NATIONAL OPEN UNIVERSITY OF NIGERIA

ECONOMIC PLANNING II

ECO 448

FACULTY OF SOCIAL SCIENCES

Department of Economics

COURSE GUIDE

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CONTENT

Introduction

ECO 448 is designed to teach you and to build on your understanding of Economic planning as contained in the course material of Economic planning I. In this course, attention is given to the dynamics and workings of the techniques and models of economic planning as it relates to the functionality of the economy for desired Economic growth and development. It is primarily concerned with the explanations of the models and techniques of Economic planning that can be adopted by the central authority to exercise their conscious effort of achieving definite targets and objectives within a specified period of time. In this wise, Economic planning incorporate all aspect of human development aspirations to accelerate the pace of a country's social, economic and political development. More specifically, it is a study that shows the technique of deliberate control and direction of the economy by a central authority through various tools and sub-systems within the main system, for the purpose of achieving definite targets and objectives within a specified period of time.

You will be taught the dynamics and workings of the techniques and models of economic planning as it relates to the functionality of the economy for desired Economic growth and development by the central planning authority to achieve desired set goals and objectives in Less Developed Countries of which Nigeria is one. It is also to provide a basic quantitative and qualitative understanding of how the models works to achieve medium and long-term economic aims which requires a blend of macroeconomic analysis and real-life application in executing economic planning policies.

Course Content

This course builds on the exposure of students to Economic planning I. Topics covered include: Understanding techniques, model and requisites of economic planning, Input-output analysis in planning, social accounting matrix, General equilibrium and computable general equilibrium models of economic planning, Linear programming technique and cost benefit analysis in planning.

Course Aims

There are Twelve (12) study units in the course and each unit has its objectives. You should read the objectives of each unit and bear them in mind as you go through the unit. In addition to the objectives of each unit, the overall aims of this course include:

(i) To introduce you to the Understanding of Techniques and Models used in Economic Planning.

(ii) To teach you the concept of Input-Output Analysis in Plan Programming.

(iii) To expose you to the concept of Linear Programming Techniques in planning.

(iv) To give you the detailed analysis of how Social Accounting Matrix technique is used in Economic Planning.

(v) To show you the importance and limitations of General Equilibrium Models and Computable General Equilibrium Models in Economic Planning.

(vi) To teach you the workings of Cost Benefit Analysis and project selection techniques.

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 serve 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

The objectives of this course are:

- To instill in students the familiar models and techniques used in Economic Planning
- To educate students on how Economic integrated plan is executed using the common quantitative development models for Economic Planning of a country most especially developing countries by the planning authorities i.e., the Government.
- To educate learners on the usefulness, importance and problems of models and techniques of Economic Planning.

Working through This 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 Student 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 12weeks to complete and some components of the course are outlined under the course material subsection.

You have to work through all the study units in the course. There are Four modules and Twelve study units in all.

Course Materials

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 are 12 units in this course which should be studied carefully and diligently.

The breakdown of the four modules and twelve study units are as follows:

Module 1: Understanding Techniques, Models and Requisites of Economic Planning.

Unit 1: Meaning of models in Economic Planning

Unit 2: Rationale and prerequisite for successful planning

Unit 3: Categories of development planning models in focus

Module 2: Input-Output Analysis in Planning.

Unit 1: Meaning of Input-Output technique

Unit 2 Input –Output model

Unit 3: Uses, Limitations and importance of input-output analysis to planning

Module 3 Social accounting matrix, General Equilibrium and Computable General Equilibrium Models of Economic Planning

Unit 1 Social accounting matrix technique of economic planning.

Unit 2 General equilibrium model of economic planning.

Unit 3 Computable General equilibrium model of economic planning.

Module 4: Linear Programming Techniques and Cost-benefit Analysis in Planning.

Unit 1: Introduction to the concept of Linear Programming technique

Unit 2: Linear Programming technique and its application in Planning

Unit 3: Project selection technique of cost-benefit analysis

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 colleges. You are advised to do so in order to understand and get acquainted with historical economic event as well as notable periods.

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:

Akosile I.O, Adesanya A.S Ajani A.O (2012). Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

Jhingan M.L. (2012). The Economics of development and planning, Vrinda publications India. (40th Edition).

Koutsoyiannis A. (2003) Modern Microeconomics. Macmillan Press Ltd., London.

Michael P. Todaro and Stephen C Smith (2011). Economic development, Pearson education Ltd, Edinburgh gate Harlow, Essex, England.

Mohammed H. (2015) Microeconomic Analysis - Theories and Applications (1st edition) Stirling-Horden Publishers Ltd. Lagos.

Olajide O. T (2004). Theories of Economics development and planning, Lagos, Nigeria, Pumark Nigeria Ltd.

Paul Krugman and Robbin Wells (2006) Macroeconomics. Worth Publishers, New York, USA.

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 to your tutor for formal Assessment in accordance with the deadlines stated in the Presentation Schedule and the Assignments File. The work you submit to your tutor 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 of three hours' duration. 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.

Final Examination and Grading

The final examination will be of three hours' duration and 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, Economic planning II (ECO 408).

Units	**Title of Work**	**Week's Activities**	**Assessment (End of unit)**
	Course Guide		

Module 1 Understanding Techniques, Models and requisites of Economic Planning			
1	Meaning of models in Economic Planning	Week 1	Assignment 1
2	Rationale and prerequisite for successful planning	Week 2	Assignment 1
3	Categories of development planning models in focus	Week 3	Assignment 1

Module 2 Input-Output Analysis in Planning			
1	Meaning of Input-Output technique	Week 4	Assignment 2
2	Input –Output model	Week 5	Assignment 2
3	Uses, Limitations and importance of input-output analysis to planning	Week 6	Assignment 2
Module 3 Social accounting matrix, General equilibrium and computable general equilibrium models of economic planning			
1	Social accounting matrix technique of economic planning	Week 7	Assignment 3
2	General equilibrium model of economic planning	Week 8	
3	Computable General equilibrium model of economic planning	Week 9	Assignment 3
Module 4 Linear Programming Techniques and Cost-benefit analysis in Planning			
1	Introduction to the concept of Linear Programming technique	Week 10	Assignment 4
2	Linear Programming technique and its application in Planning	Week 11	Assignment 4
3	Project selection technique of cost-benefit analysis	Week 12	Assignment 4
Total		**12weeks**	

How to Get the Most from this Course

In distance learning the study units replace the university lecturer. This is one of the great 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 material, and when to embark on discussion with your colleagues. Just as a lecturer might give you an in-class exercise, your study units provide 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, Economic Planning II (ECO 408), expose you to the field of economic development planning, in this course, attention has been given to the dynamics and workings of the techniques and models of economic planning as it relates to the functionality of the economy for desired Economic growth and development. It is primarily concerned with the explanations of the models and techniques of Economic planning that can be adopted by the central authority to exercise their conscious effort of achieving definite targets and objectives within a specified period of time. In this wise, Economic planning incorporate all aspect of human development aspirations to accelerate the pace of a country's social, economic and political development. More specifically, it is a study that shows the technique of deliberate control and direction of the economy ,by a central authority through various tools and sub-systems within the main system and also incorporate other technique like input-output analysis, social accounting matrix technique, linear programming technique, computable general equilibrium model and cost-benefit analysis for project selection, for the purpose of achieving definite targets and objectives within a specified period of time.

On successful completion of the course, you would have developed critical thinking skills with the material necessary for proper economic planning. However, to gain a lot from the course please try to apply anything you learn in the course to term papers writing in other economic planning development courses. We wish you success with the course and hope that you will find it fascinating and handy.

MODULE 1

Understanding Techniques, Models and Requisites of Economic Planning.

Unit 1: Meaning of models in Economic Planning
Unit II: Rationale and prerequisite for successful planning
Unit III: Categories of development planning models in focus

UNIT 1 Meaning of Models in Economic Planning.

1.1 Introduction

It is expected that you have read the Course Guide. I also assume that you have familiarized yourself with the introductory comments in Module 1. This unit is the first among the three constituent units of this module. The main aim of this unit is to introduce you to the meaning of Models in Economic Planning as a concept; expound its elements and highlight its various types. This unit is fundamental to the understanding of subsequent units and modules. This is simply because other units and modules will be discussed on the basis of the fundamental concepts explained here, hence, requires your maximum attention and understanding.

1.2 Learning Outcomes

At the end of this unit, you should be able to:

- Define what economic planning models are as scholarly established and in your own words.
- Enumerate the elements of development planning models to actual development plan making.
- Identify the types of economic development planning models available.

1.3 What are Economic planning models?

Generally, our focus in this course is to understand the meaning of techniques and models of Economic planning, its applications to achieving set economic development targets of an actual plan, various types of models available for plan making, its importance and usefulness. It is important for you to know that planning is essential in whatever we do both at micro and macro level of human existence. Quantifying what we want to achieve as set targets and how to realize them given the limited resources at our disposal is of paramount importance to even the planning authorities i.e., the government for them to meet up with the set targets of developing the economy using available resources. This can only be done using quantitative equations which expresses relationships among economic variables to explain and predict past and future events under a set of simplifying assumptions known as Model. Planning models have been increasingly used in less developed countries of which Nigeria is one, for the drawing up of plans for economic development. To start with, I consider it important for us to examine what Planning models are all about. I believe this will provide a convenient platform for us to have a full grasp of the entire course content.

Let us begin our understanding of the models of economic planning by first defining the word ‘Models’.

According to Jhingan M.L (2012), a model is mathematical statement that expresses the relationships among economic variables which explain and predict past and future events under a set of simplifying assumptions. In other words, a model consists of a series of equations each of which represents the association among certain variables.
In this sense, a planning model is a series of mathematical equations which help in the drawing up of a plan for economic development. Jhingan M.L (2012).

Krugman and Wells (2006) view an economic model as a simplified representation of reality that is used to better understand real-life situations. Thus, a model is a simplified representation of a real situation. It includes the main features of the real situation which it represents. Although many economic models are developed for purely scientific purposes, others are developed to help individuals, firms and governments make economic decisions and policies.

A model implies abstraction from reality which is achieved by a set of meaningful and consistent assumptions, which aim at the simplification of the phenomenon or behavioural pattern that the model is designed to study. The degree of abstraction from reality depends on the purpose for which the model is constructed. The series of assumptions in any particular case are chosen carefully so as to be consistent, to retain as much realism as possible and attain a 'reasonable' degree of generality.
Broadly, a model may have endogenous and exogenous variables. Endogenous variables are those whose values are determined from within the system such as national income, consumption, saving, investment, etc. On the other hand, exogenous variables are determined from outside the system such as prices, exports, imports, technological changes, etc. A planning model specifies relationships between endogenous and exogenous variables and aims at ensuring the consistency of the proposed plan for economic development. It is also meant to yield an optimally balanced collection of measures known as ‘Model Targets’ which can help the planning authority in the drawing of an actual plan. It is also important to let you know that there are important elements of development model.

Self-Assessment Exercise 1: What is an economic model?

1.4 Elements in Development Planning Model.

The following are the important elements of the development planning models.

- Objectives
- Instrument Variables
- The functional Relationships

Objectives: In a development plan, there should be a focus on what the planning authority is aiming to achieve within the given time frame of the plan. For example, the achievement of a certain rate of growth, a certain level of employment, or a certain balance of payment position should be specified in the plan as dependent variables of the model. Let us consider the Economic Recovery and Growth Plan (ERGP) which aimed at making Nigeria a major player in the global economy by the year 2020. Part of the means of a achieving this objective was to boost local refining for self-sufficiency; reduce petroleum product imports by 60 per cent by 2018, become a net exporter by 2020, save foreign exchange and prevent reversion to the fuel subsidy regime. Therefore, objectives have to be specified by planning authorities in a given economic development plan.

Instrument Variables: Instruments are tools for achieving a set target. Instrument variables are regarded as the policy measures that would be necessary to achieve the objectives. For example, the level of savings and investment in different sectors, the volume of imports and exports to be achieved, the supply of skills or workforce for projects to be built up or acquired, to mention but few, are the principal instrument variables operatives in development planning models. Therefore, let it be known to you that instrument variables are the independent variables of the model and it has to be specified and expressed in the plan.

The functional Relationship: This is the third element in development planning model that shows the relationship between the variables in the form of structural equations of the specified model. The dependent (endogenous) and the independent (exogenous) variables have to be functionally expressed in a related form of structural equations of the specified model. These functional or (casual) relationship would show the responded of the dependent variable when any design or expected change in the independent of variables is specified. These functional relationships are expressed in the form of co-efficient of the model.

Therefore, it is clear to say that in a policy model underlying a plan, the objectives to be achieved would be the dependent variables and given the values of the independent variables i.e. (the policy instruments) and the coefficient, the outcome can be determined or the equations of the system worked out. You will understand this more when discussing different types of planning models.

Self-assessment Exercise 2

Examine the concept of instrument variable.

1.5 Types of Planning Models

Having understood what economic planning models and the elements of development planning models are, it is important for us to discuss the various types of development or economic planning models available. Most development plans have traditionally been based initially on some more or less formalized macroeconomic model. Such economy wide planning model can be divided into three basic categories.

The first category is the aggregate growth, macroeconomic or simple models which involves macroeconomics estimate of planned or required changes in principal economic variables. It deals with the entire economy in terms of a limited set of macroeconomic variables deemed most critical to be determination of levels and growth rates of national

output; i.e., savings, investment, capital stock, exports, imports, foreign aid etc. The model provides a convenient method for forecasting output (and perhaps also employment) growth over a three-to-five-year period. Harrod Domar and two gap models are of this type.

The second category is the multi-sector models. Multi-sector includes input-output, social accounting and computable general equilibrium (CGE) models which ascertain among other things, the production, resources, employment and foreign exchange implication of a given set of final demand targets within an internally consistent framework of inter-industry product flows. It is a sophisticated approach to development planning in which the activities of the major industrial sectors of the economy are interrelated by a means of a set of simultaneous algebraic equations expressing the specific production processes or technology of each industry. All industries are viewed both as producers of outputs and users of inputs from other industries. For example, the agricultural sector is both a producer of output e.g. (wheat) and a user of input from the manufacturing sector e.g. (machinery, fertilizer), therefore there is interdependence of industry which could lead to direct and indirect repercussions of planned changes in the demand for the products of any one industry on outputs, employment, and imports of all other industries can be traced throughout the entire economy in an intricate web of economic interdependent. This inter-industry model can be used to determine intermediate material, import, labour and capital requirements with the result that a comprehensive economic plan with mutually consistent production levels and resource requirements can in theory be constructed.

The third stage or category of planning models is the decentralized models. It is the type that have sector of project level variables which are used to prepare models for individual sectors or projects. This type of models is useful in the early stages of a country's economic development when information is available for only individual sectors or projects, project evaluation or project appraisal social cost benefit Analysis are techniques that fit into this category. The most important component of plan formulation is the detailed selection of specific investment projects within each sector through ay of

the decentralized models. You will be exposed in details to the workings of these models and their co-efficient in subsequent units and modules.

Self-assessment Exercise 3

What are the types of economic planning models?

1.6 Summary

In this unit, we have attempted to show various definitions on models and techniques of economic planning from various scholars of repute. Also, from the point of view of harmonization, you have learnt that all the definitions agreed to the fact that planning model is a series of mathematical equations which help in the drawing up of a plan for economic development. I believe your understanding of this unit has given you a basis for the understanding of the next unit and in fact subsequent modules. I expect you by now to be anxious of reading more about the need and rationale for planning in less developed countries which will be duly served in the next unit.

1.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

Jhingan M.L. (2012): - The Economics of development and planning, Vrinda publications India. (40th Edition).

Michael P. Todaro and Stephen C Smith (2011). Economic development, Pearson education ltd., Edinburgh gate Harlow, Essex, England.

Michael P. Todaro: Development planning, models and methods, Chapter 2-3.

Olajide O.T (2004):_ Theories of Economics development and planning, Lagos, Nigeria, Pumark Nigeria Ltd.

Paul Krugman and Robbin Wells (2006). Macroeconomics. Worth Publishers, New York, USA.

1.8 Possible Answers to Self-Assessment Exercise(s)

Answer to Self-Assessment Exercise 1

According to Jhingan M.L (2012), a model is mathematical statement that expresses the relationships among economic variables which explain and predict past and future events under a set of simplifying assumptions.

Answer to Self-Assessment Exercise 2

Instruments are tools for achieving a set target. Instrument variables are regarded as the policy measures that would be necessary to achieve the objectives.

Answer to **Self-assessment Exercise 3**

- Aggregate growth, macroeconomic or simple models.
- The multi-sector models which include input-output, social accounting and computable general equilibrium (CGE) models.
- The decentralized models. It is the type that have sector of project level variables which are used to prepare models for individual sectors or projects.

Unit 2

UNIT 2: Rationale and prerequisite for successful Economic Planning.

2.1 Introduction

Having familiarized yourself with the explicit explanations in the first unit of this module which discusses what economic planning models are and what it entails. This unit is the second among the three constituents' units of this module. The main thrust of this unit is to show the rationale and prerequisite for successful economic planning, it will also highlight the usefulness and importance of development models to actual economic planning. This unit is also fundamental to the understanding of subsequent units and modules. This is simply because other units and modules will be discussed on the basis of the fundamental concepts explained here, hence, requires your maximum attention and understanding.

2.2 Learning Outcomes

At the end of this unit, you should be able to:

• Show the rationales behind a successful economic planning

- Enumerate the usefulness of development models to actual economic planning.
- Identify the need for planning in Less Developed Countries
- List with relevant examples the requirements for a successful planning in less developed countries of which Nigeria is one.

2.3 Needs for planning in less developed countries

One of the principal objectives of planning in underdeveloped or less developed countries is to increase the rate of economic development. Let us consider the words of Dalton, that economic planning in the widest sense is the deliberate direction by persons in charge of large resources of economic activity towards chosen ends. As you know that LDCs are characterized with low level of savings, low level of income, what is prevalence in such countries are poverty ridden people. This visions economic circle can only be broken by planned development. This can be achieved through importing capital from abroad know as foreign direct investment (FDI) and localized force saving to support the level of industrialization.

Therefore, the rationale and the need for planning arise in such countries to achieve the following.

1. To Increase the Rate of Economic Development.

One of the principal objectives of planning in underdeveloped countries is to increase the rate of economic development. In the words of D.R. Gadgil, "Planning for economic development implies external direction or regulation of economic activity by the planning authority which is in most cases, identified with the government of the state." It means increasing the rate of capital formation by raising the levels of income, saving and investment. But increasing the rate of capital formation in underdeveloped economies is beset with a number of difficulties.

To remove market imperfections, to mobilise and utilise efficiently the available resources, to determine the amount and composition of investment, and to overcome structural rigidities, the market mechanism is required to be perfected in underdeveloped countries through planning.

2. Strengthen and Improve the Market Mechanism

The market mechanism works imperfectly in LDC because of the ignorance and unfamiliarity with it. This is so because the production factor, money and capital markets are not organized properly, thus the price system fails to bring about adjustments between aggregate demand and supply of good and services. Therefore, to remove market imperfection, to mobilize and utilize efficiently the available resources, to determine the amount and composition of investment and to overcome structural rigidities, the market mechanism is required to be perfected in LDCs through planning Using a workable planning model.

