problems of interpersonal comparison of utility.
In a Robinson Crusoe economy, utility (welfare) is maximized when the marginal rate of transformation in production equals the marginal rate of substitution in consumption.

Community indifference curves can be used to illustrate a theoretical welfare maximum for a multi-person economy. However, community indifference

curves are an abstraction that tends to overlook the essential problem of defining a social welfare function.

The importance of interpersonal utility trade-offs in welfare analyses is underscored by the utility possibilities curve, which shows that for every efficiently produced output combination, there is any number of Pareto optimal distributions of output among consumers. However, for a given product mix; only one distribution will be Pareto optimal in terms of utility possibilities. The grand utility possibilities frontier consists of all Pareto optimal utility possibility combinations, one combination corresponding to each possible product mix.

It is not possible to identify a welfare maximum on the grand utility possibilities frontier unless a social welfare function is specified. It is not clear how such a function could be spirited, although it is certain that any such procedure would require some individual or group to make value judgments about how the economy's benefits should be distributed among persons

5.0   SUMMARY

In this unit you were introduced to welfare economics proper as some part of the concept had well discussed in the preceding unit of this module. The meaning of the welfare economics and its nature was explained. Welfare maximization in the case of Crusoe was dealt with as well as Group Welfare and Interpersonal Comparisons of Utility.The condition that marginal rate of transformation must be equal to marginal rate of substitution for Pareto optimal position to hold.

6.0   TUTOR MARKED ASSIGNMENT

1.   Suppose that the isoquants for the commodities X and Y are given by X_1, X_2, X_3 and Y_1, Y_2, Y_3 respectively, in the following table. Suppose also that a total of 14L and 9K are available to produce commodities X and Y. draw the Edgeworth box diagram for exchange and show the production contract curve.

X's Isoquant

X1		X2		X3	
L	K	L	K	L	K
5	7	8	5	10	7
6	2	9	3	11	5
7	1	11	2	13	4.5

Y's Isoquant

Y1		Y2		Y3	
L	K	L	K	L	K
9	2	7	4	10	4
3	4	5	6	8	7
1	6	4	8	7.5	8.5

7. 0 REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc. New York. USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA

UNIT 4:   WELFARE ECONOMICS II

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1.0   INTRODUCTION

Given the difficulty encountered in specifying a social welfare function or locating a point of constrained bliss, it is not surprising that economists have focused their attention on somewhat less abstract problems related to the issue of social welfare. Two types of problems have received a great deal of attention. The first is the development of methodologies for determining when a change that is detrimental to some individuals or groups but beneficial to others is desirable from a social welfare point of view. The second concerns the relation between democracy and social welfare and centres on the question of whether a voting process based on majority rule can identify policies consistent with welfare maximization. We will begin with the question of evaluating changes.

2.0   OBJECTIVES

At the end of this unit student should be able to:
1. Discuss any three of the welfare theory
2. Trace some fault lines in each of the three theories discussed

3.0   MAIN CONTENT
3.1   The Social Welfare Function

Most economists view the social welfare function as something that cannot be specified in a scientific way, since by its very nature. It requires that value judgments be made about which members of society deserve to get more of its product and which ones deserve to get less. Given the foregoing

assumption, we will view the social welfare function as something similar to an ordinal utility function for an individual consumer. The difference, of course, is that what we will be ranking is society's preferences regarding the distribution of well-being (utility) between two persons. For Ade and Kunle, a social welfare function appears in Figure 4.1. The figure shows contours of the welfare function (W_1, W_2, W_3) that appear very much like indifference curves. Any single contour, such as W_1, shows combinations of Ade's utility (U_J) and Kunle's utility (U_K) that yield a given level of social welfare.
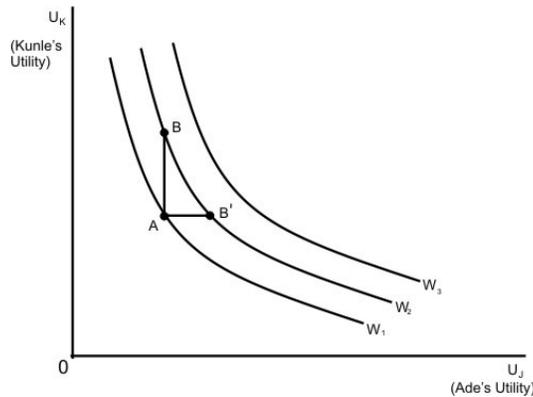

Figure 4.1 Contours of a Social Welfare Function

Any change in the distribution of consumers' utility along a given contour like W_2 produces no change in social welfare. Society is as well off if Ade and Kunle are at point B as if they are at B'. The shape of these particular social welfare contours suggests that it is easier to improve social welfare by raising the utility of those who have relatively little than by raising the utility of those who have a lot. Thus, from point A, a small increase in Ade's utility moves society to W_2, but it would take a larger increase in Kunle's utility to do the same.

