INTER-INDUSTRY LINKAGES AND THE CONTRIBUTION OF THE OIL AND GAS INDUSTRY[1] TO THE GROWTH OF THE NIGERIAN ECONOMY

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[1] Industry and sector are used interchangeably depending on the context of analysis. Also the term petroleum is intermittently used to refer to oil and gas.

DECLARATION OF RIGHTS

DEDICATION

To my Parents, Wife, and Children.

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ABSTRACT

Technological progress is the driving force of economic growth. The neoclassical growth models postulate that technological progress is derived from exogenous impact of production relationship while the endogenous growth models ascribe the source of technological progress to the ability of factors of production to respond to externalities generated by production activities in accordance with " learning-by-doing" complemented by R&D. This implies a convergence on the crucial relevance of technology in enhancing the effectiveness and value-adding functions of factors of production as the bedrock of economic growth. It follows intuitively that inter-industry linkage process, which involves multisectoral input-output interdependence of productive activities of different sectors of the economy, is germane to the value-adding capabilities of factors of production that propels economic growth. As a key sector with intrinsic versatility, the oil and gas industry in Nigeria has enormous linkage potentials that can be a cylinder for robust inter-industry linkage processes for sustainable growth of the Nigerian economy.

Various linkage measures; backward and forward linkages, output multipliers; employment, income and value-added effects and multipliers for sectors of the Nigerian economy are computed and analysed with focus on the linkage significance of the oil and gas industry. It reveals that a formidable inter-industry linkage processes is not emerging with relative low level of integration of the oil and gas industry with other sectors of the economy. Hypothetical Extraction scenario indicates that the stimuli from the oil and gas industry are not inspiring. By policy simulation, it is discovered that the inter-industry linkage process cannot be significantly improved by more refining activities, suggesting the existence of low levels of absorptive capacities of the sectors of the economy arising from structural distortions and technological weakness.

By implication, the effectiveness of factors of production, the critical requirement of economic growth, is hampered, compounded by the absence of system of innovation that could inspire the emergence of technological capabilities. Investments in social and economic services as well as physical infrastructures that leads to a bourgeoning income earning household sector that seeks to satisfy its consumption needs and create effective markets that facilitates inter-industry linkages is the veritable route towards innovation, endogenous technology and sustainable growth.

Chapter 1
INTRODUCTION

1.1: RESEARCH ISSUE

The fundamental issues of economic growth revolve around critical determinants, as well as supporting and retarding factors, which lies in the complex interactions among various forces within the economic environment. Kuznets (1971)[1] defined economic growth of a country as *"a long term rise in capacity to supply increasingly diverse economic goods to its population; this growing capacity is based on advancing technology and the institutional and ideological adjustments that it demands"*. The increase in the outputs of major sectors of an economy such as manufacturing and natural resource due to increase in the use of inputs or improvement in technology, leads to economic growth. Key macroeconomic indicators such as the gross national product (GNP), gross domestic product (GDP) and net national product (NNP) are used, among other economic parameters, as measures of economic growth performance of an economy. Thus progressive increase in the outputs of major sectors of an economy is a manifestation of the attainment of economic growth.

Basically, economic growth is driven by a process that is generated and sustained by the efficient utilisation of economic resources to meet effective demand and social needs. The challenge facing countries in attaining economic growth is that of creating an enabling atmosphere for harnessing of economic resources. This challenge has become even more intensified by an increasingly interdependent global economic dispensation that tends to undermine and marginalise indolent economies, which has given rise to disparities among countries of the world in terms of their levels of attainment of economic growth. Some economies have witnessed a sudden and remarkably very high growth rates above the world average. This achievement is being referred to as growth miracles. On the other hand those economies that have performed abysmally below world average are referred to as growth disasters.

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[1] Kuznets, (1971) Modern Economic Growth: Findings and Reflections, Nobel Lecture delivered in Stockholm, Sweden and Published in the American Economic Review, 63, September, 1973. quoted in Todaro (1994)

The neoclassical and endogenous growth models of economic growth, regarded as the two broad classifications of economic growth theory (McCallum, 1996), have dwelled extensively on the theoretical and empirical requisites of economic growth. In cognisance with the classical argument of Malthus (1798), natural resource utilisation, pollution and other environmental considerations have become critical to the possibilities of long-run economic growth (Romer, 2001). The effect of natural resources on society is as old as human activities. The environment inserts itself at the intersection between nature and society, in that outputs of human economic activities (production, exchange and consumption) generate environmental problems while the depletion of scarce renewable and non-renewable natural resources raise concerns about the sustainability of economic rents from the exploitation of natural resources. Considering that economic growth entails the capacity to supply increasingly diverse economic goods, natural resources such as oil and gas have the potential for being catalyst for generating economic growth process if properly harnessed. Even though natural resources have been part of economic growth analysis much earlier, the publication of *The Limits of Growth* (Meadows *et al.*, 1972) propelled an upsurge in research on the economics of natural resources. Beside the perception of being a basis for national prosperity, power and wealth, issues such as essentiality, intergenerational equity, sustainability and optimal utilization of natural resources have crystallised the crucial role of natural resources in the attainment of economic growth. Natural resources, conceived as factor inputs, fit into the classical production function, and have thus become a significant component of economic growth analysis, which stresses the constraints imposed by finite resources and the principle of diminishing returns.