3. The Necessity of Removing Unemployment.

Unemployment is a situation where resources are not fully utilized. Capital is scarce and labour is in abundance thereby creating the problem of providing gainful employment and resulting in absence of sufficient enterprises and initiatives. This required an urgent attention by the planning authority in LDCs to immediately adopt a planning model that can salvage the situation.

4. The Development of Agricultural and Industrial Sectors.

Agricultural sector is known to produce food for household, raw materials for industries and foreign earnings to government when exported abroad. Industrial sector on the other hand utilizes the raw materials from the agricultural sector for the production of further finished goods that can be used for infrastructural development like roads, railways, power stations etc. Therefore, there should be a conscious attempt by the LDCs planning authority to have a road map planning model towards the development of their agricultural and industrial sector.

5. The Necessity of Removing the Nations Poverty.

The need for reducing inequalities income and wealth raising per-capital income, increasing employment opportunities, all round rapid development and national independence substance requires a careful ad conscious idea of planning targeted through

a planning model that can achieve this. This was seen in the rapid development and transformation of USSR, a poor country at the time of October revolution.

To sum this up, in the words of professor Gadgil, Planning for economic development is undertaken presumably because the pace of direction of development taking place in the absence of external intervention is not considered to be satisfactory and because it is further held that appropriate external intervention will result in increasing considerable the pace of development and directly it properly.

6. Development of Infrastructure.

The agricultural and industrial sectors cannot, however, develop in the absence of economic and social overheads. The building of canals, roads, railways, power stations, etc., is indispensable for agricultural and industrial development. So are the training and educational institutions, public health and housing for providing a regular flow of trained and skilled personnel. But private enterprise in underdeveloped countries is not interested in developing the social and economic overheads due to their unprofitability. It is motivated by personal gain rather than by social gain. It, therefore, devolves on the state to create social and economic overheads in a planned way.

Self-Assessment Exercise 1

Enumerate and briefly explain five needs for planning in less developed countries.

2.4 Usefulness of Development Models to Economic Planning.

By now, the relevance of development models to problem of economic planning must have been clear to you.

The following are the usefulness of development models to economic planning.

a. It provides a framework for checking of consistency or the optimality of the official plan targets.
b. It provides a framework for the actual setting of targets.
c. It provides a framework for the evaluation and selection of projects.
d. It provides an insight into the structure of the economy and its dynamics to help better policy decisions.
e. It assists in budget and budgeting control.
f. It helps the preparation of feasible plan.
g. It helps the projection and forecasting of measurable changes.
h. It helps in adjusting competing participants within available time path
i. It helps the planning authorities to know their objectives, instrument variables and the functional relationship of the variables in the desired plan and how to achieve it.
j. It gives the planner a clear direction to follow on a projected economic plan.

Self-Assessment Exercise 2

Briefly explain five relevance of development models to economic planning in Nigeria.

2.5 Requirements for a successful planning.

The formulation and success of a plan requires the following

1. Planning Commission: The first pre-requisite for a plan is the setting of a planning commission which should be organized in a proper way and should consist of experts like economist, statistician, mathematician, engineer, etc. to deal with various aspects of the economy. In Nigeria, it is called National Planning Commission.

2. Statistical Data: A prerequisite for sound planning is a through survey of the existing potential resources of a country together with its resources. To have a successful planning in a country statistical data and information with regard to the available material, capital and human resource are needed.

3. Objectives: There must be a clear objective of what the plan aims at achieving. The objectives might be to increase national and per capital income, to expand employment opportunities, to reduce inequalities of income and wealth, to raise agricultural production or to industrialize the economy etc to mention but few.

4. Fixation of Targets and Priorities: One of the Major requirements for successful planning is to fix targets and priorities well for achieving the objectives laid down in the plan. These targets should be global and sectoral. Priorities should be laid down on the basis of the short and long terms need of the economy keeping in view the available resources.

5. Incorrupt and Efficient Administration: It should be known to you that an incorrupt and efficient administration is a strong determinant of successful planning. This however is lacking in most less developed countries. Competent administrative staff should be appointed into various ministries which should first prepare good feasibility reports of proposed projects before embarking on them. Therefore, the secret of successful planning lies more in sensible politics and good administration.

6. Balancing in the Plan: A plan should ensure proper balance in the economy, otherwise shortages or surpluses will arise as the plan progresses. There should be balance between saving and investment, between the available supply of goods and the demand for them, between manpower requirements and their availabilities, and between the demand for imports and the available foreign exchange.

7. Mobilisation of Resources: A plan fixes the public sector outlay for which resources are required to be mobilised. There are various internal and external resources for financing a plan. The plan should lay down such policies and instruments for mobilising resources which fulfil the financial outlay of the plan without inflationary and balance of payments pressures. At the same time, they should encourage corporate and household savings of the private sector.

2.5.1 Problems of Development Planning

Development planning has to face the following problems:

1. Inadequate Statistical Data: One of the major problems of development planning has been the inadequacy of statistical data concerning all aspects of the economy. There are gross errors in the estimation of accurate data in many fields of the economy, such as population, capital, labour, employment, input, output, coefficients, exports and imports, etc.

2. Limitations of the Use of Models: Another problem is the use of models mostly of the Tinbergen type. These models require specific targets and instruments to attain stated objectives. These objectives have to be made in some kind of index and there have to be as many instruments as there are independent targets. This is a complex process and also misleading, as the plan is often a political document of the ruling party. Further, targets and instruments are not really separable as in the case of taxation, exchange rates, etc., though they change in the process of planning.

3. Absence of Control over Private Sector Plan: A development plan provides for schemes of allocations for both public and private sectors. Since the government is not in a position to fully control the private sector, the plan relating to the private sector is never implemented as per the physical targets and financial allocations. This creates problems for the success of the plan.
4. Lack of Coordination between Plan Policies and Annual Budgets: There are many institutional rigidities and scarcities in underdeveloped countries which lead to lack of

coordination between plan policies and annual budgets. Consequently, the annual budget does not reflect and implement the plan policies. This is a serious problem of development planning.

5. Uncertainties: A development plan faces many uncertainties which make it difficult to implement it. These may arise due to foreign exchange crisis or balance of payments problem, unreliable statistical data, inflationary pressures, international recession, internal unrest, disputes with neighboring countries, etc. Such uncertainties create problems in plan implementation.

Self-Assessment Exercise 3

Discuss at least four requirements for a successful planning in a nation.

2.6 Summary

In this unit, we have attempted to show the need for planning in Less Developed Countries of which Nigeria is one, Usefulness of development models to actual economic planning and the requirements for successful planning. From the point of view of harmonization of all these rationales, you have learnt that all these are a good model road map for a successful economic planning and development. I believe your understanding of this unit has given you a basis for the understanding of the next unit and in fact subsequent modules. I expect you by now to be anxious of reading more about the categories of development planning models in focus which will be duly served in the next unit.

2.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

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2.8 Possible Answers to Self-Assessment Exercise(s)

Answer to Self-Assessment Exercise 1

Students should briefly be able explain the followings:

- To Increase the Rate of Economic Development.
- Strengthen and Improve the Market Mechanism
- The Necessity of Removing Unemployment.
- The Development of Agricultural and Industrial Sectors.
- The Necessity of Removing the Nations Poverty

Answer to Self-Assessment Exercise 2

Students should be able to explain the followings:

- It provides a framework for checking of consistency or the optimality of the official plan targets.
- It provides a framework for the actual setting of targets.
- It provides a framework for the evaluation and selection of projects.
- It provides an insight into the structure of the economy and its dynamics to help better policy decisions.
- It assists in budget and budgeting control.

Answer to Self-Assessment Exercise 3
Students are expected to explain the followings:

- Planning Commission
- Statistical Data
- Objectives
- Fixation

Unit 3

Unit 3: Categories of Development Planning Models in Focus

3.1 Introduction

In our discussions so far with what planning models is all about, the rationale and problems of planning, there is need for us to look critically at the categories of planning models and its broad explanation using available quantitative growth models. In this wise, we shall again be considering explicitly, aggregate or macroeconomic models, sectoral and sub-sectoral models and the inter-industry models of development planning. I will advise that you carefully follow the explanation for easy assimilation of the contents in this unit. This unit is the third among the three constituents' units of this module. The main thrust of this unit is to show the explicit explanation of development planning models categories using algebraic and numerical notations for its explanations. Hence it requires proper concentrations

3.2 Learning Outcomes

At the end of this unit, you should be able to:

- Show the quantitative workings of some growth models
- Do some quantitative workings on aggregate or macroeconomic models.
- Do some quantitative workings on sectoral and sub-sectoral models
- Show some quantitative workings on the inter-industry models.

3.3 Aggregate or macroeconomic or simple models

In the earlier unit, this model was not explained in detail, but that will be done in this unit. As the name implies, this type of models tries to provide solutions to the development problems in terms of such aggregative variables like consumption, investment, savings, imports, exports, labour supply, balance of payment, etc. which you are familiar with in macroeconomic theory as macroeconomic variables. They are also regarded as simple in the sense that the complexities involved in sectoral distribution of resources are done away with. Such macro models are usually used to determine the value of the instrument variables when the target rate of growth of national output is given. In the exercise, the constraints such as the availability of foreign exchange skilled labour, taxable capacity, etc. may also be specified. A good example of this category of planning model is the Harrod Domar model which shows the determination of the relationship among the aggregative variables such as savings, investment, labour and capital productivity rate of growth of population, etc. which will determine the overall growth rate of the economy.

In the absence of economic planning in the LDCs, the independence or natural growth rate may be so slow to result to near stagnation prevalence situation. The task of the planners is therefore to intimate and influence the aggregative instrument variables in these economies and to ensure that the growth rate gets accelerated to a satisfactory and desired target.

Let us now consider the Harrod-Domar model. According to the model, the growth rate of an economy is determined by the level of net capital formation and its productivity. Although, the net capital formation in LDCs is constrained by the amount of savings available, savings are a function of the level of income and productivity of capital is ascertained from the overall or the global capital output ratio.

Thus, if

$s = S/Y$ (The saving/ income ratio)

$k = I/\Delta Y$ (The Incremental Capital Output ratio)

(The growth rate of national income)

$$g = s/k = \frac{S/Y}{I/\Delta Y}$$

$$= S/Y \times \Delta Y/I$$

$$= \Delta Y/Y = S = I$$

Then, if I = S i.e., Investment equals savings

$\Delta Y/Y = S/Y \times I/\Delta Y = S/Y \times Y/I = (\Delta Y/Y = S = I)$

$g = s/kI$. This is the growth equation of Harrod Domar Model.

In the above analysis, it shows that given the values of S and K and assuming them to be constant over the plan period, the growth rate of the economy would be determined by the ratio s/k. When a near stagnant LDC starts its process of planned economic development, it saves 5 – 6% of its national products. That was in fact the case when Nigeria first 5-year plan was launched in 1962, the process of its planned economic development saved about 5.6% of its national product. The (ICOR) Incremental capital output ratio of such an economy may be between 2% & 4%; Thus, if the value of S is

assumed to be 6% (0.06) and that of K = 3% (0.03),

Then growth rate = $\Delta Y/Y = 0.06/3 \times 100 = 2\%$

For instance, if the annual growth rate of population ($\Delta p/p$) is also 2%, we will therefore have $\Delta Y/Y - \Delta p/p = 0$

This implies that the growth of per capita income would be zero. I want you to know that it is here planning model would realize that if no effort is made to change the variable of the system suitably, there would be hardly any improvement in economic welfare and standard of living of the people. While using this model for plan formulation, it is natural that changes would have to be made in the strategic variables so as to produce a plan which would make some visible impacts on the standard of living of the people.

Self-Assessment Exercise 1

Examine the concept of macrocosmic variables

3.4 Sectoral and sub-sectoral model of development planning.

The macroeconomic models provide only the first approximations to the problems of plan formation. They yield the broad aggregative targets and the values of the aggregative instrument variables. However, in order to make the plan an operational document, sectoral models are presented.

The sectoral models may be Single Sector Project Model (SSPM) or complete main sector planning models (CMSP).

a. In the case of the former, (SSPM) plan formulation starts from the project levels. Individual projects are appraised for inclusion in the plan and thus, the aggregative requirements of the plan are built up through the summation of projects. For instance, if the saving, investment, imports and skill requirements of all appraised projects come to an aggregative figure that is not feasible or difficult to achieve, some projects are excluded. Such an approach was followed in Nigeria and few other developing countries in their earlier plan. Although, such models are capable of producing an internally consistent and coordinated plan but the danger is that they may yield a plan which is only a collection of sundry projects.

b. The Complete Main-Sector Planning (CMSP) Models, are some sophisticated forms of sectoral models, which divide the whole economy into a few main or broad sectors, such as public and private sectors, consumption and investment goods sectors, domestic and exports sectors, agricultural and none agricultural sectors, etc. The investment skills, foreign exchange requirements etc, are worked out for each main sector and consistent targets are set for each of them.

The analysis that follows is a presentation of a simple main sector planning models.

Simple Main Sector Model: In a simplified main sector model, one can suppose that the entire economy is sub-divided into two main sectors, namely (i) the consumption goods sector and (ii) the investment goods sector.

The two sectors have a total product function, which is represented with X1 and X2

Where;

X1 = the total product of the consumption goods sector.

X2 = the total produced of the investment goods sector and

GDP = the Gross Domestic Product of the economy.

C = denotes the marginal (and average) propensity to consume.

S = denotes the propensity of save (and closely related to investment thus, S = I (I – C)

From the equations, a summation of X1 and X2 results to the Gross Domestic Product of the economy.

Thus, X1 +X2 = GDP and if X1/X2 = C/ I – C and C = 0.6, then 0.6/0.4 = 3/2.

Now, if the value of C remains constant during the plan, the outputs of the two sectors will grow at these relative rates 3/2. Consequently, the planner would try to lower the value of C, so that by saving more, the investment goods sector could grow at a faster rate.

For example: lowering the value of C would imply.

(1). C/1 – c and C = 0.6 then x1/x2 = 0.6/0.4 = 3/2.

(2). C/1-c and C = 0.5 then = x1/x2= 0.5/0.5 =1

(3). C/1 –c and C = 0.4 then = x1/x2 = 0.4/0.6 = 2/3.

Meaning that, the planner would require in the third example, 2 units in total product of consumption goods sectors to obtain 3 units in investment goods sector.

Self-Assessment Exercise 2

Distinguish between Single Sector Project Model (SSPM) and Complete Main Sector Planning models (CMSP)

3.5 The Inter-Industry Models:

You may have heard about the input-output technique which will be elaborately discussed in the next module. The inter-industry models make use of the input-output technique and some of them make use of even linear programming.

As it will be observed in the next module, the input- output table gives a synoptic view of the inter-industry relations and transaction. It is however, necessary for building up input-output tables that two conditions are satisfied as pre –requisites, these are:

i. That a country should have developed at least a few manufacturing industries, so that the inter-industry transactions are quite substantial.

ii. That sectoral data should be available so as to facilitate the construction of input – output tables. Thus, only those LDCs satisfying these conditions should rely upon inter – industry models in their plan formulation.

Whenever it is practicable to build inter – industry models (using input-output technique), these turn out to be the most elaborate ones and can be really termed as multisectoral models. The entire economy is divided into as many sectors or industries for as many as the requisite data can be mustered.

3.5.1 The Static Planning Model:

Let us look at a static planning model of this type. The objective of such a model may be to ensure consistency among sectoral output at a future date, say, end of the five years plan period, (4+x). Using the input – output technique which you will be familiar with

and its table happens to be the centre piece. If you look at table that will be presented, you will notice that each sectoral row gives a relationship of this type.

$$X1 = \sum xij + X1C + X1l + X1X$$

Where:

X1 = total output of section i

$\sum$ Xij = is the total delivery of goods from i sectors

J =1 (which are 4 in number)

X1C = use of sector's output for consumption.

X1l =use of sector's output for investment and

X1 = exports of i sector's output.

Such a disposal of sectorial outputs can be expressed for all the n sectors that would be there in a table.

Now, as stated above, if the objective of constructing such a model is to ensure consistency in sectoral outputs in a target year (t + x), we can proceed like this.

- Given that the input coefficients of different sectors are already known (from the input output table of the base year).
- The deliveries of goods from one sector to the other can be related in the year as follows

  Xij = aijXj

  Where

  aij is the input coefficient of j sectors and expresses the unit of i goods needed to produce one unit of j goods.

  Now, $\sum$xaij + X1C + X1lX1X (l = 1.2 ……. n) …. (iii) j

  = i

  Equation (ii), therefore, shows that if X1C, X1l and X1X are exogenously (independently) determined, then the output of sectors i needed for inter industry deliveries (Xij) in year t+x can also be determined. This equation, therefore, becomes a system of n simultaneous equations (each equation for a sector) in n unknown variable which can be solved. With the help of such a static

model, the planner can explicitly lay –down production targets in such industry and sectors. Other models like the input output model, social accounting matrix and computable general equilibrium model will be explicitly discussed in the next modules.

Self-Assessment Exercise 3

What are the conditions that need to be satisfied to build an input-output table?

3.6 Summary

In this unit, we have attempted to show the categories of development planning models comprising Aggregate or macroeconomic or simple models, Sectoral and sub-sectoral model of development planning and the Inter- industry Models of development planning. You have learnt that all these models are useful and important in making a viable road map for a successful economic planning and development. I believe your understanding of this unit has given you a basis for the understanding of the next unit and in fact subsequent modules. I expect you by now to be anxious of reading more about the input-output analysis which will be critically treated in the next module.

3.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

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2.8 Possible Answers to Self-Assessment Exercise(s)

Answers to Self-Assessment Exercise 1

This type of variables tries to provide solutions to the development problems in terms of such aggregative variables like consumption, investment, savings, imports, exports, labour supply, balance of payment, etc.

Answers to Self-Assessment Exercise 2

In the case of the former, (SSPM) plan formulation starts from the project levels. Individual projects are appraised for inclusion in the plan and thus, the aggregative requirements of the plan are built up through the summation of projects. While the Complete Main-Sector Planning (CMSP) Models, are some sophisticated forms of sectoral models, which divide the whole economy into a few main or broad sectors, such as public and private sectors, consumption and investment goods sectors, domestic and exports sectors, agricultural and none agricultural sectors, etc.

Answers to Self-Assessment Exercise 3

i. That a country should have developed at least a few manufacturing industries, so that the inter-industry transactions are quite substantial.

ii. That sectoral data should be available so as to facilitate the construction of input – output tables. Thus, only those LDCs satisfying these conditions should rely upon inter – industry models in their plan formulation.