Contours that are further out from the origin than W_1 represent higher levels of welfare for our two-person society. However, very little which is definite can be said about the shape of the welfare contours. Certain shapes reflect specific propositions about society, but there is no a priori reason to expect one shape rather than another.

The contours in Figure 4.1suggest that when one of the two parties enjoys a high level of utility relative to the other, the fortunate person's utility will have to increase a great deal in order for social welfare to increase, but the unfortunate person's utility need only increase by a small amount in order to result in an increase in social welfare. For example, at point A in Figure 4.1, Kunle's utility must increase by a large amount in order to move the economy from W_1 to W_2. However, from the same point, a much smaller increase in Ade's utility will move the economy to W_2. Thus, it seems that downward-sloping welfare contours that are convex toward the origin reject a value judgement that the distribution of product or income should not be too

lopsided. In fact, a completely egalitarian view of income distribution would yield right- angled welfare contours, since social welfare could not be increased by increasing that of only one of the two parties. (See Figure 4.2.)

3.2   Constrained Bliss

Given a set of contours of the social welfare function, the objective, as in indifference curve analysis, is to reach the highest contour. For the two consumers in our example, Ade and Kunle, we illustrate a welfare maximum in Figure 4.3 that combines the social welfare function of Figure 4.1with the grand utility possibilities frontier of Figure 6-4. In Figure 4.3, the social welfare maximum occurs at point Z on welfare level W_2. Thus, Z is the distribution of utility between Ade and Kunle that will be best for the two-person society. A point like Z is frequently referred to as a point of "constrained blissful," since the grand utility possibilities frontier, which was based on society's resources, available technology, consumer preferences, and efficiency clearly limits the level of welfare that can be attained. In Figure 4.3, something (resources, technology, tastes) would have to change in order for society to be able to reach a welfare level higher than W_2.
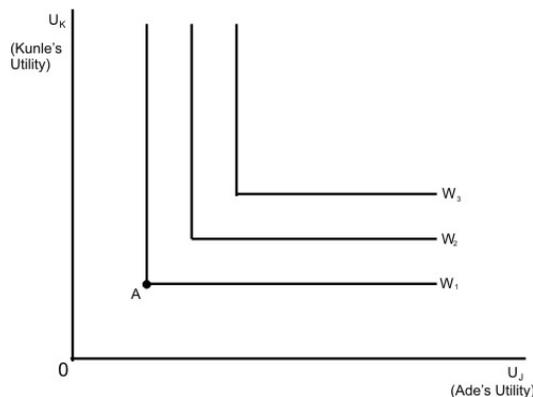

Figure 4.2. Welfare Contours for an Egalitarian Income Distribution

If it is not possible to increase social welfare by increasing the utility of only one of two parties in the society, welfare contours will be right angled. From point A, no increase in social welfare would take place unless both consumers gained.
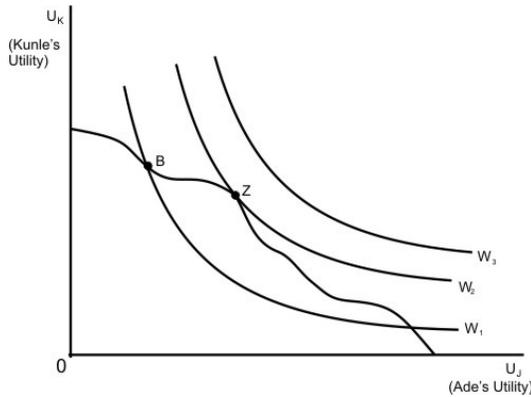
Figure 4.3. A Social Welfare Maximum for Ade and Kunle

Given the grand utility possibilities curve for Ade and Kunle and a social welfare function with contours like W_1, W_2, and W_3, the social welfare maximum occurs at point Z on W_2. A point like Z is called a point of "constrained blissful," since the welfare attainable is limited by the grand utility possibilities curve, and the resources, technology, consumer preferences, and efficiency conditions that lie behind it.