MODULE 2

Input- Output Analysis in Planning

Unit 1: Meaning of Input-Output technique
Unit 2: Input –Output model
Unit 3: Uses, Limitations and importance of input-output analysis to planning

Unit 1: Meaning of Input-Output Technique

1.1 Introduction

Our discussion in the first module of this course was too general and aggregative in nature. Similarly, we referred to the necessity of a plan being consistent; therefore, our task in the present module would be to look at the process of plan formulation at a somewhat disaggregated level. For the above reasons, we shall familiarize ourselves with the methods that are usually adopted at the operational level to make physical as district from financial targets of the plan consistent with each other, so that both surpluses and shortages could be avoided. It is therefore intended to introduce you to what input-output analysis in plan programming is all about, it's essential feature, assumptions and its usefulness and importance in planning.

1.2 Learning Ouncomes

At the end of this unit, you should be able to:

- State what input-output technique is all about.
- Show the essential features of input –output technique.
- Highlight the assumptions of the input –output technique.

1.3 What is input-output technique?

Input–output analysis is the name given to an analytical framework developed by Professor Wassily Leontief in the late 1951, in recognition of which he received the Nobel Prize in Economic Science in 1973.

It is a technique used to analyse inter-industry relationship in order to understand the inter dependencies and complexities of the economy and thus the conditions for maintaining equilibrium between supply and demand. It is also known as inter-industry analysis. According to Michael P. Todaro and Stephen C. Smith (2011), Input-output is defined as a formal model dividing the economy into sectors and tracing the flows of inter industry purchases (input) and inter industry sales (output).

Before analysing the input-output method, let us understand what the terms input and output means. Raa, T.T. (2009) views input as that objects or material which is demanded by the entrepreneur or producer for the purpose of production and output, is the result or outcome of the productive effort. Thus, input is that object which is purchased with a view to use it in an enterprise where as the output is things made and sold by the entrepreneur. Thus, the input is the expenditure of the firm and output is its income.

In short input-output analysis is a technique for analyzing inter-industry relations and interdependence in the entire economy because input on one industry is the output of other. The major share of the economic activity is involved in the production of intermediate goods or inputs, goods that are output for one industry but are again employed as input for further production by another industry. In this way it is a cyclical

process following incessantly among many industries. In short it can be said that in an input-output analysis, in a state of perfect equilibrium, the monetary value of the total output of an economy must be equal to the monetary value of all the inputs and outputs of all the industry taken together.

The quantitative step by step of this analysis shall be considered and discussed in the subsequent unit of this module.

Self-Assessment Exercise 1

Who develop the input-output analysis?

1.4 **Essential features of input-output technique**.

Features as you know are related to the characteristics of a particular thing under observation. The main features of the input-output analysis are

i. The analysis applies to an economy that is in equilibrium and economy with partial equilibrium falls outside its sphere.

ii. The technique bears no relationship with demand analysis because its sole function is to analyse and consider the technical problems of the production.

iii. The analysis is based on empirical study.

iv. Input output analysis has two parts first, constructing an input-output table and second making systematic use of the input-output model.

Self-Assessment Exercise 2

Highlight two features of input-output technique.

1.5 **Assumptions of the input-output technique**.

This analysis is based on the assumptions highlighted as follows:

1.5.1 The economy is in perfect equilibrium

1.5.2 The total economy is divided into two sectors i.e., inter- industry sector and final demand sector both sectors can be further sub-divided.

1.5.3 The total outputs of any inter- industry sector are generally capable of being used as inputs by other inter- industry sectors, by itself and by final demand sectors.

1.5.4 Every industry produces only one commodity and no two products are produced jointly.

1.5.5 Prices, consumer demands and factors supplies are given.

1.5.6 Production follows the law of constant return to scale.

1.5.7 There are no external economies or diseconomies of production.

1.5.8 The combinations of inputs are employed in rigidly fixed proportions.

1.5.9 The inputs remain in constant proportion to the level of output.

1.5.10 There is no substitution between different materials and no technological progress.

1.5.11 There are fixed input coefficients of production.

Self-Assessment Exercise 3

Highlight any two main assumptions of input-output technique.

1.6 Summary

In this unit, we have attempted to show the meaning of input-output technique, covering what is input-output technique is all about, showing the essential features of input –output technique and highlighting the assumptions of the input –output technique. You have learnt that input-output model is also known as inter –industry model which rely solely on available industries for its workability. Your understanding of this unit i expect should encourage you to be familiar more with the topics in this module as you read ahead against the next unit.

1.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

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1.8 Possible Answers to Self-Assessment Exercise(s)

Self-Assessment Exercise 1

Professor Wassily Leontief in the late 1951

Self-Assessment Exercise 2

The analysis applies to an economy that is in equilibrium and economy with partial equilibrium falls outside its sphere.

Self-Assessment Exercise 3

- The economy is in perfect equilibrium
- The total economy is divided into two sectors i.e., inter- industry sector and final demand sector both sectors can be further sub-divided.

UNIT 2

Input-Output Model.

2.1 Introduction.

It is good that we have familiarized ourselves with what input-output analysis, technique or model is all about in the preceding unit which provides a basic foundational platform that we shall be looking at in this unit. In this unit, we shall be looking at the input-output model table, feasibility and consistency of the plan, input-output coefficients, the Leontief solution, the dynamic input- output model. An in-depth explanation of the above topics shall be provided. It is advisable that you critically concentrate as we move along with explanations that will be given.

2.2 Learning Outcomes

At the end of this unit, you should be able to:

- Interpret, draw and decode the input-output table.
- Understand the Feasibility and consistency in planning.
    - Understand the Matrix of technical coefficient of production calculations and the Leontief solutions.

2.3 Input –Output Table

Leontief's analysis is based on the assumptions outlined above. In this economy, it is presumed that the output of one industry is an input for another. Consequently, there are clear inter-industry relationships and interdependencies in the economy because of these inter-relationships the total demand and supply of the economy are in equilibrium. This can be explained with the following example:

Suppose there is three-sector economy. Among these agriculture and industry combine to form the inter industry sector while the house hold sector is the final demand sector. The following table provides a simplified form of this economy.

Table 2.1. Input-Output Table.

(In value terms) ("m")

Sector	Input to Agriculture	Input to Industry	Final Demand	Total Output or Total Revenue
Agriculture	25	175	50	250
Industry	40	20	60	120
Household	10	40	0	50
Total Input or Total Cost	75	235	110	420

In the above table the total output of the three sector is shown in rows and their inputs in columns. The total of the first raw is 250 million out of which 50 are used for final consumption and the remaining output become the input of the other two sectors (175 to industry and 25 to agriculture). Similar is the case of industry. A column wise study will

reveal the cost structure of these sectors. The first column is concerned with the cost-structure or inputs of agriculture. Agricultural output worth 250 million is made possible by the use of units worth 25, 40 and 10 million respectively from each of the three sectors. The zero finger in the third column indicates the fact that the household sector is a simply spending sector that does not sell anything to itself.

In general, the above table can be written as follows

Table 2.2: Input-Output Table

		PURCHASING SECTOR			
SELLING SECTOR		S1	S2	FINAL DEMAND	TOTAL OUTPUT
	S1	X_{11}	X_{12}	D_1	X_1
	S2	X_{21}	X_{22}	D_2	X_2
	S3	X_{31}	X_{32}	0	X_3

where $X1 = x11 + x12 + D1$, $X2 = x21 + x22 + D2$, $X3 = x31 + x32$.

Self-Assessment Exercise 1

Using different symbol construct an input-output table indicating a three sector inter industry flow of a three-sector economy.

2.4 Feasibility and Consistency in Planning.

It should be noted that a plan should have a level of feasibility and consistency for it to survive. An economy behaves and assumes a certain pattern of flows of resources in two ways which are:

2.4.1 The internal consistency or balance of each sector of the economy i.e., survival within the economy.

2.4.2 The external stability of each sector or inter- sectoral relationship i.e., survival outside the sector. This according to Leontief is regarded as fundamental relationship of balance and structure. It is also known as balance equations and structural equation when

expressed mathematically. If the total output of say xi of the ith industry is divided into various number of industries, 1,2,3, n, then we have the balance equation: xi = xi1 + xi2 + xi3 + ------ xin +Di ---------- (1)

and if we take into consideration, the amount says yi absorbed by the outside sector, the balance equation of the ith industry becomes.

$Xi = xi1 + xi2 + xi3 + \text{-------} xin + Di + Yi$

OR

$\sum xij + Yi = xi$ .....(2). $J = i$

It is to be noted that Yi stands for the sum of the flows of the products of the iyh industry, to consumption, investment exports and net of imports etc. It is also called the –final bill of goods which is the function of the output to fill. The balance equation shows the conditions of equilibrium between demand and supply. It shows the flows of outputs and inputs to and from one industry to other industries and vice versa.

Let it be known to you that the system of balance equations in the analysis presents the conditions of internal consistency of a plan. The plan would not be feasible without them because if these equations are not satisfied, there might be excess of some goods and deficiency of others. Since xi2 stands for the amount absorbed by industry 2 of the ith industry, it follows that xij stands for the amount absorbed by the jth industry of ith industry. Thus the –input or technical coefficient‖ of the ith industry is denoted by: $aij = \frac{xij}{Xj}$ --------(3)

Where xij is the flow from industry I to industry j, xj is the total output of industry j and aij as already indicated above as a constant called technical coefficient shows the number of units of one industry's output that are required to produce one unit of another industry's output.

Equation (3) is called a structural equation which tells us that the output of one industry is absorbed by all industries so that the flow structure of the entire economy is revealed.

Self-Assessment Exercise 2

What do you understand by consistency in planning?

2.5 Matrix of Technical Coefficient of Production.

The matrix of technical coefficient of production for any input -output table with (n) sectors would consist of nxn elements. In our example, there are two sectors, which means a 2x2 technical coefficients of the matrix would be arranged symbolically as follows. Look at the table below

Table 2.5.1 Technology Matrix A.

Agriculture	Industry	
Agriculture	a11	a12
Industry	a21	a22

If we use equation (3) to calculate the aij for our example of the above two sector input- output table in 2.1, we will get the following technology matrix.

Table 2.5.2 Technology Coefficient Matrix A

Agriculture	Industry	
Agriculture	50/300 =.17	150/500 =.30
Industry	100/300 =.33	250/500 =.50

To get these input coefficients, we will divide each item in the first column of table 2.1 by its row total, and each item in the second column by the second row and soon. You should understand that each column of the technological matrix reveals how much agricultural and industrial sectors require from each other to

produce *n* Naira's worth of agricultural output requires inputs worth 33 kobo from industries and worth 17 kobo from agriculture itself.

2.5.3 The Leontief Solution

This is a solution that can be used to measure the direct and indirect effects on the entire economy of any sectoral change in total output of final demand. For the purpose of elaborate explanation, the above table can be utilized to measure these effects. We have the following.

Again, using equation

(3) aij =xij/xi

When you cross multiply, we will have xij =aij. Xi

By substituting the value of xij into equation (2) and transposing terms, we will obtain the basic input – output system of equations as follows.

$$x_i - \sum_{i=1}^{n} a_{ij} x_i = Y_i$$

In terms of our two –sectors economy, there would be two linear equations that could be written symbolically as follows.

$$X_1 - a_{11} x_i - a_{12} x_2 = Y_1$$

$$X_2 - a_{21} x_1 - a_{22} x_2 = Y_2$$

The above symbolic relationship can be shown in matrix form as follows

$$X - [A]X = Y$$

$$X[I-A] = Y$$

Where matrix (I-A) is known as the Leontief matrix

$$(I-A)^{-1}(I-A)\, X = I(I-A)^{-1}Y$$

$$X = (I - A)^{-1} Y \; [\, (I - A)^{-1} (I - A)]$$

Thus, we can have the identify matrix as follows i.e.

$$I_{nan} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Hence, [X1] = [1 0] –[A]-1 [Y1]

[X2] = [0 1] -[Y2].

Therefore, to have a numerical solution, we will make use of our technology matrix table 2.3 thus

A = [.1.3] and Y = [100]

[.3.5] [150]

(I –A) = [.9 -.3]

[.3 -.5]

The value of inverse = Adjoint/Determinant = Adj/ [A]

[Aij] = [.5 .3]

[.3 .9]

By transposing we will have:

Aij = [.5 .3]

[.3 .9]

The value of determinant will now be

=.9(.5) – (-.3) (-.3)

=45 -.09 =.36

Hence [X1] = 1/.36 [.5.3] [100]

[X2] [.3.9] [150].

Thus, the total of agricultural sector (x1) will be equal to

=.5x100 +.3x150 /.36 = 264.

The total output of industrial sector (x2) as well will be

=.3x100 + .9x150/.36 = 458.

Self-Assessment Exercise 3

Explain your understanding of the Leontief solution using any numerical values for your explanations.

2.6 Summary

In this unit, we have seen the input-output technique table `, the Feasibility and consistency in planning and the Matrix of technical coefficient of production calculations and the Leontief solutions.

You have learnt the workings of input-output model using matrix algebra. Your understanding of this unit will usher you into the next unit which discuss the uses, limitations and importance of input-output technique to economic planning. I expect you to read ahead against the next unit.

2.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

Jhingan M.L. (2012):- The Economics of development and planning, Vrinda publications India. (40th Edition).

Michael P. Todaro and Stephen C Smith (2011). Economic development, Pearson education ltd, Edinburgh gate Harlow, Essex, England.

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Paul Krugman and Robbin Wells (2006) Macroeconomics. Worth Publishers, New York, USA.

Thijs Ten Raa (2009) Input-Output Economics: Theory and Applications: Featuring Asian Economies, World Scientific, Netherlands.

2.8 Possible Answers to Self-Assessment Exercise(s)

Self-Assessment Exercise 1

Replace the symbol in Table 2.2 with the symbol of your choice

Self-Assessment Exercise 2

Consult the literature and provide to this exercise

Self-Assessment Exercise 3

Follow the explanation in 2.5.3 to answer this exercise

UNIT 3

Uses, Limitations, and Importance of Input-Output to Planning.

3.1 Introduction

In this unit, attention will be given to the uses of input- output analysis technique in planning, limitations of the input- output technique to planning and the importance of input-output technique to the planning of less developed countries like Nigeria.

3.2 Leaning Outcomes

At the end of this unit, you should be able to:

- Know the uses of input-output analysis in plan formulations.
- Highlight the limitations and problems of input-output analysis.
- Understand the significance of input-output model in development planning as listed by the United Nations.

3.3 Uses of input-output models in development planning formation.

The following are the uses of input-output analysis.

1. They provide sub-sectoral estimates of production and import levels that are consistent with each other and with that of the final demand.
2. The solution to the model aids in the allocation of the investment required to achieve the production levels in the programme and it provides a more accurate test of the adequacy of available investment resources.
3. Since inputs are considered proportional to outputs, this technique helps in determining the amount of inter-industry flows of goods and services in less developed countries.
4. It helps in reducing the need for collecting and computing vast statistical data since constant flow and capital coefficients has been assumed.
5. It helps the planner to see more clearly the implications of raising the level of investment in a particular sector given the requirements of inter-sectoral balancing.
6. It is also used for national economic planning of a nation.
7. It provides the necessary information about the structural coefficients of the various sectors of the economy during a period of time which can be utilized for the optimum allocation of the economy's resources towards a desired end.
8. The dynamic model is particularly helpful in a developing economy to determine the impact of different growth rates of the various sectors of the economy and thus choose the most desired one.

Self-Assessment Exercise 1

Mention at least seven uses of input – output model to economic development planning of a nation.

3.4 Limitations and problems of input - output Analysis.

Any mode, no matter how reliable and useful, it is having its own limitations or short comings. Input-output model as well is not an exception. The following are the limitations and short comings or problems of input-output model.

- The framework of input-output analysis is based on Leontief's basic assumption of constant input co-efficient of production and constant returns to scale; and technique of production only holds good in a stationary economy with zero technological progress.
- It does not take into account, the dynamism of inter-industry analysis.
- It remained silent on how technical coefficients would change in a situation of changed conditions.
- The variation in capital requirements of industries makes the assumption of constant co-efficients of production unrealistic.
- The assumption of fixed co-efficients of production ignores the possibility of factor substitution.
- The assumption of linear equations, which relates outputs of one industry to inputs of others, appears to be unrealistic, since factors are mostly indivisible, increase inputs.
- The input-output model cannot reflect increasing costs due to its rigidity bottlenecks.
- Due to its restriction on production side of the economy, the technique remained silent as to why the inputs and outputs are of a particular pattern in the economy.
- It fails to utilize all the factors proportionately or need more than their available supply.
- There is no mechanism for price adjustment in the input-output analysis which makes it unrealistic.
- The input-output model thrives on equations that cannot be easily arrived at

therefore making it difficult and abstract.

- Large reliable data are not always available in many less developed countries to construct input-output table.
- In smaller countries, only few industries or sectors exist and the input-output table is of little use.
- In case of a subsistence agricultural sector, labour is the only input, and output sold in the market sectors is insignificant while commercial crops are sold to the consumption sector which does not need the input-output table.
- It is only useful in a large economy where the number of industries or sectors is large for inter industry transactions to take place and for reliable statistical information to be available.

Self-Assessment Exercise 2

Enumerate the problems or limitations of input -output analysis known to you.

3.5 Significance of Input-output Models in Development. Planning As Listed by United Nation's Studies.

The United Nations identified and listed some significance of input -output models in development planning. These are highlighted below.

1.The U.N. posits that the analysis of import requirements and substitution possibilities is facilitated by the knowledge of the use of domestic and imported material in different branches of the economy.

2. The U.N stated that, in addition to direct requirements of capital, labour, and imports, the indirect requirements in other sectors of the economy can also be estimated.

3. Another major significance of input / output models in development planning as posited by the United Nations study was that they provide for individual branches of the economy's estimates of production and import levels that are consistent with each other and with the estimates of final demand.

4. The U.N also highlighted that the solution to the model aids in the allocation of the investment required to achieve the production levels in the programme and provides a more accurate test of the adequacy of available investment resources.

5. The requirements for skilled labour can be evaluated for planning purposes to explore the implications of development programmes for the particular region concerned as well as for the economy as a whole.

7. They are primarily applicable in economics that have achieved a certain degree of industrial development and thus have a substantial volume of inter industry transactions.

8. They are significant and useful for national economic planning.

3.6 Summary

In this unit, we have examined the uses of input- output analysis technique in planning, limitations or problems of the input- output technique to planning and the importance of input-output technique to the planning of less developed countries as listed by the United Nation. It can therefore be concluded that input-output analysis is significant and useful for national economic planning. I strongly believe that your understanding of this unit and module will usher us into the next module which discusses the Social Accounting Matrix. I expect you to read ahead as you prepare for the next module.

3.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

Jhingan M.L. (2012): - The Economics of development and planning, Vrinda publications India. (40th Edition).

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Paul Krugman and Robbin Wells (2006) Macroeconomics. Worth Publishers, New York, USA.

Thijs Ten Raa (2009) Input-Output Economics: Theory and Applications: Featuring Asian Economies, World Scientific, Netherlands.

3.8 Possible Answers to Self-Assessment Exercise(s)

Refer to the sections of each Self-assessment exercise for guide on these questions

MODULE 3

Social Accounting Matrix, General Equilibrium and Computable General Equilibrium Models of Economic Planning

Unit 1 **Social accounting matrix technique of economic planning**
Unit 2 **General equilibrium model of economic planning**
Unit 3 **Computable General equilibrium model of economic planning**

Unit 1: Social Accounting Matrix Technique of Economic Planning

1.1 Introduction:

Our discussions from preceding modules had introduced to us what we need to know about models used in proper economic planning of nations. There is no country, whether developed or less developed that has not in one way or the other made use of models that

are useful for their economic plan. Other models that we will be concerned with in this module are: the Social Accounting Matrix, Computable General Equilibrium and the General Equilibrium Models. Therefore, our discussion in this module will describe the basic structure of social accounting matrix, computable general equilibrium and the general equilibrium and investigates how they are used in macroeconomic planning of Less Developed Countries of which Nigeria is one.

In this unit, we shall be looking at the Social Accounting Matrix, its structure and its usefulness to effective economic planning of nations.

1.2 Leaning Outcomes

At the end of this unit, you should be able to;

- Define what Social Accounting Matrix (SAM) is as scholarly established in your own words.
- Know the origin and structure of social accounting matrix.
- Identify the uses of social accounting matrix for macroeconomic planning of developing nations.

1.3 What is Social Accounting Matrix (SAM)?

Social Accounting Matrices (SAMs) have become the database of preference for most macroeconomic modellers. A SAM is a comprehensive, economy-wide database that contains information about the flow of resources associated with all transactions that have taken place between economic agents in a certain economy during a certain period of time. As such it presents a snapshot picture of the economy at hand (Punt, 2003).

Initial theoretical developments in social accounting are largely attributable to Sir Richard Stone who addressed the matter of integrating disaggregated production accounts (in the form of input-output systems) into the national accounts. The aim was to form an economy-wide database, which not only included information about productive activities

in the economy, but also incorporated other non-productive institutions and markets, such as factor markets, capital markets, households, government, and the rest of the world.

Although a number of SAMs were developed for a number of developing countries in the 1970s, since the 1980 and 1990s, there has been an increasingly growing interest in the designing, constructing and use of SAM in these countries especially in the 20th century. It is represented in the form of a square matrix with rows and columns, which brings together data on production and income generation as generated by different institutional groups and classes, on the one hand, and data about expenditure of these incomes by them on the other.

In a SAM, incomings are indicated as receipts for the row accounts in which they are located and outgoings are indicated as expenditure for their column accounts. Since all incomings must be, in a SAM, accounted for by total outgoings, the total of rows and columns must be equal for a given account.

Lofgren (2001) described SAM as a "comprehensive, economy-wide data framework" presented in the form of a square matrix. It has two principal objectives: firstly, to organise information about the economic and social structure of an economy (e.g., a region or a country) in a specific period (usually one calendar year), and secondly, to provide the statistical basis for the creation of plausible economic models.

When economic agents are involved in transactions with each other financial resources exchange hands. The first objective of a SAM is to organise data. For this purpose, accounts are included in the SAM to represent agents that are involved in economic transactions. Transactions are captured in the relevant accounts of the SAM, showing the values and direction of the flow of resources. A SAM thus forms a complete database of all transactions that take place between agents in a given period, presenting a 'static image' or 'snapshot picture' of the structure of an economy for that period.

In the same vein, a Social Accounting Matrix (SAM) is a summary table, which refers to a given period, representing the production process, income distribution and

redistribution which occurs between sectors, factors of production, actors in an economic system and the "Rest of the World" (ROW), meaning, all actors outside the economic system were being studied.

Let it be known to you that SAM is a data system, including both social and economic data for an economy. The data sources for a SAM, comes from input-output tables, national income statistics, and household income and expenditure statistics. Therefore, a SAM is broader than an input-output table and typical national account, showing more detail about all kinds of transactions within an economy. However, an input-output table records economic transactions alone irrespective of the social background of the transactors.

A SAM is a way of logical arrangement of statistical information, concerning income flows in a country's economy within a particular time period (usually a year). It can provide a conceptual basis to analyse both distributional and growth issues within a single framework. For instance, a SAM shows the distribution of factor incomes of both domestic and foreign origin, over institutional classes and re-distribution of income over these classes. In addition, it shows the expenditure of these classes on consumption, investment and savings made by them.

SAM represents the whole economic system, it highlights the inter linkages and the circular flow of payments and receipts among the different components of the system such as goods, activities, factors, and institutions. SAM has three main aims;

1.3.1 organize the information on the social and economic structure of a country for a given period;

1.3.2 provide a synoptic view of the flows of receipts and payments in an economic system; and

1.3.3 form a statistical basis for building models of the economic system, with a view to use this to simulate the socio-economic impact of policies.

Self-Assessment Exercise 1

What do you understand by Social Accounting Matrix?

1.4 Origin and Structure of Social Accounting Matrix

For any invention, there must be the inventor, and same is applicable to SAM. Social Accounting Matrices were developed in 1962 at the Cambridge growth project in Cambridge, UK, Stone and Brown, (1962). They were built as a matrix representation of the national account, and came to the World Bank with Graham Pyatt in the 1960s (Pyatt had worked for Richard Stone at the Cambridge Growth Project).

"By the early 1980s, CGE models were heavily ensconced as the approach of the World Bank for development analysis. Social Accounting Matrices (SAMs) were similarly a mainstay of Bank analysis, which had been adopted as a presentational device by the CGE modelers" Mitra-Kahn, (2008). It is therefore important for us to look at its structure and how it is arranged.

Let us look at it from an accounting perspective, the SAM is a two-entry square table which presents a series of double-entry accounts whose receipts and outlays are recorded in rows and columns respectively. Accounts usually refer to the following:

a) Goods and services: these accounts depict the origin of final goods available in the economic system (production activities and imports) and their destination (activities as intermediate inputs and institutions.
b) Production activities: these are basically the production activities of the economy being analysed and generally refer to the defined sectors.
c) Factors of production: these accounts depict receipts from productive activities, which pay for factor services, and payments to institutions, which provide those services. They are usually distinguished in labour and capital, but may refer also to natural resources, such as land and water.
d) Institutions i.e. (economic agents), normally comprising households, companies (corporations) and the government. These accounts record incomes of institutions along the rows and expenditure on the columns.
e) The capital account or saving-investment or accumulation account, which records allocation of resources for capital formation and use of these resources for the

purchase of investment products and building up stocks of goods.

f) The rest of the world account or external account, in which the row records payments received by the rest of the world from the economic system and the column records the outlays of the rest of the world towards the economic system.

Each category is then normally split into several more detailed accounts which will be shown in specific rows and columns.

Here, it must be stressed that the sequence of accounts in rows and columns are identical. Regarding recording different flows in one SAM, all receipts from an account are recorded in one row (i) and expenditure in one column (j). In this way, all monetary flows (sij) in a cell

SAMs are square in nature i.e. (columns equal rows) in the sense that all institutional agents (Firms, Households, Government and 'Rest of Economy' sector) are both buyers and sellers. Columns represent buyers (expenditures) and rows represent sellers (receipts). SAMs were created to identify all monetary flows from sources to recipients, within a disaggregated national account. The SAM is read from column to row, so each entry in the matrix comes from its column heading, going to the row heading. Finally, columns and rows are added up, to ensure accounting consistency, and each column is added up to equal each corresponding row. In the illustration below for a basic open economy, the item C (consumption) comes from Households and is paid to Firms.

Table 1.4.1

Illustrative Open Economy SAM:

	Goods & Services (1)		Production activities (2)	Factors (3)		Resident Information (4)			Savings Investments (5)	(Row) Rest of the world (6)	TOTAL
				Labour	Capital Services	Household	Firms	Public Sector			
Goods and Services (1)	Trade/Transport Margin		Intermediate Consumption			Final cons. Hous.		Final cons. of P. S	Investment & various Stocks	Export	Demand of goods
Productions Services (2)	Domestic Production										Inflows of activities
Factors (3)	Labour		Wages & Salaries							Labour income from ROW	Labour incomes
	Capital		Earn b. Taxes (EBT)								Capital incomes
Residents Institutions (4)	Household			Wages & Salaries		Intra house transfers	Distributed profits	Transfer to households		Transfer from ROW	Household incomes
	Firms				Earn b. Taxes (EBT)					Transfer from ROW	Firm incomes
	Public Sector	Taxes on goods & services	Taxes on activities			Taxes on social securities	Taxes	Transfer within P. S	Budget deficit	Transfer from ROW	PS Incomes
Savings	Decreases of		Depreciation			Savings of	Savings of	Budget		Deficit	Financi

Investment (5)	stocks	of capital			household	firms	surplus		balance of paymen ts	al Resourc es
(Row) Rest of the World (6)	Imports		Remun eration of extra labour		Transfer to ROW	Transfer to ROW	Transfer to ROW	Surplus balance of payments		Outlays to ROW
TOTAL	Supply of goods & services	Domestic production	Paymen t for labour	Paymen t for capital services	Household expenditure s	Use of EBT	Public Expenditur es	Total Investmen ts	Paymen ts of ROW	

For the purpose of understanding the interpretation of the SAM table, we will analyse the flows of receipts (reading per account row) and payments (reading per account column) of each account compared to the next. Only the first two rows and columns will be explained because the same applies to the remaining rows and columns.

1.4.2 Reading The Rows Goods and

services accounts (row 1)

The rows for goods and services accounts, record payments made at market prices, which include indirect taxes (VAT etc.) due to intermediate consumption of production activities, end consumption by households, the government and investment, represented by changes in stock, and gross fixed capital formation and exports.

Activity accounts (row 2)

If we read production activity accounts, by row, we can see that activities receive payments for: goods and services produced (output from domestic production activities),

net of tax and product subsidies; export subsidies and exported goods and services. These elements make up the total production value.

1.4.3 Reading the Columns

By reading the matrix column by column, the payments made by each account to other accounts can be identified. Only the first two columns are analysed

Goods and services accounts payments (column 1)

Goods and services pay the value of goods and services produced by activities (domestic production) into the activities accounts and pay the value of imported products to the rest of the world account. This account also records payments due to net stock reductions of goods held in stock (negative changes in stock over the period being analysed). The prices used for evaluating goods and services are market prices, which include indirect taxes but exclude consumption subsidies.

Activities accounts payments (column 2)

This column represents the account for domestic production activities. Activities pay: intermediate consumption to the goods and services accounts, labour and capital services to the factors accounts, indirect taxes (VAT) to public administration and physical capital consumption (depreciation) to the capital account;

1.4.4 The Different Blocks in Sam

The different blocks of the SAM are made up of intermediate consumption, added value, production, end consumption, salaries and profits paid out to institutions, imports and exports, transfers, gross fixed capital formation and taxes.

1.4.4.1The intermediate consumption blocks

All purchases made by the activities of intermediate consumption goods and services for use in their production process, the SAM, they are translated into monetary flows of the production activities accounts to the various goods and services accounts.

1.4.4.2Value Added

The value-added block refers to payment of factors of production. This payment comprises salaries and capital payment (machines, buildings and other equipment). In general, the value added for each production activity is calculated by taking the difference between the value of total production shown in the total row and the value of intermediate consumption used. The value added is shown in the SAM by monetary flows from production activity accounts in columns to the labour and capital accounts in rows.

1.4.4.3Domestic sales

This block deals with payments made from the goods and services accounts to production activities accounts. These domestic sales refer to the share of goods and services intended for the domestic market; exports of goods and services are therefore not included.

1.4.4.4End consumption

This block covers household and State expenditure on food, non-food products and services for end consumption. In the SAM, end consumption is shown by monetary flows from household and State accounts to accounts of consumed goods and services.

1.4.4.5Imports and exports

This refers to all agricultural and non-agricultural products traded abroad. In the SAM, imports are represented by payments made by imported goods and services accounts to the rest of the world account. Exports are represented by monetary flows from the rest of the world account to the exported goods and services accounts.

1.4.4.6Salaries and profits

This refers to all monetary flows from factors of production accounts to household accounts. They are made up salaries received in exchange for work and as revenue from capital.

1.4.4.7Transfers

They represent monetary flows which exist between the various institution accounts. These are payments between household accounts, payments from corporate accounts to household accounts, payments from the State account to household accounts and corporate accounts, payments from the Rest of the World account (emigrates) to household account and payments from household accounts to the rest of the world account.

1.4.4.8Gross capital formation

This refers to all payments made by the savings and investments account to the goods and services account. It is made up of changes in stock and of GFCF.

1.4.4.9Taxes

These are payments without anything in form of exchange which household, corporate and goods and services accounts make to the State account. They are made up of general income tax, of production taxes (VAT), income and earnings taxes (corporate tax and income tax), local taxes (patents, urban taxes and council tax), registration fees and stamp duty and other payments without anything directly being exchanged.

Let us look at Figure 3.1 below which shows a SAM of a simple 2-sector economy (agriculture and industry) and two institutions (households and government).

The values are expressed in **monetary units (mu)**.

Figure 1.4.3: A simple SAM (matrix S)

	Agriculture	**Industry**	**Households**	**Government**	**Total**
Agriculture	50	20	25	15	1**10**
Industry	30	30	15	5	80

Households	20	10	0	15	**45**
Government	10	20	5	2	**37**
Total	110	80	45	37	272

If we look at matrix S, column by column, it can be seen that to produce 110 mu of output, the agricultural sector must pay 50 mu to the agricultural sector and 30 mu to the industrial sector for intermediate consumption. It must also pay 20 mu in salaries to households and 10 mu in taxes to the government (see "Agriculture" column).

Similarly, the industrial sector, in order to produce 80 mu of output, must pay 20 mu to the agricultural sector and 30 mu to the industrial sector for intermediate consumption. Furthermore, it must pay 10 mu in salaries to households and 20 mu in taxes to the government. (see "Industry" column).

The third column shows household expenditure. Households spend 25 mu in final consumption of agricultural products, 15 mu of industrial products and pay 5 mu in taxes. The fourth column shows government expenditure: 15 mu are allocated to the agricultural sector and 5 mu to the industrial sector through subsidies for production. Additionally, 15 mu are transferred to households (for example, in the form of transfers as income support for poor households). Finally, 2 mu are made as an internal transfer to the public administration.

In mathematical terms, this is defined as follows:

a) SAM elements. Each element in matrix S is indicated S ij, where i = 1, 2,..n ; is the row index, j = 1, 2,.....n is the column index. For example, for SAM in figure 2, where i = 1,2,3,4 and j = 1,2,3,4, s_{22}= 30, s_{13}= 25.

b) Column sums s.j = ∑ sij are the column totals. In our example, $S._1$ = 110, $S._3$ = 45.

(c) Row sums Si**.** = ∑ sij are the row totals,

In our example, S2**.** = 80, S3 = 45**.**

As already mentioned, for a given K account, expenditure is equal to receipts and is shown by the fact that the sum of row is equal to sum of column as shown in the formula below.

$\sum Sih = \sum Shj$

i. e S.h = Sh

If you divide each element in matrix S, Sij by the total of the corresponding column S.j, you will get the column ratios or coefficients Cij = $\underline{Sij}$

S.j

Therefore, you will have the following matric C:

$$\begin{vmatrix} C_{11} = \underline{S_{11}} & C_{12} = \underline{S_{12}} \ldots\ldots\ldots\ldots & C_{1n} = \underline{S_{1n}} \\ S._1 & S._2 & S._n \\ \\ C_2 = \underline{S_{21}} & C_{22} = \underline{S_{22}} \ldots\ldots\ldots & C_{2n} = \underline{S_{2n}} \\ S._1 & S._2 & S._n \\ \\ \ldots & \ldots & \ldots \\ C_{n1} = \underline{S_{n1}} & C_{n2} = \underline{S_{n2}} \ldots\ldots\ldots\ldots & C_{nn} = \underline{S_{nn}} \\ S._1 & S._2 & S._n \\ \\ 1 = \underline{S._1} & 1 = \underline{S._2} \ldots\ldots\ldots\ldots & 1 = \underline{S._n} \\ S._1 & S._2 & S._n \end{vmatrix}$$

Therefore, the column coefficients matrix (matrix c) will be:

Figure 1.4.4

	Agriculture	Industry	Household	Government
Agriculture	0.455	0.250	0.556	0.405
Industry	0.273	0.375	0.333	0.135
Household	0.182	0.125	0.000	0.4**05**
Government	0.091	0.250	0.111	0.054
Total	1.000	1.000	1.000	1.000

Self-Assessment Exercise 2

Provide a brief account the history and origin of social accounting matrix.

1.5 Uses Of Social Accounting Matrix for Macroeconomic Planning:

The SAM is an approach for data organisation, reconciliation, and descriptive analysis of the structure of the economy. –The most important feature of a social accounting matrix is that it provides a consistent and convenient approach to organising economic data for a country and it can provide a basis for descriptive analysis and economic modelling in order to answer various economic policy questions Pleskovic & Trevino, (1985). A SAM can be used for Macroeconomic planning in two ways: first, a SAM can provide a framework for the organisation of information related to economic and social structures of a country's economy.

Second, a SAM can serve as a database for a model of the economy under consideration. A SAM provides comprehensive one-period information on variables, such as the structure, composition and the level of production, the distribution of income among households, and the factorial value-added. Similarly, it can provide statistical information on consumption and production pattern of the economy, imports, exports, investment and so on. Moreover, it may have more detailed information, depending on the data availability and particular interest, on income distribution, tax structure and monetary

variables. Therefore, SAMs can be used to improve the capabilities of countries to obtain descriptive analysis of the economy, indicating its income distribution picture, institutional and industrial structure. In a SAM, the information which takes place in public sector statistics is represented as a component of whole economy. A

SAM can thus provide a comparison opportunity the public sector with either the private sector or the economy as a whole.

A SAM can also be used as a database for macroeconomic policy modelling in developing countries. Its framework may contribute to arrangement of different sources of data in a consistent manner. Different sources of data, such as national accounts, taxation data, household surveys, input-output tables, can be arranged into an economy-wide data framework. In most LDCs economic planning suffers from a number of problems such as insufficient, unreliable and poor quality of data.

Self-Assessment Exercise 3

Highlight the uses of social accounting matrix to a nation's economic planning.

1.6 Summary

In this unit, we have attempted to show what social accounting matrix, its origin and structures, as well as the uses of the technique for economic planning is all about from

various scholars of repute. Also, from the point of view of harmonization, you have learnt that SAM can provide a framework for the organisation of information related to economic and social structures of a country's economy and can as well serve as a database for a model of the economy under consideration. I believe your understanding of this unit has given you a basis to understand the next unit. I expect you by now to be anxious of reading more about computable general equilibrium model which will be duly served in the next unit.

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1.8 Possible Answers to Self-Assessment Exercise(s)

Answer to **Self-Assessment Exercise 1**

A SAM is a comprehensive, economy-wide database that contains information about the flow of resources associated with all transactions that have taken place between economic agents in a certain economy during a certain period of time.

Answer to Self-Assessment Exercise 2

For any invention, there must be the inventor, and same is applicable to SAM. Social Accounting Matrices were developed in 1962 at the Cambridge growth project in Cambridge, UK, Stone and Brown, (1962). They were built as a matrix representation of the national account, and came to the World Bank with Graham Pyatt in the 1960s (Pyatt had worked for Richard Stone at the Cambridge

Growth Project).