Figure 4.3 may give the impression that the welfare maximum must be unique. This is not so, since both the grand utility possibilities frontier and the welfare contours can assume a wide variety of shapes. For example, in Figure 4.4, we illustrate a utility possibilities frontier that is tangent to the highest attainable welfare contour, W_2, attired points, R, Z, and V. What this says is that there are three (perhaps widely diver
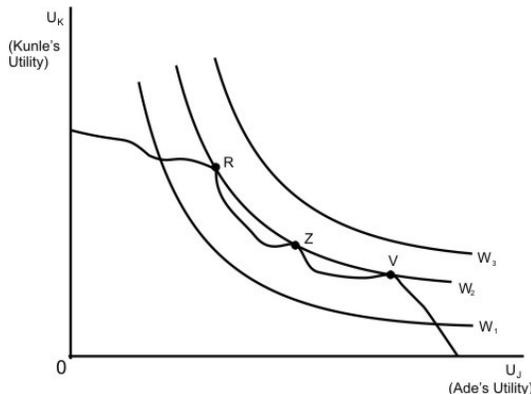
Figure 4.4. A Case of Multiple Welfare Maxima

The social welfare maximum may not be unique. Here, there are three distributions of utility between Ade and Kunle that are consistent with tangency of the grand utility possibilities curve to the highest social welfare contour attainable, W_2. Points, R, Z, and V suggest that widely divergent states of the economy and distributions of welfare may constitute social welfare maxima, given the shape of the grand utility possibilities curve and the social welfare contours.

gent) states of the economy that will maximize social welfare. Setting prices that are consistent with the $MRS_{YX} = MRT_{YX}$ equilibrium from which point Z was derived in Figure 4.3 will maximize welfare, but two other sets of prices will do just as well.

Welfare economists have not viewed the possibility of multiple maxima as much of a problem. If there are several such points, never mind. If the "ethic" at hand is really indifferent, pick any one. If it doesn't matter, it doesn't matter.

We can conclude that although constrained bliss is conceivable, it may correspond to not one, or even three, but numerous states of the economy (a hundred, a thousand, or an infinite number) or structures of prices that are consistent with reaching it. Formulating a policy to achieve constrained bliss in such a setting might be a very frustrating task (or no task at all, depending on one's point of view.

3.4   The Pareto Criterion

The Pareto criterion for evaluation of a change in the state of the economy or in economic policy relates directly to the notion of Pareto optimality. We already know that a position is identified as Pareto optimal if any movement away from it causes harm (such as a reduction in utility) to any party. The contract curve in an Edge- worth box diagram is a locus of such Pareto optimal points. The Pareto criterion simply states that a change is desirable if it improves the position of one party and does no harm to any other party. In the Edgeworth box, from a point off the contract curve there is always some pattern of movement that will harm neither party and result in gains for one or both.

Although the Pareto criterion is a useful one, it is widely recognized that most decisions affecting social welfare involve changes that improve the position of one group at the expense of another. For example, a change in farm price supports that benefits farmers will be detrimental to consumers. The Pareto criterion would rule out any such change. In such a setting, its application would constitute a bias in favour of the status quo.

Figure 4.3 can be used to underscore this point. (Remember, all points on the grand utility possibilities frontier are Pareto optimal.) If the economy comes to rest at point R. the Pareto criterion would rule out any change that would move it toward Z, the welfare maximum. The status quo would be preserved, even though it would indeed be possible to institute changes that improve social welfare.

Hypothetical example:

Question: Explain why one individual may favour a particular Pareto-efficient allocation over another. (b) Assume that the social-welfare function (SW) has the form $SW = U_A + 1.5U_K$. Calculate the social welfare levels for option X, Y, and Z. which option would provide the highest level of social welfare.

Answer: an individual may prefer one pareto-efficient allocation because of the differences in the mix of goods produced or in the division of the goods among consumers. Ade would clearly favour option X over Y or Z, shown in the following table. Ade has more of all goods in option A. Kunle, on the other hand, would prefer option Z.

	Ade		*Kunle*	
Option	*Goods A*	*Goods B*	*Goods A*	*Goods B*
X	10	20	1	0
Y	6	10	8	11
Z	0	2	12	18

Society may prefer one Pareto-efficient allocation over another because of the values and ethics of its members. While Ade may prefer option X and Kunle may prefer option Z, collectively they may prefer option Y. The aggregation of utility levels for option Y may yield the highest social welfare. Note that if this society starts out at either option X and Z, it may be necessary to redistribute income from participant to another in order to reach option Y.

(b)

Utility		
Option	*Ade*	*Kunle*
X	100	2
Y	60	50
Z	5	80

Answer
The social welfare for each option is

$SW_X = 100 + 1.5 * 2 = 103$
$SW_Y = 60 + 1.5 * 50 = 135$
$SW_Z = 5 + 1.5 * 80 = 125$

So, option B would provide the highest level of social welfare.

3.5   Kaldor-Hicks Criterion

Given the inapplicability of the Pareto criterion to cases involving both winners and losers of well-being, a number of economists have attempted to develop schemes for determining when a change that violates the Pareto criterion is, nonetheless, a desirable change. The Kaldor-Hicks criterion, popularized in the late 1930s by British economists Nicolas Kaldor and John Hicks, is essentially a restatement of the compensation principle described by the Italian economist Enrico Barone in 1908.

The compensation principle states that an economic change is desirable if those who gain from it can compensate the losers and still be better off than in their initial position.

As originally stated, the compensation principle did not require that compensation actually be paid. Kaldor and Hicks did not insist that it be paid when they wrote their early works in the 1930s. However, it was later realized that actual payment would be the only feasible way to identify the size of the necessary compensation.

Aside from the question of payment, the Kaldor-Hicks criterion suffers from another flaw. It has been pointed out that two offsetting policies might both pass the Kaldor-Hicks test. In otherwords, if a given policy moves the economy from one state, A, to another. B, and passes the Kaldor-Hicks test, once at B it may be possible to devise another policy that will move the economy back to A and again pass the test.

3.6   Scitovsky Criterion

Professor TiborScitovsky attempted to improve on the Kaldor-Hicks criterion by developing a "double criterion" to make certain that a policy that reversed a previous change could not improve welfare. In essence, the Scitovsky test is simply a double Kaldor-Hicks test. One would first apply the Kaldor-Hicks test to a change to see if the change produced an improvement. If so, then the test would be applied again to a change that would restore individuals to their original state. Failure of the second change to pass the test would be an indication that the first was desirable.

Although the Scitovsky double criterion eliminates the reversal problem associated with the Kaldor-Hicks test, it still does not address the issue of

actual versus potential compensation. William J. Baumol argues that both the Kaldor-Hicks and the Scitovsky tests depend on a concealed interpersonal utility comparison on a monetary basis. He gives the following example of a change that result in a loss for person X but a gain for person Y:

If Y's gain is worth ₦200 to him evaluates his loss at ₦70, we are not entitled to jump to the conclusion that there is a net gain in the move. . . If X is a poor man or a miser, ₦70 may mean a great deal to him, whereas if Y is a rich man or a profligate, the ₦200 may represent a trifle hardly worth his notice. Thus, unless X is actually compensated for his loss (in which case the Kaldor criterion is unnecessary- and the Pareto criterion can do the job) the change ... may represent a major loss to X and a trivial gain to Y even if it passes the Kaldor criterion with flying colours.

The Scitovsky criterion also would not escape this problem. In other words, economics is unable to get beyond Pareto optimality in the question of social welfare because it can provide no scientific means of determining whether one person's gain is worth more than another person's loss.

3.7   Beacon's Welfare Function

Abram Bergson, whose writing is contemporary with that of Kaldor and Hicks, suggested that the only plausible social welfare function is one that takes into account an explicit set of value judgements about the society it is supposed to describe; Such value judgements would have to deal with the problem of determining what constitutes a just distribution of a society's benefits among its members. It is not clear who would specify the social welfare function, though it might be developed by some governmental body such as a legislature.

The result of setting up a Bergson-type social welfare function would be an scientific identification of a pattern of combinations of utility that are somehow rank ordered by the welfare authority. In other words, an ordinal function such as the one used above in Figure 4.3 would be specified. Once this is done, a maximum point, such as Z in that figure, might be located. It would then be possible to prescribe the structure of prices necessary to attain point Z. Working backwards from the grand utility possibility frontier to the consumers' Edgewot'th box, to the product transformation curve, and, finally, to the producers' Edgeworth box, the efficiency conditions consistent with point Z could all be established. Note, however, that there is nothing in the Bergson approach that precludes the problem of multiple maxima described in Figure 4.4.

The real problem with the Bergson approach is that it does not get to the bottom of the question of how the social welfare function is developed. Where there is only a one person economy

(Crusoe case), or an economy run by a dictator, that single individual's preferences may constitute the social welfare function (assuming he or she knows what is good for himself or herself). In any other than these two situations, defining the social welfare function may be an intractable problem. Appreciation for the difficulty encountered in defining social welfare in a democracy was enhanced by the work of Kenneth Arrow and other scholars who investigated the process of group choice through voting.