Answer to Self-Assessment Exercise 3

SAM can serve as a database for a model of the economy under consideration. A SAM provides comprehensive one-period information on variables, such as the structure, composition and the level of production, the distribution of income among households, and the factorial value-added.

UNIT 2

General Equilibrium Model of Economic Planning

2.1 Introduction:

Having studied critically the concept of social accounting matrix and its usefulness in the economic planning of developing nations, it is imperative to familiarise you with the topic to be discussed in this unit. There is no country, whether developed or less developed that has not in one way or the other made use of models or their economic plan. Another model that we will be concerned with in this unit is the general equilibrium models. Therefore, our discussion in this unit will describe the overview and modern concept of general equilibrium theory in economics, ascertain the properties and characterization of general equilibrium analysis and discuss the unresolved problems in general equilibrium analysis to check how they are used in macroeconomic analysis of Less Developed Countries of which Nigeria is one.

2.2Learning Outcomes

At the end of this unit, you should be able to;

- Understand the overview and modern concept of General equilibrium theory in economics
- Ascertain the Properties and characterization of general equilibrium analysis
- Discuss the unresolved problems in general equilibrium analysis

2.3 Overview and Modern Concept of General Equilibrium theory in Economic Problem

In economics, general equilibrium theory attempts to explain the behavior of supply, demand, and prices in a whole economy with several or many interacting markets, by seeking to prove that a set of prices exists that will result in an overall (or "general") equilibrium. General equilibrium theory contrasts to partial equilibrium, which only analyzes single markets. As with all models, this is an abstraction from a real economy; it is proposed as being a useful model, both by considering equilibrium prices as long-term prices and by considering actual prices as deviations from equilibrium.

General equilibrium theory both studies economies using the model of equilibrium pricing and seeks to determine in which circumstances the assumptions of general equilibrium will hold. The theory dates to the 1870s, particularly the work of French economist Léon Walras in his pioneering 1874 work Elements of Pure Economics.

It is often assumed that agents are price takers, and under that assumption two common notions of equilibrium exist: Walrasian (or competitive) equilibrium, and its generalization; a price equilibrium with transfers.

Broadly speaking, general equilibrium tries to give an understanding of the whole economy using a "bottom-up" approach, starting with individual markets and agents. Macroeconomics, as developed by the Keynesian economists, focused on a "top-down" approach, where the analysis starts with larger aggregates, the "big picture". Therefore, general equilibrium theory has traditionally been classified as part of microeconomics.

The difference is not as clear as it used to be, since much of modern macroeconomics has emphasized microeconomic foundations, and has constructed general equilibrium models of macroeconomic fluctuations. General equilibrium macroeconomic models usually have a simplified structure that only incorporates a few markets, like a "goods market" and a "financial market". In contrast, general equilibrium models in the microeconomic tradition typically involve a multitude of different goods markets. They are usually complex and require computers to help with numerical solutions.

In a market system the prices and production of all goods, including the price of money and interest, are interrelated. For example, a change in the price of one good, say bread, may affect another price, such as bakers' wages. If bakers differ in tastes from others, the demand for bread might be affected by a change in bakers' wages, with a consequent effect on the price of bread e.g., sweet sensation bread and Mr. Biggs bread. Calculating the equilibrium price of just one good, in theory, requires an analysis that accounts for all of the millions of different goods that are available.

The first attempt in neoclassical economics to model prices for a whole economy was made by Léon Walras. Walras argued that all prices and quantities in all markets are determined simultaneously through their interaction with one another. Walras used a system of simultaneous equations to describe the interaction of individual sellers and buyers in all markets, and he maintained that all the relevant magnitudes (prices and quantities of all commodities and all factor services) can be determined simultaneously by the solution of this system.

In the Walrasian model the behaviour of each individual decision-maker is presented by a set of equations. For example, each consumer has a double role: he buys commodities

and sells services of factors to firms. Thus, for each consumer we have a set of equations consisting of two subsets: one describing his demands of the different commodities, and the other his supplies of factor inputs. Similarly, the behaviour of each firm is presented by a set of equations with two subsets: one for the quantities of commodities that it produces, and the other for the demand for factor inputs for each commodity produced. The important characteristic of these equations is their simultaneity or interdependence. The solution of this system of millions of simultaneous equations defines the 'unknowns' of the model, namely the prices and quantities of all commodities and all factor inputs.

In a general equilibrium system of the Walrasian type there are as many markets as there are commodities and factors of production. For each market there are three types of functions: demand functions, supply functions and a 'clearing-the-market' equation, which stipulates that the quantities demanded be equal to the quantities supplied.

In a commodity market the number of demand functions is equal to the number of consumers, and the number of the supply functions is equal to the number of firms which produce the commodity. In each factor market the number of demand functions is equal to the number of firms multiplied by the number of commodities they produce. The number of supply functions is equal to the number of consumers who own *(ex hypothesis)* the factors of production.

A necessary (but not sufficient) condition for the existence of a general equilibrium is that there must be in the system as many independent equations as the number of unknowns. Thus, the first task (in establishing the existence of a general equilibrium) is to describe the economy by means of a system of equations, defining how many equations are required to complete (and solve) the system.

2.4 Current Concept of General Equilibrium Theory in Economics

The modern conception of general equilibrium is provided by a model developed jointly by Kenneth Arrow, Gerard Debreu, and Lionel W. McKenzie in the 1950s. Debreu presents this model in *Theory of Value* (1959) as an axiomatic model, following the style of mathematics promoted by Nicolas Bourbaki. In such an approach, the interpretations

of the terms in the theory (e.g., goods, prices) are not fixed by the axioms.

Three important interpretations of the terms of the theory have been often cited. First, suppose commodities are distinguished by the location where they are delivered. Then the Arrow-Debreu model is a spatial model of, for example, international trade.

Second, suppose commodities are distinguished by when they are delivered. That is, suppose all markets equilibrate at some initial instant of time. Agents in the model purchase and sell contracts, where a contract specifies, for example, a good to be delivered and the date at which it is to be delivered. The Arrow–Debreu model of inter temporal equilibrium contains forward markets for all goods at all dates. No markets exist at any future dates.

Third, suppose contracts specify states of nature which affect whether a commodity is to be delivered: "A contract for the transfer of a commodity now specifies, in addition to its physical properties, its location and its date, an event on the occurrence of which the transfer is conditional. This new definition of a commodity allows one to obtain a theory of (risk) free from any probability concept.

Some of the recent work in general equilibrium has in fact explored the implications of incomplete markets, which is to say an inter-temporal economy with uncertainty, where there do not exist sufficiently detailed contracts that would allow agents to fully allocate their consumption and resources through time. While it has been shown that such economies will generally still have equilibrium, the outcome may no longer be Pareto optimal. The basic intuition for this result is that if consumers lack adequate means to transfer their wealth from one time period to another and the future is risky, there is nothing to necessarily tie any price ratio down to the relevant marginal rate of substitution, which is the standard requirement for Pareto optimality. Under some conditions the economy may still be constrained Pareto optimal, meaning that a central authority limited to the same type and number of contracts as the individual agents may not be able to improve upon the outcome, what is needed is the introduction of a full set of possible contracts. Hence, one implication of the theory of incomplete markets is that

inefficiency may be a result of underdeveloped financial institutions or credit constraints faced by some members of the public. Research still continues in this area.

Self-Assessment Exercise 1

What does general equilibrium attempt to explain?

2.5 Properties and Characterization of General Equilibrium Model

Basic questions in general equilibrium analysis are concerned with the conditions under which equilibrium will be efficient, which efficient equilibria can be achieved, when equilibrium is guaranteed to exist and when the equilibrium will be unique and stable.
For us to know this, we shall look at the following

a) First Fundamental Theorem of Welfare Economics

The First Fundamental Welfare Theorem asserts that market equilibria are Pareto efficient. In a pure exchange economy, a sufficient condition for the first welfare theorem to hold is that preferences being locally none satiated. The first welfare theorem also holds for economies with production regardless of the properties of the production function. Implicitly, the theorem assumes complete markets and perfect information. In an economy with externalities, like Nigeria for example, it is possible for equilibria to arise that are not efficient.

This theorem is informative in the sense that it points to the sources of inefficiency in markets. Under the assumptions above, any market equilibrium is tautologically efficient. Therefore, when equilibria arise that are not efficient, the market system itself is not to blame, but rather some sort of market failure.

b) Second Fundamental Theorem of Welfare Economics

While every equilibrium is efficient, it is clearly not true that every efficient allocation of resources will be an equilibrium. However, the second theorem states that every efficient allocation can be supported by some set of prices. In other words, all that is required to reach a particular outcome is a redistribution of initial endowments of the agents after

which the market can be left alone to do its work. This suggests that the issues of efficiency and equity can be separated and need not involve a trade-off. The conditions for the second theorem are stronger than those for the first, as consumers' preferences now need to be convex (convexity roughly corresponds to the idea of diminishing rates of marginal substitution, or to preferences where "averages are better than extrema"). Further up, the Second Fundamental Theorem of Equilibrium Analysis leads to Perfect Equilibrium Analysis where market forces join together planned economies in a perfect bound.

c) Existence, Uniqueness and Stability of an Equilibrium

Three problems arise in connection with a general equilibrium:

i. Does a general equilibrium solution exist? (Existence problem)
ii. If an equilibrium solution exists, is it unique? (Uniqueness problem)
iii. If an equilibrium solution exists, is it stable? (Stability problem)

These problems can best be illustrated with the partial-equilibrium example of a demand-supply model. Assume that a commodity is sold in a perfectly competitive market, so that from the utility-maximising behaviour of individual consumers there is a market demand function, and from the profit-maximising behaviour of firms there is a market supply function. An equilibrium exists when at a certain positive price, the quantity demanded is equal to the quantity supplied. The price at which $Q_d = Q_s$ is the equilibrium price. At such a price there is neither excess demand nor excess supply. (The latter is often called *negative excess demand.)* Thus, an equilibrium price can be defined as the price at which the excess demand is zero: the market is cleared and there is no excess demand.

The equilibrium is stable if the demand function cuts the supply function from above. In this case an excess demand drives price up, while an excess supply (excess negative demand) drives the price down (figure 3.1).

The equilibrium is unstable if the demand function cuts the supply function from below. In this

case an excess demand drives the price down, and an excess supply drives the price up (figure 3.2).

In figure 3.3 we depict the case of multiple equilibria. It is obvious that at P_1 there is a stable equilibrium, while at P^e_2 the equilibrium is unstable. Finally in figure 3.4 an equilibrium (at a positive price) does not exist.

It should be clear from the above discussion that (a) the existence of equilibrium is related to the problem of whether the consumers' and producers' behaviour ensures

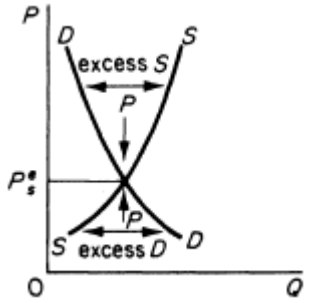

Figure 3.1:
Unique, stable equilibrium

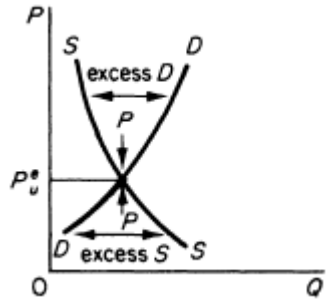

Figure 3.2:
Unique, unstable equilibrium

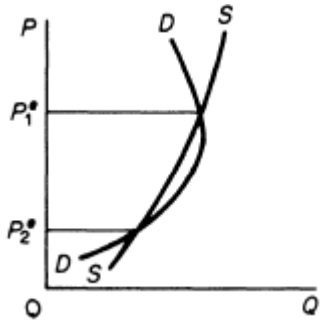

Figure 3.3:
Multiple equilibria

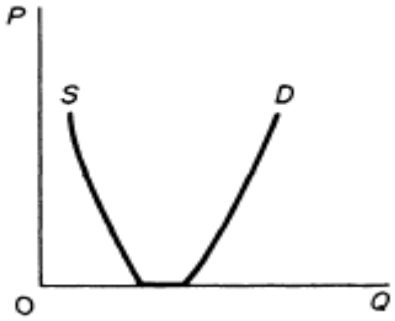

Figure 3.4:
No equilibrium exists

that the demand and supply curves intersect (at a positive price); (b) the stability of equilibrium depends on the relationship between the slopes of the demand and supply curves; (c) the uniqueness of equilibrium is related to the slope of the excess demand function, that is, the curve which shows the difference between *QD* and *Qs* at any one price. In fact, the three basic questions related to the existence, stability and uniqueness of an equilibrium can be expressed in terms of the excess demand function:

$$E(P_i) = Q_d(P_i) - Q_s(P_i)$$

To see this, we redraw below figures 3.5 – 3.8 in terms of the excess demand function.

For each of these cases we have derived the relevant excess demand function by subtracting Q_s from Q_d at all prices.

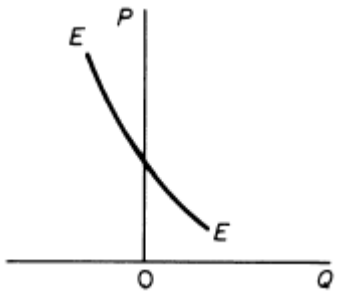

Figure 3.5: Stable equilibrium

Slope of $E_{(p)} < 0$

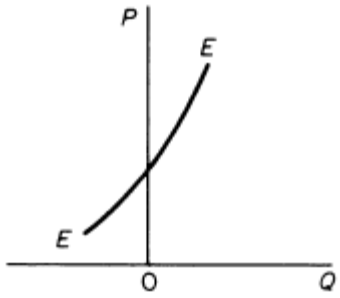

Figure 3.6: Unstable equilibrium

Slope of $E_{(p)} > 0$

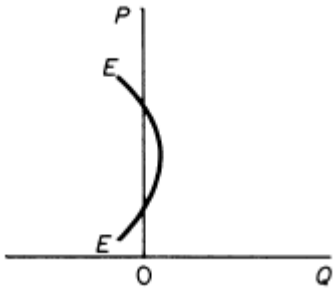

Figure 3.7: Multiple equilibria

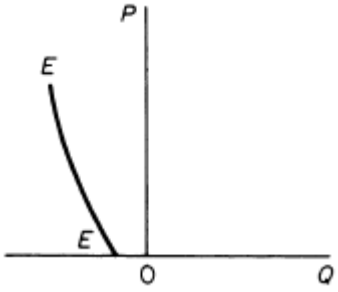

Figure 3.8: No equilibrium exists

From the redrawn diagrams (in conjunction with the corresponding ones 3.1 – 3.8) we can draw the following conclusions.

1. The excess demand function, $E_{(P)}$ *intersects* the vertical (price)-axis when there is an equilibrium, that is, when the excess demand is zero. If $Q_D = Q_S$, then $E_{(P)} = 0$.
2. There are as many equilibria as the number of times that the excess demand curve $E_{(P)}$ *intersects* the vertical price-axis (figure 3.7).
3. The equilibrium is stable if the slope of the excess demand curve is negative at the point of its intersection with the price-axis (figure 3.5).

4. The equilibrium is unstable if the slope of the excess demand curve is positive at the point of its intersection with the price-axis (figure 3.6).
5. If the excess demand function does not intersect the vertical axis at any one price, an equilibrium does not exist (figure 3.8).

Self-Assessment Exercise 2

Using appropriate diagrams, explain the existence, uniqueness and stability of general equilibrium and show that the existence, uniqueness and stability of general equilibrium can be expressed in terms of the excess demand function. What conclusions can be drawn?

2.6 Unresolved Problems in General Equilibrium Model

Research building on the Arrow–Debreu–McKenzie model has revealed some problems with the model. The Sonnenschein-Mantel-Debreu results show that, essentially, any restrictions on the shape of excess demand functions are stringent. Some think this implies that the Arrow-Debreu model lacks empirical content. At any rate, Arrow-Debreu-McKenzie equilibria cannot be expected to be unique, or stable.

A model organized around the atonement process has been said to be a model of a centrally planned economy and not a decentralized market economy. Some research has tried to develop general equilibrium models with other processes. In particular, some economists have developed models in which agents can trade at out-of-equilibrium prices and such trades can affect the equilibria to which the economy tends. Particularly noteworthy are the Hahn process, the Edgeworth process and the Fisher process.

The data determining Arrow-Debreu equilibria include initial endowments of capital goods. If production and trade occur out of equilibrium, these endowments will be changed and further complicating the picture.

In a real economy, however, trading, as well as production and consumption, goes on out of equilibrium. It follows that, in the course of convergence to equilibrium (assuming that occurs), endowments change. In turn this changes the set of equilibria. Put more

succinctly, the set of equilibria is path dependent. This path dependence makes the calculation of equilibria corresponding to the initial state of the system essentially irrelevant. What matters is the equilibrium that the economy will reach from given initial endowments, not the equilibrium that it would have been in, given initial endowments, had prices happened to be just.

The Arrow-Debreu model in which all trade occurs in futures contracts at time zero requires a very large number of markets to exist. It is equivalent under complete markets to a sequential equilibrium concept in which spot markets for goods and assets open at each date-state event (they are not equivalent under incomplete markets); market clearing then requires that the entire sequence of prices clears all markets at all times. A generalization of the sequential market arrangement is the temporary equilibrium structure, where market clearing at a point in time is conditional on expectations of future prices which need not be market clearing ones.

Although the Arrow-Debreu-McKenzie model is set out in terms of some arbitrary numerals, the model does not encompass money. Frank Hahn, for example, has investigated whether general equilibrium models can be developed in which money enters in some essential way. One of the essential questions he introduces, often referred to as the Hahn's problem is: "Can one construct an equilibrium where money has value?" The goal is to find models in which existence of money can alter the equilibrium solutions, perhaps because the initial position of agents depends on monetary prices.

Some critics of general equilibrium modeling contend that much research in these models constitutes exercises in pure mathematics with no connection to actual economies. "There are endeavors that now pass for the most desirable kind of economic contributions although they are just plain mathematical exercises, not only without any economic substance but also without any mathematical value as put by Georgescu-Roegen in one of his papers that assumes more traders in existence than there are points in the set of real numbers.

Although modern models in general equilibrium theory demonstrates that under certain

circumstances prices will indeed converge to equilibria, critics hold that the assumptions necessary for these results are extremely strong. As well as stringent restrictions on excess demand functions, the necessary assumptions include perfect rationality of individuals; complete information about all prices both now and in the future; and the conditions necessary for perfect competition. However some results from experimental economics suggest that even in circumstances where there are few, imperfectly informed agents, the resulting prices and allocations may wind up resembling those of a perfectly competitive market (although certainly not a stable general equilibrium in all markets).