3.8   Arrow's Impossibility Theorem

Arrow's investigation of social choice centres around the so-called "voting paradox's." The voting paradox occurs when a democratic process based on majority rule results in an inconsistent ranking of alternatives.

Arrow lists the following four conditions that he believes must hold for a social welfare function to reflect individual preferences:

1. Social welfare choices must be transitive. That is, if X is preferred to Y and Y is preferred to Z, then X must be preferred to Z.

2. Social welfare choices must not be responsive in the opposite direction to changes in individual preferences. That is, if choice X moves up in the ranking of one or more individuals and does not move down in the social welfare ranking.

3. Social welfare choices cannot be dictated by any one individual inside or outside the society

4. Social choices must be independent of irrelevant alternatives. That is, if the society prefers X to Y and Y and Z, then society must prefer X to Y even in the absence of alternative.

The voting paradox is easy to illustrate by example.

Suppose there are three persons who are designated to choose from among three social policy alternatives. We will call these persons Kunle, Ade, and Chucks. The policy alternatives will be designated X, Y, and Z. Suppose the three persons are asked to rank order the alternatives (1 for most preferred, 3 for least preferred), and the following pattern of rankings occurs:

Table 4.1: Ranking of Alternatives X,Y, and Z by Kunle Ade and Chucks

Names	Policy X	Policy Y	Policy Z
Kunle	1	2	3
Ade	3	1	2
Chucks	2	3	1

What is the group preference? Note that Kunle and Chucks prefer X to Y, Kunle and Ade preferY to Z, and Ade and Chucks prefer Z to X. Thus, a majority of the group prefers X to Y and Y to Z; but a majority also prefers Z to X. The ranking system is logically inconsistent and, therefore, cannot result in a single preferred choice.

Upon further examination of the voting paradox, Arrow determined that procedures for social choice could not be both democratic and consistent. However, his conclusion was derived subject to the condition that people only rank order their preferences, giving no weight to the intensity of one person's or group's preference in comparison to that of another person or group. Thus, if half the public were strongly in favour of building a new city hall and the other half were mildly opposed to it, the difference in the intensities of these preferences would have to be disregarded in the decision process.

4.0   CONCLUSION

Given a social welfare function, the point of constrained bliss (the welfare minimum) occurs where a contour of the function is tangent to the grand utility possibilities frontier. However, tangency may occur at any number of points, indicating that society is indifferent regarding various possible welfare-maximizing distributions.

Economists have attempted to develop several kinds of criteria to assess the welfare impact of changes from one to another state of the economy. The Pareto criterion simply says that a change is desirable if someone benefits from it and no one is harmed. The Kaldor-Hicks criterion judges a change to be desirable if those who gain from it could compensate those who lose and still have something left over. The Scitovsky criterion adds a reversal test to the Kaldor-Hicks criterion to ensure that a return to the original state would not also pass the Kaldor-Hicks test.

Abram Bergson argued (hat a social welfare function would have to take value judgements into account in an explicit way. With a Bergson-type function specified, economists could then concentrate on the efficiency conditions required to reach the maximum point.
As Kenneth Arrow's impossibility theorem states, a group choice procedure cannot be both logically consistent and democratic. It follows that majority rule cannot be depended upon to identify policies that are socially preferred.

5.0   SUMMARY

You have learnt about prominent theories in social welfare function and various proponents of these theories. Each of them tried to find scientific way to define welfare which seemed difficult. Pareto optimum as earlier explained

was among popular theory in welfare economics that plays down a bit the use value judgement to describe the social welfare. However, Abram Bergson, Kenneth Arrow's, Kaldor-Hicks, TiborScitovsky and William Baumol all made significant contribution the concept of welfare many policy makers found useful today.

6.0   TUTOR MARKED ASSIGNMENT

1.   How 'Arrow's impossibilities' is related to the so-called 'voting paradox'
2.   Discuss the compensation principle and relate it to the Kaldor-Hicks criterion

7. 0   REFERENCES /FURTHER READINGS

Emery E.D (1984): Intermediate Microeconomics, Harcourt brace Jovanovich, Publishers, Orlando, USA

Jhingan M.L (2009): Microeconomics Theory, Vrinda Publications (P) Limited, Delhi

Pindyck R.S and Daniel L. R. (2009): Microeconomics (7ed), Pearson Education, Inc. New Jersey, USA.

Salvatore D. (2003): Microeconomics Harper Publishers Inc. New York. USA

Salvatore D. (2006): Microeconomics. Schuams Series. McGraw-Hill Companies, Inc. USA