Frank Hahn defends general equilibrium modeling on the grounds that it provides a negative function. General equilibrium models show what the economy would have to be like for an unregulated economy to be **Pareto efficient.**

2.6.1 Critics of General Equilibrium Theory

General equilibrium theory is a central point of contention and influence between the neoclassical school and other schools of economic thought, and different schools have varied views on general equilibrium theory. Some, such as the Keynesian and Post-Keynesian schools, strongly reject general equilibrium theory as "misleading" and "useless"; others, such as the Austrian school, show more influence and acceptance of general equilibrium thinking, though the extent is debated. Other schools, such as new classical macroeconomics, developed from general equilibrium theory. In this context, while some criticize positively, some do not.

2.6.1.1Keynesian and Post-Keynesian

Keynesian and Post-Keynesian economists, and their under consumptionist predecessors criticize general equilibrium theory specifically, and as part of criticisms of neoclassical economics generally. Specifically, they argue that general equilibrium theory is neither accurate nor useful, that economies are not in equilibrium, that equilibrium may be slow and painful to achieve, and that modeling by equilibrium is "misleading", and that the resulting theory is not a useful guide, particularly for understanding of economic crises.

They said let us beware of this dangerous theory of equilibrium which is supposed to be automatically established. A certain kind of equilibrium, it is true, is reestablished in the long run, but it is after a frightful amount of suffering.

More methodologically, it is argued that general equilibrium is a fundamentally *static* analysis, rather than a *dynamic* analysis, and thus is misleading and inapplicable. The theory of dynamic stochastic general equilibrium seeks to address this criticism.

2.6.1.2Austrian economists

Whether Austrian economists supports or rejects general equilibrium theory and the precise relationship is unclear. Different Austrian economists have advocated differing positions, which have changed as Austrian economics developed over time. Some new classical economists argue that the work of Friedrich Hayek in the 1920s and 1930s was in the general equilibrium tradition and was a precursor to business cycle equilibrium theory. Others argue that while there are clear influences of general equilibrium on Hayek's thought, and that he used it in his early work, he came to substantially reject it in his later work, post 1937. It is also argued by some that Friedrich von Wieser, along with Hayek, worked in the general equilibrium tradition, while others reject this, finding influences of general equilibrium on the Austrian economists superficial.

C) New classical macroeconomics

While general equilibrium theory and neoclassical economics generally were originally microeconomic theories, New classical macroeconomics builds a macroeconomic theory on these bases. In new classical models, the macroeconomy is assumed to be at its unique equilibrium, with full employment and potential output, and that this equilibrium is assumed to always have been achieved via price and wage adjustment (market clearing). The best-known of such model is Real Business Cycle Theory, in which business cycles are considered to be largely due to changes in the real economy, unemployment is not due to the failure of the market to achieve potential output, but due to equilibrium potential output having fallen and equilibrium unemployment having risen.

d) Socialist economics

Within socialist economics, a sustained critique of general equilibrium theory and neoclassical economics generally is given in *Anti-Equilibrium*, based on the experiences of Janos Kornai with the failures of Communist central planning.

Self-Assessment Exercise 3

In your own words summarise the criticism of modern economist to the theory of general equilibrium applications

2.6 Summary

In this unit, we have attempted to show what general equilibrium models is all about, its properties, features and critics from various scholars of repute. Also, from the point of view of our discussion, you have learnt that General equilibrium theory both studies economies using the model of equilibrium pricing and seeks to determine in which circumstances the assumptions of general equilibrium will hold. I believe your understanding of this unit has given you a basis to understand the next unit. I expect you by now to be anxious of reading more about computable general equilibrium model which will be duly served in the next unit.

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2.8 Possible Answers to Self-Assessment Exercise(s)

Answers to Self-Assessment Exercise 1

General equilibrium theory attempts to explain the behavior of supply, demand, and prices in a whole economy with several or many interacting markets, by seeking to prove that a set of prices exists that will result in an overall (or "general") equilibrium. General equilibrium theory contrasts to partial equilibrium, which only analyzes single markets.

Answers to Self-Assessment Exercise 2

Consult more literature in addition to section 2.5 to provide answer to the question

Answers to Self-Assessment Exercise 3

Your answer should relate to the Keynesian and Post- Keynesian view, Australian Economist, Neo-classical Economist and Socialist Economists

UNIT 3

Computable General Equilibrium Model of Economic Planning

3.1 Introduction

It is good that we have familiarized ourselves with what General equilibrium theory is all about in the preceding unit which provides a basic foundational platform that we shall be looking at in this unit. In this unit, we shall be looking at Computable General Equilibrium Model of economic planning. An in-depth explanation of the above topics shall be provided. It is advisable that you critically concentrate as we move along with explanations that will be given.

3.2 Learning Outcomes

At the end of this unit, you should be able to:

a. Show the Overview, structure and developments in CGE modelling.
b. Understand CGE models as multisectoral model and its main features

c. Identify the Advantages and limitations of GCE
d. Identify the Uses, Types and Solutions of CGE

3.3 Overview, Structure and Developments in CGE Modelling.

Computable general equilibrium (**CGE**) models are a class of economic models that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. CGE models are also referred to as AGE which is applied general equilibrium models.

Beyond macroeconomics, a family of models termed computable general equilibrium (CGE) models focuses on issues related to resource allocation across different supply sectors, relative prices of goods and factors of production, and welfare levels of different income groups. Planning models used for national purposes in countries with a large government role in determining sector prices and quantities combined macroeconomic (and particularly fiscal) policy analysis with aggregate and sector-level budgeting and planning.

Computable general equilibrium (CGE) models also known as applied general equilibrium (AGE) models are built on the timeless economics foundations of Adam Smith's invisible hand, Walras law, Edgeworth's contract curve, Arrow- Debreu proof of existence and Leontief's input-output analysis (Manne 1985).

A CGE model consists of (a) equations describing model variables and (b) a database (usually very detailed) consistent with the model equations. The equations tend to be neo-classical in spirit, often assuming cost-minimizing behaviour by producers, average-cost pricing, and household demands based on optimizing behaviour. However, most CGE models conform only loosely to the theoretical general equilibrium paradigm. For example, they may allow for:

a. non-market clearing, especially for labour (unemployment) or for commodities (inventories)

b. imperfect competition (e.g., monopoly pricing)
c. demands not influenced by price (e.g., government demands)
d. a range of taxes
e. externalities, such as pollution

A CGE model database consists of:0000 and the following.

1. tables of transaction values, showing, for example, the value of coal used by the iron industry. Usually the database is presented as an input-output table or as a social accounting matrix. In either case, it covers the whole economy of a country (or even the whole world), and distinguishes a number of sectors, commodities, primary factors and perhaps types of household.
2. elasticities: dimensionless parameters that capture behavioural response. For example, export demand elasticities specify by how much export volumes might fall if export prices went up. Other elasticities may belong to the Constant Elasticity of Substitution class. Amongst these are Armington elasticities, which show whether products of different countries are close substitutes, and elasticities measuring how easily inputs to production may be substituted for one another. Expenditure elasticities show how household demands respond to income changes.

CGE models are descended from the input-output models pioneered by Wassily Leontief, but assign a more important role to prices. Thus, where Leontief assumed that, say, a fixed amount of labour was required to produce a ton of iron, a CGE model would normally allow wage levels to (negatively) affect labour demands.

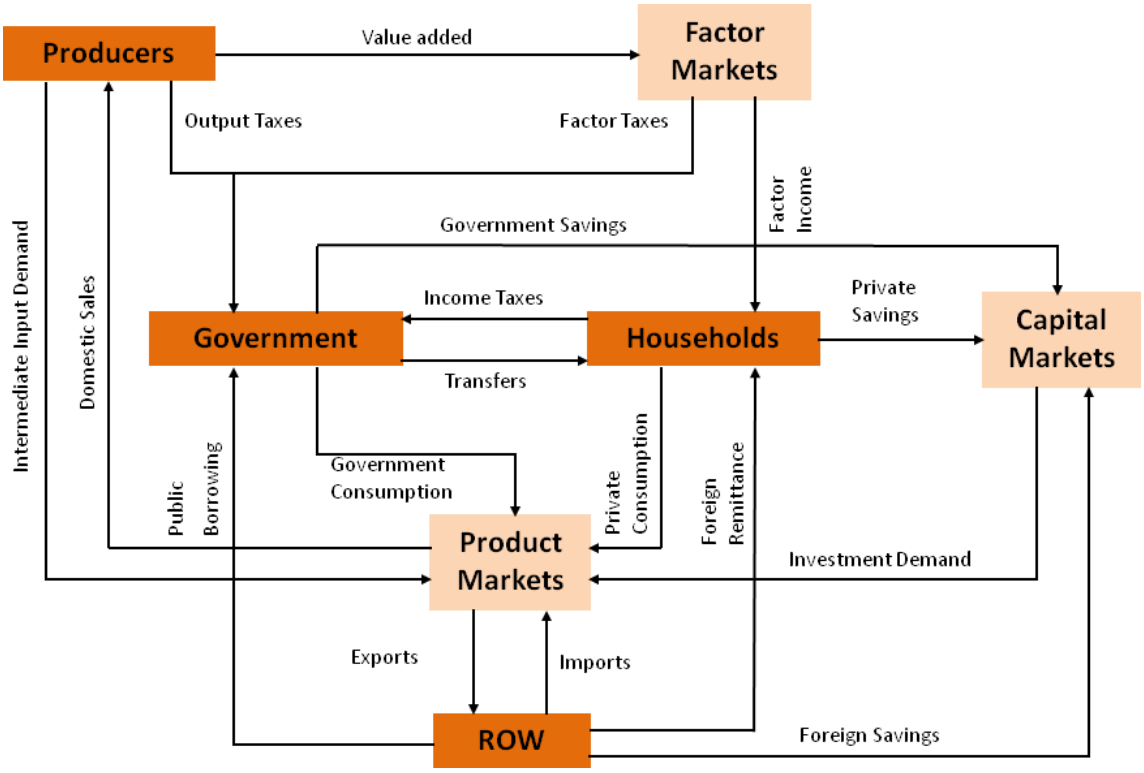
CGE models derive too from the models for planning the economies of poorer countries constructed (usually by a foreign expert) from 1960 onwards. Compared to the Leontief model, development planning models focused more on constraints or shortages—of skilled labour, capital, or foreign exchange.

CGE modelling of richer economies descends from Leif Johansen's 1960 MSG model of Norway, and the static model developed by the Cambridge Growth Project in the UK.

Both models were pragmatic in flavour, and traced variables through time. The Australian MONASH model is a modern representative of this class. Perhaps the first CGE model similar to those of today was that of Taylor and Black (1974). These models are as well applicable to economic planning of developing nations.

Self-Assessment Exercise 1

Discuss briefly the structure of CGE modeling in economic analysis.



A Simplified Structure of CGE Model

3.4 CGE Models as Multisectoral Model and Its Main Features

This section provides a review of different types of multisectoral models and then focuses in particular on CGE models. CGE model belong to a class of models generally referred to as multisectoral macro models. As we have earlier discussed in previous modules, Models that fall into category include the following:

(a). Input-Output Models

(b). Linear Programming Models.

(c). Macroeconometric Models.

(d). Computable (or applied) General Equilibrium Models.

The essential features of the different types of models, are presented below. It should be mentioned however that these are broad generalizations for the purpose of identifying the dominant characteristic of each type of model. For instance, CGE

Model have both static and dynamic components. However, in most cases we have static CGE models because the dynamic components are not as well developed as what we may find with macroeconometric models.

Typology of Macro Models.

Classification of models: LP, IO, MM and CGE

Where:

LP - Linear programming Models

IO - Input Output Models

MM - Macroeconometric Models

CGE – Computable General Equilibruim Models

The focus of this section is however on CGE models. CGE represents one of the most prominent types of models used for policy analysis.

Unlike macroeconometric models that emphasize time series data analysis, CGE model focus on interindustry analysis thereby permitting the analysis of the impacts of policy on

resource allocation. Another feature is that CGE models in general can be numerically solved for market clearing prices on all product and factor markets, Moreover, CGE models are generally focused on the real side of the economy, although financial instruments and financial markets are gaining increasing attention.

CGE models are highly non-linear and allow for feedback relations from production levels and prices to final demand. They have neo-classical production and expenditure functions and incorporate a variety of substitution possibilities in production, demand and trade. Formalized analyses of general equilibrium systems have provided insights into the factors determining the allocation of resources and the distribution of incomes in market economies. With the development of CGE models, the general equilibrium theory has become an operational tool in empirically oriented economic analysis.

The basic structure of a CGE model can be generalized as follows: It starts with the specifications of the agents in the economy and their behavior; the rules that bring different markets to equilibrium and macroeconomic conditions. Most CGE models identify four categories of agents: households, producers, government and the rest of the world. Usually, behavioural rules are specified for these actors that reflect their assumed motivations. For example, producers maximize profits subject to technological constraints and households maximize utility subject to budget constraints. Third, agents make their decisions based on signals they observe. In the neoclassical models, these signals are the prices. Next, a set of market equilibrium conditions and macro constraints are imposed on the system: the balance of payments, savings-investment balance, the government budget and factor market equilibrium.

A CGE model is one of the most rigorous, cutting-edge quantitative methods to evaluate the impact of economic and policy shocks -particularly policy reforms- in the economy as a whole. Because of its nature, this tool is significantly useful for policy design.

3.5 Advantages and Limitations of CGE

a) Advantages or Strengths of CGE

CGE models have a number of strong advantages and expectedly, some drawbacks. Among the several benefits of the CGE models are the following. They provide conceptual consistency for model analysis. CGE models are based on established axioms and principles of microeconomics such as profit and utility maximization, and rational behaviour of economics agents. For instance, under the Walras law, households are presumed to be on their budget constraint, there are zero profit conditions for firms; and demand and supply are equal for all commodities and factors of production. In addition to conceptual consistency, the social accounting matrix, which provides the data base for CGE models, ensures accounting consistency: expenditures cannot exceed incomes and there is also consistent factor allocation making sure that factor markets are cleared.

Other advantage of CGE models is that analysis is based on inter-industry or multi- sector backward and forward linkages. Hence, they permit analyses of resource allocation and how policies impact or permeate through the various sectors of the economy. A major strength of CGE is that it allows for welfare analysis. It provides a laboratory for evaluating winners and losers from policy changes which may provide an avenue to apply compensatory schemes for losers from economic reforms, especially if they belong to the vulnerable groups. In other words, it allows for the analysis of equity implications of policy measures and changes in real income resulting from changes in prices.

b) Limitations or Problems Of CGE

CGE models also have some important limitations. Firstly, like other types of models, CGE models are abstractions from reality, hence, their structures are influenced

significantly by the judgements and predispositions of the modeller. Modellers have significant flexibility in the choice of model set up, especially, functional forms, disaggregation, closure rules, etc. Secondly, CGE models are still relatively aggregated given their focus on macroeconomic, sectoral and social effects. Thirdly, they require large numbers of parameters and elasticities, which often have to be borrowed.

Additionally, there are no common statistical tests for the model specifications. Hence, unlike macroeconometric models, it is difficult to assess the validity and reliability of the particular specification forms chosen by the modeler. Fourthly, CGE models are not appropriate for forecasting. Fifth, issues of uncertainty, financial sector, and true dynamics are sill rudimentary in CGE models. Finally, it requires considerable technical skill to formulate, solve and interpret the results of a CGE model.

Self-Assessment Exercise 2

Highlight the advantages and problems of CGE modelling

Uses, Types and Solutions of CGE Models

a) Uses of CGE Models

CGE models are useful whenever we wish to estimate the effect of changes in one part of the economy upon the rest. For example, a tax on flour might affect bread prices, the CPI, and hence perhaps wages and employment. They have been used widely to analyse trade policy. More recently, CGE has been a popular way to estimate the economic effects of measures to reduce greenhouse gas emissions.

CGE models always contain more variables than equations-so some variables must be set outside the model. These variables are termed exogenous; the remainder, determined by the model, is called endogenous. The choice of **which** variables are to be exogenous is called the model **closure**, and may give rise to controversy. For example, some modellers

hold employment and the trade balance fixed; others allow these to vary. Variables defining technology, consumer tastes, and government instruments (such as tax rates) are usually exogenous.

Today there are many CGE models of different countries. One of the most well-known CGE models is global GTAP model of world trade.

CGE models are useful to model the economies of countries for which time series data are scarce or not relevant (perhaps because of disturbances such as regime changes). Here, strong, reasonable, assumptions embedded in the model must replace historical evidence. Thus, developing economies are often analysed using CGE models, such as those based on the IFPRI template model.

CGE models are the best choice if the economic or policy shock to be evaluated is expected to have significant impacts throughout the economy. Moreover, CGE models are the best option if the research question involves analyzing the static/dynamic, direct/ indirect and short/long term effects caused by a shock. Thus, because of its nature, CGE analysis performs well when evaluating, among others:

- Fiscal policy
- Trade policy
- Climate Change shocks
- Shocks in international prices etc.

b) Comparative-static and dynamic type of CGE model

Many CGE models are comparative-static: they model the reactions of the economy at only one point in time. For policy analysis, results from such a model are often interpreted as showing the reaction of the economy in some future period to one or a few external shocks or policy changes. That is, the results show the difference (usually reported in percent change form) between two alternative future states (with and without

the policy shock). The process of adjustment to the new equilibrium is not explicitly represented in such a model, although details of the closure (for example, whether capital stocks are allowed to adjust) lead modellers to distinguish between **short-run** and **long-run** equilibria.

By contrast, dynamic CGE models explicitly trace each variable through time—often at annual intervals. These models are more realistic, but more challenging to construct and solve—they require for instance that future changes are predicted for all exogenous variables, not just those affected by a possible policy change. The dynamic elements may arise from partial adjustment processes or from stock/flow accumulation relations: between capital stocks and investment, and between foreign debt and trade deficits. However, there is a potential consistency problem because the variables that change from one equilibrium solution to the next are not necessarily consistent with each other during the period of change.

Recursive-dynamic CGE models are those that can be solved sequentially (one period at a time). They assume that behaviour depends only on current and past states of the economy. Alternatively, if agents' expectations depend on the future state of the economy, it becomes necessary to solve for all periods simultaneously, leading to full multi-period dynamic CGE models. Within the latter group dynamic stochastic general equilibrium models explicitly incorporate uncertainty about the future**.**

c) Solution Techniques

Early CGE models were often solved by a program custom-written for that particular model. Thus, models were expensive to construct, and sometimes appeared as a 'black box' to outsiders. Today most CGE models are formulated and solved using one of the GAMS or GEMPACK software systems. AMPL, Excel and MATLAB are also used. The use of such systems has lowered the cost of entry to CGE modeling, allowed model simulations to be independently replicated, and increased the transparency of the models.

Self-Assessment Exercise 3

Elucidate on the uses of CGE modeling in economic analysis.

3.6 Summary

In this unit, we have attempted to show what Computable general equilibrium models is all about, its structures, advantages, limitations as well as its uses, types and critics from various schools of thought. Also, from the point of view of our discussion, you have learnt that CGE model consists of the equations describing model variables and a database that is consistent with the model equations. The equations tend to be neo-classical in spirit, often assuming cost-minimizing behaviour by producers, average-cost pricing, and household demands based on optimizing behaviour. However, most CGE models conform only loosely to the theoretical general equilibrium paradigm. I believe your understanding of this unit has given you a basis to prepare for the next unit. I expect you by now to be anxious of reading more about linear programming techniques which will be duly served in the next unit.

3.7 References/Further Reading/Web Resources

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2.8 Possible Answers to Self-Assessment Exercise(s)

Answers to Self-Assessment Exercise 1

Computable general equilibrium (CGE) models are a class of economic models that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors.

Answers to Self-Assessment Exercise 2

They provide conceptual consistency for model analysis. CGE models are based on established axioms and principles of microeconomics such as profit and utility maximization, and rational behaviour of economics agents.

Answers to Self-Assessment Exercise 3

CGE models are useful whenever we wish to estimate the effect of changes in one part of the

economy upon the rest. For example, a tax on flour might affect bread prices, the CPI, and hence perhaps wages and employment.

MODULE 4

Linear Programming Technique and Cost-Benefit Analysis of Economic Planning

Unit 1: Introduction to the concept of Linear Programming technique
Unit 2: Linear Programming technique and its application in Planning
Unit 3: Project selection technique of cost-benefit analysis

UNIT 1: Introduction to the Concept of Linear Programming Technique

1.1 Introduction

Our discussion in the last module of this course was based on a multisector economic model known as SAM, GE, and CGE. Similarly, we referred to the necessity of a plan being consistent and constructive based on the economic nature that is prevalent in such economy. Therefore, our task in this last module would be to look at the process of plan formulation using other multi sector model or technique. It is therefore intended to introduce you to the concept of Linear programming technique and benefit-cost analysis and their relevance in economic planning of nations.

1.2 Learning Outcomes

At the end of this unit, you should be able to:

- Identify the Origin and meaning of linear programming technique
- Show the Conditions and generalisations of linear programming
- Highlight the assumptions of linear programming technique.

1.3 Origin and Meaning of Linear Programming Technique

As we have been discussing from the earlier modules and unit, another multi-sector model is what we shall be looking at which is Linear Programming.

Linear Programming is a mathematical device developed by the mathematician George Dantzig in 1947 for planning the diversified activities of the US Air Force connected with the problem of supplies to the forces. Linear or mathematical programming, also known as activity analysis, has been further developed in its application to the firm, managerial economics and finally to development planning.

Linear programming is a devised technique for providing specific numerical solutions of problems which earlier could be solved only in vague qualitative terms by using the apparatus of the general theory of the firm. Linear programming has thus helped to bridge the gap between abstract economic theory and managerial decision making in practice. The use of linear programming is expanding fast due to the use of computers which can quickly solve complex problems involving the optimal use of many resources which are given to the firm in any particular time and thus set constraints on the firm's choice. Linear programming can be considered as providing an operational method for dealing with economic relationships, which involve discontinuities. It is a specific approach within the general framework of economic theory.

Jhingan, M.L. (2012) opines that linear programming is a mathematical technique for the analysis of optimum decisions, subject to certain constraints in the form of linear inequalities. Mathematically speaking, it applies to those problems which require the solution of maximization or minimization problems subject to a system of linear inequalities stated in terms of certain variables which are also referred to as optimization problems. The problem is said to be linear, when cost and price per unit do not change with output. However, the problem is non-

linear when cost and price per unit change with the size of output. Linear programming may thus be defined as a method to decide the optimum combination of factors to produce a given output or the optimum combination of products to be produced by given plan and equipment. It is also used to decide between a variety of techniques to produce a commodity. The technique involved in linear programming is similar to the one adopted in input-output analysis for the industry.

Self-Assessment Exercise 1

Examine the concept of linear programming technique.

1.4 Conditions and Generalizations of Linear Programming

You should know that for any principle to hold in any situation, certain conditions and generalizations has to be satisfied. The application of linear programming (LP) technique to any problem rests on certain conditions and generalizations. First, there is a definite objective. It may be the maximization of profits or national income or employment of the minimization of costs. It is known as the objective function or the criterion function. If a quantity is maximized, its negative quantity is minimized. Every maximization problem has its dual problem, that of minimization. The original problem is the primal problem which always has its dual. If the primal problem pertains to maximization, the dual involves minimization and vice versa.

Secondly there should be alternative production processes for achieving the objective. The concept of process or activity is the most important in linear programming. A process is a specific method of performing an economic task. It is some physical operation, e.g., consuming something, storing something, selling something, throwing something away, as well as manufacturing something in a particular manner. The LP technique enables the planning authority to choose the most efficient and economical process in attaining the objectives.

Thirdly, there must be certain constraints or restraints of the problem. They are the limitations or restrictions pertaining to certain conditions of the problems, as to what cannot be done and what has to be done. They are also known as inequalities. They may be limitations of resources such as land, labour or capital.

Fourthly, there are the choice variables, the various production processes or activities so

as to maximize or minimize the objective function and to satisfy all the restraints.

Lastly, there are the feasible and optimal solutions. Given the income of the consumer and the prices of goods, feasible solutions are all possible combinations of the goods he can feasibly buy. Feasible solutions of two goods for the consumer are all combinations that lie on and to the left of the budget line. Whereas, on an isocost line, they are the combinations that lie on and to right of it. We may put it differently that a feasible solution is one which satisfies all the restraints. The optimal solution is the best of the feasible solutions. If a feasible solution maximizes or minimizes the objective function, it is an optimal solution. The best available procedure for finding out the optimal solution out of the possible feasible solutions is the simplex method. It is a highly mathematical and technical method involved in linear programming. However, the main aim of linear programming is to find out optimal solutions and study their characteristics.

Self-Assessment Exercise 2

Briefly Show the conditions and generalizations involves in Linear Programming technique.

1.5 **Assumptions of Linear Programming Technique**

The linear programming analysis is based upon the following assumptions.

i. The decision variables must be continuous; they can take on any value within some restricted range.

ii. The objective function must be a linear function.

iii. The left-hand sides of the constraints must be linear functions.

iv. It assumes a limited number of alternative production processes Institutional factors are also assumed to be constant.

v. Proportionality: that the contribution of individual variables in the objective function is proportional to their value.

vi. Additivity: the total value of the objective function and each constraint is the sum of the individual contributions from each variable.

vii. Divisibility: the decision variables can take on any real numerical values within a

specified range.

viii. Certainty: the parameters are known.

Self-Assessment Exercise 3

What are the axioms of Linear Programming

1.6 Summary

In this unit, we have attempted to discuss the introductory concept of linear programming, its origin and meaning, conditions and generalization, and assumptions underlying the concept. Also, from the point of view of our discussion, you have learnt that the main aim of linear programming is to find out optimal solutions and study their characteristics. I believe your understanding of this unit has given you a basis to understand the next unit. I expect you by now to be anxious of reading more about what will be duly served in the next unit.

1.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

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1.8 Possible Answers to Self-Assessment Exercise(s)

Answers to Self-Assessment Exercise 1

Linear programming is a devised technique for providing specific numerical solutions of problems which earlier could be solved only in vague qualitative terms by using the apparatus of the general theory of the firm. Linear programming has thus helped to bridge the gap between abstract economic theory and managerial decision making in practice.

Answers to Self-Assessment Exercise 2

Refer to 1.4 and do extra-reading to answer this question

Answers to Self-Assessment Exercise 3

Refer to 1.5 and do additional readings

UNIT 2

Linear Programming Technique and Its Application in Planning

2.1 Introduction:

Our discussion in the last unit has introduced to us the linear programming technique and its properties as it can be used in formulating economic plan. Therefore, our discussion in this unit will describe the procedure for stating and solving the problem of Linear Programming, Show the various limitations of linear programming and the Uses of linear programming model in planning of Less Developed Countries of which Nigeria is one. It is important to take closer attention to the explanations given in this unit for easy assimilation.

2.2 Learning Outcomes

At the end of this unit, you should be able to;

- Understand Statement of the linear programming problem.
- Graphically solve the linear programming problem
- Graphically determine the region of feasible solutions
- Graphical determine the objective function
- Determine the optimal solution
- Highlight the Limitations of linear programming technique.
- Mention the uses of linear programming technique in planning

2.3 Statement of the Linear Programming Problem

Assume that a firm has the following quantities of factors of production

L = 400 units of labour (hours)

K = 300 units of capital (machine hours)

S = 1000 units of land (square feet)

The firm can produce either commodity x or commodity y with the following available processes (activities)

	Activity A_1 *for x*	*Activity* A_2 *for y*
Labour	$lx = 4$	$l_y = 1$
Capital	$kx = 1$	$K_y = 1$
Land	$Sx = 2$	$S_y = 5$

In words, the production of one unit of X requires 4 hours of labour, 1 machine hour and 2 square feet of land. Similarly, the production of one unit of Y requires 1 hour of labour, 1 machine hour and 5 square feet of land.

Commodity X yields a unit profit of N2, and commodity Y yields a unit profit of N1. The goal of the firm is to choose the optimal product mix, that is, the mix that maximises its total profit.

The total profit function may be written as follows:

$$Z = 2X + 1Y$$

where: Z = total profit

X = quantity of commodity X (or level of Activity A_1)

Y = quantity of commodity y (or level of Activity A_2)

2 and 1 are the unit profits of the two commodities. The total profit function is called the objective function, because it expresses the objective of the firm, which in our particular

example is the maximisation of profit. In general, the objective function is the function which represents the goals of the economic agent.

The firm, in pursuing the maximisation of its objective function, has several constraints. We distinguish two groups of constraints, technical (or functional) constraints, and non-negativity constraints. The technical constraints are set by the state of technology and the availability of factors of production. There are as many technical constraints as the factors of production. They express the fact that the quantities of factors which will be absorbed in the production of the commodities cannot exceed the available quantities of these factors. Thus, the technological constraints take the form of inequalities.

In our example the technical constraints are the following three

$$4X + lY \leq 400$$

$$lX + 1Y \leq 300$$

$$2X + 5Y \leq 1000$$

where X and Y are the levels of commodities x and y (levels of utilisation of activities A_1 and A_2) and the integers on the left -hand side are the technical coefficients of production, that is, the factor inputs required for the production of one unit of the products X and Y. The figures on the right-hand side are the resources that the firm has at it disposition. These inequality constraints state that the levels of X and Y in the optimal product mix should not require more than the available quantities of the three resources.

The non-negativity constraints express the necessity that the levels of production of the commodities cannot be negative, since negative quantities do not make sense in economics. The level of production of any one commodity can either be zero or positive

$$X \geq 0$$

$$Y \geq 0$$

Given the above information, the linear programming problem may formally be stated as follows:

Maximise: $Z = 2X+1Y$ (objective function)

Subject to: $4X + lY \leq 400$

$lX + lY \leq 300$ {technical constraints}

$2X + 5Y \leq 1000$

$X \geq 0$ {non-negativity constraints}

$Y \geq O$

Note that all the constraints take the form of inequalities. Thus, the system cannot be solved with the usual methods of solution of simultaneous equations. The linear programming technique has been designed to deal with the solution of problems involving inequalities. Its basic approach is that of iteration: the optimal solution is defined by examining the set of possible alternative solutions and eliminating gradually the suboptimal ones until the optimal is reached.

i) Graphical Solution of The Linear Programming Problem

The graphical solution is simple when the problem can be presented on two dimensional diagrams, as in our simple example. When there are more than two variables the graphical solution becomes extremely complicated or impossible to draw. The graphical solution involves two steps. Firstly, the graphical determination of the region of feasible solutions. Secondly, the graphical presentation of the objective function.

ii) Graphical Determination of The Region of Feasible Solutions

A solution is called feasible when it satisfies all the constraints. The non-negativity constraints in our example are shown graphically by the area of the positive quadrant of the usual orthogonal co-ordinate system (figure 4.1). Points on the horizontal axis denote that the production of Y is zero, while the production of X is positive. That is, on the x-axis $X \geq 0$ and $Y = 0$. Similarly, points on they-axis denote that there is no production of x, while the production of y is positive. That is, on the y-axis $X = 0$ and $Y \geq 0$. Clearly points lying inside the two axes imply some production of both commodities ($X > 0$ and $Y > 0$). The shaded area in figure 4.1 and its boundaries (denoted by the two axes) represent the region in which the non-negativity constraints are satisfied. The complete determination of the region of feasible solutions requires in addition the determination of the boundaries or limits set by the technical (functional) constraints, that is, the availability of the factors of production and the given state of technology.

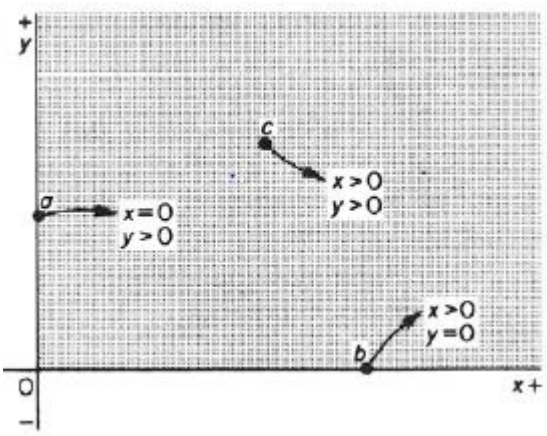

Figure 4.1

Boundary set by the factor 'labour'. This is defined by a straight line whose slope is the ratio of the labour inputs in the production of the two commodities. Thus, if we denote the boundary set by labour with the letter L, we have

[Slope of boundary L] = slope of AB = input of L in X/input of L in Y = 4/1 = l_x/l_y

We may find the boundary L as follows. If all the available labour is used in the production of *y*, the maximum quantity which can be produced of this commodity is

$$0A = L/ly = 400/1 = 400$$

If all the available labour is used in producing *x* the maximum quantity of this commodity is

$$0B = L/l_x = 400/4 = 100$$

These maximum levels of production are denoted by points *A* and *B* in figure 4.2. If we join points *A* and *B* with a straight line, we form the boundary set by the factor *L* (labour). The slope of this boundary is

$$\text{Slope of AB} = \frac{0A}{0B} = \frac{L/lY}{L/lX} = \frac{400/1}{400/4} = \frac{4}{1} = \frac{\text{input of L in x}}{input \text{ of L in y}}$$

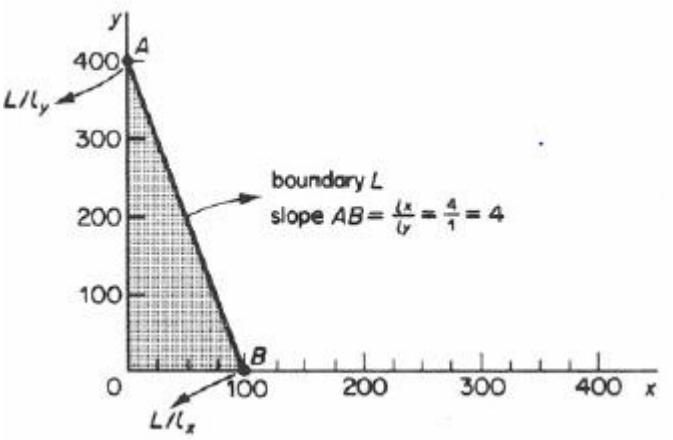

Figure 4.2

The feasible region of production of X and Y defined by the availability of labour (L) is the shaded area OAB in figure 4.2.

Boundary set by the factor capital: In a similar way we may derive the boundary (or limit) set to the production possibilities of the firm by the available quantity of the factor capital (K). The boundary of K will be a straight line (CD in figure 4.3) whose slope is the ratio of the capital inputs in the production of the two commodities.

$$[\text{Slope of boundary K}] = \text{Slope of CD} = \frac{\text{input of K in x}}{\textit{input of K in y}} = \frac{kx}{ky} = \frac{400/1}{400/4} = \frac{1}{1} = 1$$

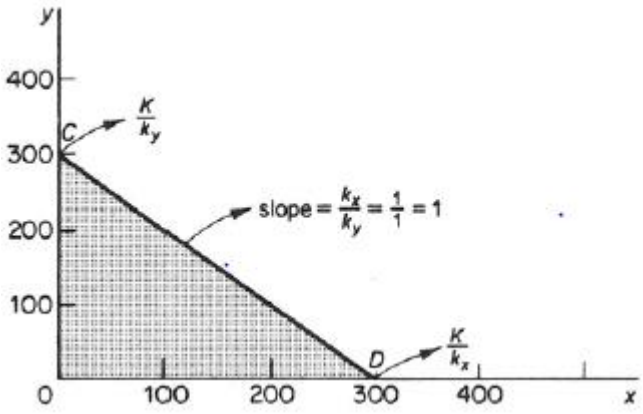

Figure 4.3: Boundary of capita K

In our example the boundary of capital can be determined as follows. If the firm uses all the available units of *K* in the production of *y*, the maximum quantity of this commodity is

$$0C = K/k_y = 300/1 = 300$$

If the firm uses all its *K* in the production of *x*, the maximum quantity of this commodity is

$$0D = K/k_x = 300/1 = 300$$

If we join the points *C* and *D* we form the boundary set by the factor *K*. The slope of this boundary is

$$\text{Slope of CD} = \frac{0C}{0D} = \frac{K/ky}{K/kx} = \frac{300/1}{300/1} = \frac{kx}{ky} = \frac{\text{input of K in x}}{\text{input of K in y}}$$

Boundary set by the factor 'land': The boundary of the factor 'land' (S) is determined in the same way as the previous two boundaries. It is a straight line (EF in figure 4.4) whose slope is the ratio of the land inputs in the production of the two commodities

$$\text{[Slope of boundary S] = slope of EF} = \frac{\text{input of S in x}}{\text{input of S in y}} = \frac{Sx}{Sy} = \frac{2}{5}$$

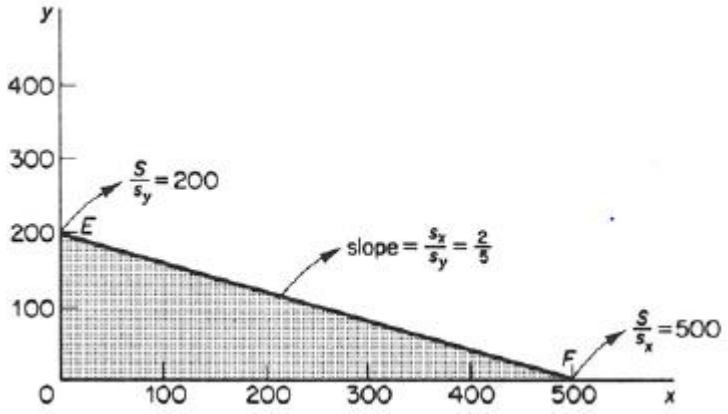

Figure 4.4: Boundary set by land

In our example the boundary of the factor 'land' is defined as follows. If the firm uses all the available units of *S* in producing *Y*, the maximum quantity of this commodity is

$$0E = \frac{S}{sy} = \frac{1000}{5} = 200$$

If all the units of *S* are used in producing *X*, the maximum quantity of this commodity is

$$0F = \frac{S}{sx} = \frac{1000}{2} = 500$$

If we join the points *E* and *F*, we form the boundary for the factor 'land' which has the slope

$$\text{Slope of EF} = \frac{0E}{0F} = \frac{S/sy}{S/sx} = \frac{1000/5}{1000/2} = \frac{2}{5} = \frac{sx}{sy}$$

The region of feasible solutions of the firm is determined graphically if we superimpose the three diagrams showing the boundary-constraints set to the production possibilities of the firm by all the factors of production simultaneously. In figure 4.5 the region of feasible solutions is shown by the area *OEGB* in which all the inequality constraints (technical and non-negativity constraints) are satisfied. Only combinations of *x* and *y* lying in this area and on its boundaries are feasible, given the availability

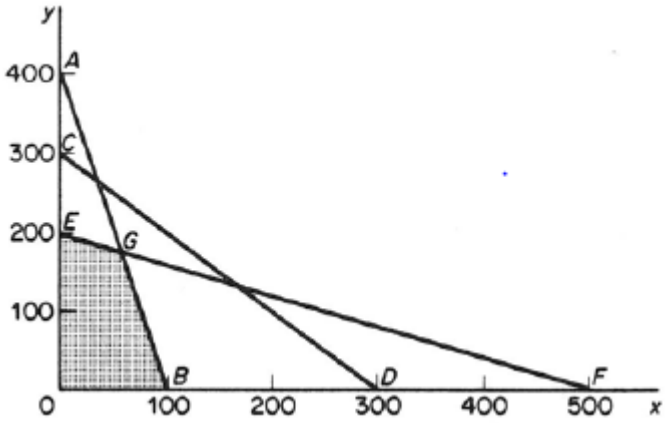

Figure 4.5: Region of Feasible solution

of factors and the state of technology. Of all the feasible solutions only the ones lying on the frontier *EGB* are technically efficient. Thus, the optimal solution must be one of the points on the frontier *(EGB).*

iii) Graphical Determination of the Objective Function

We said that among all the feasible solutions the firm will choose the one that maximises its objective function, that is, the product mix which yields the maximum profit. The objective function in our example may be presented graphically by isprofit lines. We may construct an isoprofit line by solving the objective function for *Y*. Thus, the profit function

$$Z = 2X + 1Y = \pi x X + \pi y\ Y$$

solved for *Y* yields

$$Y = \frac{1}{\pi y} Z - \frac{\pi x}{\pi y} X$$

Clearly the slope of this isoprofit line is

$$\frac{\partial Y}{\partial X} = -\frac{\pi x}{\pi y} = \frac{\text{unit profit of x}}{\text{unit profit of y}} = \frac{2}{1} = 2$$

By assigning various values to the level of total profit (Z) we can compute the whole family of isoprofit lines (isoprofit map, figure 4.6). These lines have a negative slope and are parallel, given that the unit profits of the two commodities are assumed constant. The further away from

the origin an iosprofit line is the greater the total profit it denotes.

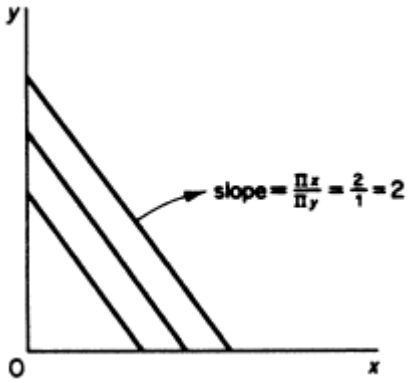

Figure 4.6: Isoprofit map

iv) Determination of the Optimal Solution

The optimal solution is found by the point of tangency of the frontier of the region of feasible solutions to the highest possible isoprofit curve. The optimal solution will be a point on the frontier of the region of all feasible solutions, because any point inside this region lies on a lower isoprofit line. It is clear that the optimal solution depends on the slope of the isoprofit lines, that is, on the ratio of the unit profits of the two commodities. In our example the optimal solution is point Gin figure 4.7.

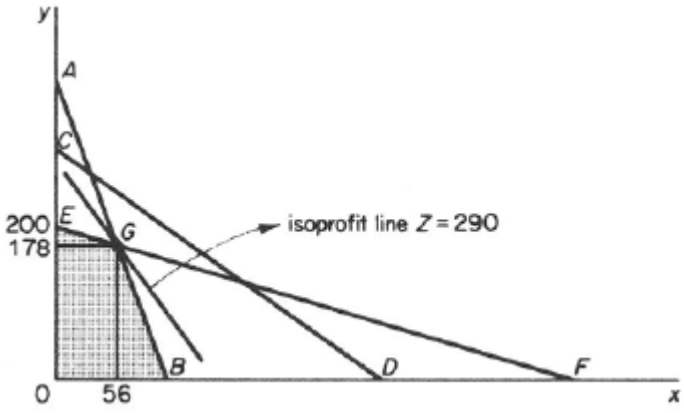

Figure 4.7: Point of optimal solution

At this point the product mix is 178 units of *y* and 56 units of *x*, and the maximum profit amounts to £290, as can be verified from the profit function

$$Z = 2X + 1Y = 2(56) + 1(178) = 290$$

If the slope of the isoprofit line is equal to the slope of any one of the boundary lines which define the region of the feasible solutions, there is no unique optimal solution to the linear programming problem. For example, if $\pi x/\pi y = lx/ly$ (=slope of *AB* which is the boundary for the factor 'labour' all the points on the segment *GB* will be optimal solutions. Similarly, if $\pi x/\pi y = sx/sy$ (=slope of *EF* which is the boundary for the factor 'land') all the points on the segment *EG* of the production-possibility frontier will be optimal solutions. From the above discussion it should be obvious that a unique optimal solution exists if the slope of the line representing the objective function has a value lying within the range set by the slopes of the boundary lines which denote the technical restrictions of the linear programming problem. We may generalise the above procedure for the determination of the optimal solution as follows.

Step 1. Write the technical inequalities in the form of equalities and solve them for *Y*

$$l_1X + l_2Y = L$$
$$k_1X + k_2Y = K$$
$$s_1X + s_2Y = S$$

Solving these equations for *Y* we obtain the equations of the three boundary lines: The equation of boundary *L* is: $Y = \frac{1}{l2}\mathrm{L} - \frac{l1}{l2}\mathrm{X}$

The slope of the *L* boundary is

$$\frac{\partial Y}{\partial X} = -\frac{l1}{l2}$$

We may draw the *L* boundary by assigning various values to *X* and plotting the resulting points on a graph. (The value of *L is* given.)

The equation of the boundary *K* is

$$Y = \frac{1}{k2}\mathrm{K} - \frac{k1}{k2}\mathrm{X}$$

The slope of the *K* boundary is

$$\frac{\partial Y}{\partial X} = -\frac{k1}{k2}$$

We may draw the *K* boundary by assigning various values to *X* (given the value of K) and

plotting the resulting points on a graph. The equation of the boundary *S* is

$$Y = \frac{1}{s2}\mathrm{S} - \frac{s1}{s2}\mathrm{X}$$

The slope of the *S* boundary is

$$\frac{\partial Y}{\partial X} = -\frac{s1}{s2}$$

We may draw the S boundary by assigning different values to X (given the quantity of S) and plotting the resulting points on a graph.

Step 2: Determine the region of feasible solutions. This is the area within all the boundaries set by the technical restrictions. Only the parts of the areas below the individual boundary lines that coincide, when the various graphs (of Step 1) are combined, do satisfy all the constraints.

Step 3: Define the isoprofit lines by solving the profit equation for Y

$$\mathrm{Z} = \pi_1\mathrm{X} + \pi_2\mathrm{Y}$$

$$\mathrm{Y} = \frac{\pi 1}{\pi 2}\mathrm{Z} - \frac{\pi 1}{\pi 2}\mathrm{X}$$

$$\frac{\partial Y}{\partial X} = -\frac{x1}{x2}$$

The set of isoprofit lines can be drawn by assigning different values to *Z* and to *X*.

Step 4: Define the optimal solution by comparing the slope of the isoprofit line with the slopes of the boundary lines that define the region of feasible solutions. Since all lines have negative slopes we can ignore their signs when doing the comparison. In our example only two boundary lines define the region of feasible solutions. (The factor *K* does not set any limit to the choice of the firm, given the other factors Land S.) The slopes of the boundary lines are

Slope of boundary L: $\frac{l1}{l2} = \frac{4}{1} = 4$

Slope of boundary S: $\frac{s1}{s2} = \frac{2}{5} = 0.4$

Slope of isoprofit line: $\frac{\pi 1}{\pi 2} = \frac{2}{1} = 2$

Given that:

$$\frac{s1}{s2} < \frac{\pi 1}{\pi 2} < \frac{l1}{l2}$$

$$\frac{2}{5} < 2 < \frac{4}{1}$$

i.e.: $0.4 < 2 < 4$

we conclude that there is a unique solution, and that this optimal solution is defined by the intersection of the two boundary lines that define the region of feasible solutions.

Self-Assessment Exercise

Graphically illustrate the optimal solution of LP as used in this section.

2.4 Limitations of Linear Programming

Linear programming has become a highly useful tool of analysis in development planning. However, it has its limitations like just other analytical tools. It should be noted as a matter of fact that, actual planning problems cannot be solved directly by the LP technique due to a number of restraints. Some of them include the following:

- It is not easy to define a specific objective function.
- Difficulty in finding out the various social, institutional, financial and other constraints which may be operative in pursuing the given objective.
- It may be possible that the constraints given might not be directly expressible as linear inequalities.
- Difficulty in estimating relevant value of the various constant co-efficient that enter into an LP problem, i.e., population, prices, etc.
- It is based on the assumption of linear relations between inputs and outputs which is not always realistic. In real life, most of the relations are non-linear.
- It is based on the unrealistic assumption of perfect competition in product and factor markets.
- The LP technique is based on the assumption of constant returns in the economy. In reality, there are either diminishing or increasing

returns.

- In practice, the LP technique is being used in solving a limited number of economic problems in developing countries. This is due to the lack of proper personnel for working out mathematical equations and for operating highly mechanical computers.

Self-Assessment Exercise

Highlight the various limitations known to you when considering Linear Programming.

2.5 Uses **of Linear Programming in Planning**

i. Linear Programming technique is extremely useful for sectoral planning in developing countries, for example, in selecting optimum alternatives in respect of location and technologies in industries, transport and power.

ii. LP technique is being used in farm management for determining the optimum combination of different crops e.g.: livestock and crops.

iii. The objective function in LP is useful in arriving at either minimization of costs or the maximization of income.

iv. The technique is being used for the solution of diet problem where the aim is to minimize costs, given the values of minimum nutrients of the diet and the prices of products as constraints.

v. It is also with the LP technique that the transport problems are being solved by the railways, airways and transport companies with regard to the selection of routes, transportation of goods, allocation of the means of transport (i.e., railway, wagons, aircrafts, trucks etc. depending on the type of transport under study).

Superiority of the Linear Programming Over Input-Output Technique

Linear programming as a tool of economic development is more realistic than the input-output approach. In input-output analysis only one method is adopted to produce a commodity. It does not take into consideration the bottlenecks (constraints) which a

development project has to face in underdeveloped countries. But in linear programming a definite objective is set to maximize income or minimize costs. All possible processes or techniques are taken into account for achieving the desired objective. This necessitates even the substitution of one factor for another till the most efficient and economical process is evolved. So, projects and techniques which are too uneconomical to implement are not undertaken.

By assuming certain constraints, linear programming as a tool of development planning is superior to the input-output technique. In underdeveloped countries, the planning agencies are faced with such constraints as the lack of sufficient capital and machinery, growing populations, etc. Resources exist that cannot be used properly for want of the co operant factors. Linear programming takes to due note of these constraints and helps in evolving an optimum plan for attaining the objectives within a specified period of time. Thus, the LP technique has been used for constructing theoretical multi- sector planning models for countries like India. Such models extend the consistency models of the input-output type to optimization of income or employment or any other quantifiable plan objective under the constraints of limited resources and technological conditions of production.

Self-Assessment Exercise

Mention the uses of Linear Programming in plan programming that you know.

2.6 Summary

In this unit, we have attempted to discuss the linear programming technique and its application in planning, Production capacity technique of LP, Limitations of linear programming technique and the uses of linear programming technique in planning. Also, from the point of view of our discussion, you have learnt that the main aim of linear programming is to find out optimal solutions to available constraints posed by available resources. I believe your understanding of this unit will prepare you for the last unit of this last module. Therefore, read ahead.

2.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

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2.8 Possible Answers to Self-Assessment Exercise(s)

Consult the literature and provide succinct explanations to all the exercises

UNIT 3

Project Selection Technique of Cost-Benefit Analysis

3.1 Introduction:

This is the last unit of the last module of this course. Our discussion in the last unit has finally taught us what we need to know about linear programming technique and its usefulness in formulating economic plan. Therefore, our discussion in this unit will describe the Projects Selection technique of cost-benefit analysis, optimal investment allocation, Problems of multiple objectives in investment allocation and assumptions underlying project selection. It is important for us to take closer attention to the explanations given in this unit for easy assimilation and understanding.

3.2 Learning Outcomes

At the end of this unit, you should be able to;

- Understand optimal investment allocation.
- Solve problems of multiple objectives
- Understand the assumptions underlying project selection

3.3 Optimal Investment Allocation

Once the planning authority has laid down the optimum investment target called the optimal investment allocation (whether derived from the availability of resource or the desired rate of growth of national output), the next important step in this macro phase of plan formulation is to determine the investment priorities. This relates to the composition of investment or the sectors and projects that should receive priority in the plan. In economics, such a decision belongs to the area of optimal investment allocation. It is therefore the responsibility of the planning authority to choose and priorities well on the best and needed projects that can fit into their plan to satisfy the condition of optimal allocations of projects. However, this is based on the economic system that is prevalent in such nation be it developed or developing.

-Types of economic system

In a decentralized economic system, or a free enterprise economy, investible resources would be attracted by those sectors or projects that offers the highest rates of return on capital invested. However, in a planned process of economic development, such a criterion of investment allocation may be a very faulty guide to the optimization of the objective of the plan. For one thing, in an LDC, the price mechanism may not act as perfectly as it does in developed countries. For another, there may be considerable divergence between social and private costs and benefits of investment in different sectors.

A less developed country can therefore not afford to draw up a plan in which the investment pattern happens to be inefficient or suboptimal. How do we decide whether an investment pattern is an efficient or inefficient one? The simple test would be that in which no sector or project included in the plan should yield a lower marginal discounted income per unit of the scarce resources used than any sector or project excluded from the plan, otherwise, it will be difficult to maximize the present value of (discounted) income.

Self-Assessment Exercise

What do you understand by optimal investment allocation?

3.4 Problems of Multiple Objectives in Investment Allocation

The selection of priority sectors and projects for inclusion in a plan is complicated by the existence of multiple objectives underlying a plan. These objectives may be, for instance, the maximization of the rate of growth of real national income or per capital output, creation of maximum employment opportunities, maximisation of consumption or some balance of payments objectives. There is no single technical criterion which would optimize all the objectives of a plan at the same time.

The second problem that arises is that even if we attach greater importance to a single objective, like the maximization of the rate of growth of national output, there is no unanimity about the most suitable investment criterion to be used. The planner has to choose a suitable investment criterion in order to make a choice therewith of priority sectors and projects.

Even after the choice of investment criterion has been made, the selection of priority areas of development is not a straight one. A scholar argued that investment planning in the LDCs consists of ranking projects in accordance with their benefit-cost ratio in descending order and choosing projects till the investible funds available for the plan are exhausted. This gives one the impression of a plan being little more than a more collection of projects. Such a method of assigning priorities obviously goes away with all the macro-economic exercises that are necessary for investment planning. Even then, little can authority of Less Developed Countries do in this regard.

Self-Assessment Exercise

Discuss the problems of multiple objectives as encountered under optimal investment allocation.

3.5 Assumptions Underlying Project Selection

The above method of ranking projects and sectors in order of their Cost- benefit ratios for determining priorities are based on two principal assumptions, namely

(1) That each project or sector of the economy is an independent entity and

(2) That it has no indirect costs and benefits ratio. This, however would be an over-simplified way of assigning priorities and would give us a less than optimal result. This would be clear from the following example.

Suppose on the basis of Cost-benefit-ratios the following five sectors have been ranked for inclusion in a hypothetical plan.

Table 3.5

Types of Projects	Cost/Benefit Ratio
1. An irrigation project	.91
2. An iron and steel mill;	.89
3. A coal mining project;	.88
4. A soil conservation scheme;	.71
5. A railway project	.69

Now, out of this list, if the total savings available would allow for the inclusion of only two schemes in the plan. Which ones can be selected? A superficial answer could be that since the first two projects yields a higher Cost-benefit ratio, these should receive priority. But it will be noted that projects (1) and (4) are complementary and would result in a greater increase in output, if undertaken simultaneously, than (1) and (2) or project (3) and (4). Similarly, the case of projects (2) and (5) are complementary in that iron and steel project compliment railway project and as such should be given higher priority of selection.

The reason behind it is that various projects and sectors, especially in an LDC, are characterized by complementary on external economies and diseconomies. Different sectors of an economy are interdependent because of which the nature and significance of a project changes dramatically. In order to evaluate the priority of a sector or project, these externalities must be internalized, i.e., taken note of any calculations that are made to determine the investment priorities.

TABLE 3.6

Project Selections and Cost-Benefit Ratio Structure

Projects CBR Complementary Structure

-1	**2**	**3**	**4**	**5**	
1. An Irrigation project	**.91**	**-**	**67.5**	**39**	**99.2**	**74.0**
2. An Iron and Steel Mill	**.89**	**67.5**	**-**	**41**	**37.4**	**90.7**
3. Coal Mining Project	**.88**	**39.0**	**41.0**	**-**	**47.0**	**81.1**
4. Soil Conservation schm	**.71**	**99.2**	**37.4**	**47**	**-**	**69.0**
5. A railway Project	**.69**	**74.0**	**90.7**	**81**	**69**	**-**

In the above CBR (cost-benefit ratio) table, we can confidently select projects that are complementary in the structure. Project 2 and 5 i.e., Iron and Steel is a complement to Railway project which has a CBR of .89 and .69 and a complementary structure of 90.7.

Invariably, if the planning authorities were to select projects, they will choose projects that has high CBR and are complementary to achieve optimum and efficient resources allocation.

Self-Assessment Exercise

As an Economic planner, rank and discuss the projects above according to order of priorities to you and make your comments.

3.6 Summary

In this unit, we have attempted to discuss Projects Selection technique of cost-benefit

analysis, optimal investment allocation, Problems of multiple objectives in investment allocation and assumptions underlying project selection. Also, from the point of view of our discussion, you have learnt that if the planning authorities were to select projects, they will choose projects that has high CBR and are complementary to achieve optimum and efficient resources allocation. I believe you have intimate yourself with your course material and have been able to acquire the needed knowledge that is expected of you. I therefore encourage you to read more for proper impartation and assimilation of this course.

3.7 References/Further Reading/Web Resources

Akosile I.O, Adesanya A.S Ajani A.O (2012): - Management of development (A Nigeria perspective) Olas Ventures, Mushin, Lagos.

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