Real productive activities engender economic growth by ensuring a continuous improvement in the methods of production, discovery of new resources and thus creating the necessary conditions for efficient utilisation of resources. A multiple sector positive performance is essential for the growth of the overall economy, but a sector of the economy that attracts large spectrum of economic activities can stimulate the productive fibre of other sectors towards real production and provide the requisite impetus for sustainable growth of the economy. A natural resource sector, such as oil and gas, tends to generate tremendous economic activities arising from their intrinsic versatile utility value. The temptation for rent seeking behaviour could undermine the efficient use of the natural resource and other resources of the economy thereby crippling the chances of growth of the economy. If rents, derived from natural resource extraction, are used to facilitate complacent consumption[2] at the detriment of real production, there will be expansion of non-tradable sector activities leading to the shrinking in tradable sector activities such as manufacturing. This phenomenon is referred as the "Dutch Disease"[3] and it is a chronic source of slow growth due to the absence of "backward and forward" linkages among sectors of the economy (Sachs and Warner, 1997). The manufacturing sector, with a thriving service sector for support, is a vital source for economic growth through learning-by-doing, as such should have a pivotal link with the oil and gas sector in terms of resource use for real productive activities that propels the economy towards sustainable growth path.

Inter-industry linkage analysis describes a multi-industry process of complex combination of numerous and diverse resources that are transformed into usable goods and services. This process is hinged on the method of input-output that illustrates the use of resources obtained from different sectors by other sectors of the economy. The absorptive capacity (ability of capital investment or resource to yield appreciable level of return) of industries and that of the overall economy provides the impetus for inter-industry linkages. The productivity level of the economy reflects on the value-adding capabilities of factors of production which hinges on the level of inter-industry linkages that exists within the economy. There is a positive relationship between the extent of inter-industry linkages and the level of output of the economy, which is an important measure of economic growth. Given that economic growth is engendered by efficient use

[2] This refers to a consumption pattern that is disconnected from economic activities of a given economy as such does not stimulate further economic activities of the economy

[3] The "Dutch disease" is an economic phenomenon in which a sharp increase in the output and revenue of one product in an economy has adverse repercussions in other sectors of the economy. There are variant models of the "Dutch disease" syndrome, all of which demonstrates that the existence of large natural resource sectors, or booms in these natural resource sectors, will affect the distribution of employment throughout the economy as wealth effects pull resources in and out of other sectors of the economy. The disease is most pernicious when the revenue of the product that started the problem reverses itself, and the economy is left high and dry with an inappropriate composition of output.

of resources and considering that inter-industry linkages are about multi-industry absorption of resources obtained from different sectors of the economy, a formidable inter-industry linkage process is crucial for attaining economic growth.

The Nigerian economy revolves around the oil and gas industry, in that the industry exerts a prominent influence on the economy as a key revenue earner, contributing over 70 per cent of total federally collected revenue annually and an average of 28.2 per cent to real GDP. Considering that the oil and gas industry dominates the economic activities of Nigeria and given the enormous economic activities within the sector and the nature of its versatile resource relevance, it is expected to stimulate other productive sectors of the economy. This in turn is expected to lead to backward and forward linkages of the sectors of the economy that could generate a sustainable growth process for the Nigerian economy. After more than forty years of oil and gas extraction (upstream activities) and about thirty-five years of oil refining in Nigeria and of recent other downstream activities such as petrochemicals, a comprehensive evaluation of the contribution of the oil and gas industry to sustainable growth of the Nigerian economy is imperative.

This research study delved into the pertinent issues relating to the activities of the oil and gas industry, its inter-industry linkage relevance and contribution to the growth of the Nigerian economy. The key research questions are:

(1) Have the activities of the oil and gas industry stimulated other sectors towards robust inter-industry linkages in the Nigerian economy?
(2) Have there been significant impacts and contributions of the oil and gas industry to the growth of the Nigerian economy?
(3) What are the possibilities of oil and gas driven process of growth of the Nigerian economy?

1.2: INTER-INDUSTRY LINKAGES AND ECONOMIC GROWTH NEXUS

Economic growth process is crucially intertwined with the transformation of resources to different forms of use. Complex interactions of several variables such as demand and supply or wages and prices, as well as a series of transactions in which actual goods and services are exchanged are involved in the transformation of resources into various uses. Given the diverse nature of contemporary economies, the process of transforming resources involves substantial mix of ideas (technology) with other factors of production such as land and labour, in addition to other resources from different activity sectors of the economy. Resources, in their natural form, have limited direct economic use in satisfying human needs but transforming them into goods and services enhances their economic value to the society. Since resources are obtained from varied natural processes based on industry/sector categorisation of the economy, the mix of productive activities by different sectors of the economy is the fountain of the transformation of resources into goods and services and the bedrock of economic growth process.

Inter-industry linkage analysis seeks to establish the multi-industry relationship that is involved in the transformation of resources into goods and services. The essence of inter-industry linkages is to describe with precision, the complex combination of numerous and diverse resources and the processes of their transformation that leads to the production of final commodities. This illuminates the different stages of production chain in that the intensity of inter-industry linkages illustrates the level of value-adding activities of factors of production, which is also a determinant of the output level of the entire economy, a *sine qua non* for economic growth. Basically, inter-industry linkages are of two basic types, namely backward and forward linkages; backward linkages occur when an industrial activity induces domestic production and supply of inputs needed in that activity and forward linkages occur when an industrial activity induces the utilisation of its output by other domestic production activities (Hirschman, 1958).

The absorptive capacity of industries and that of the overall economy provide impetus for inter-industry linkages. The productivity of factors of production has a positive relationship with absorptive capacity and the level of inter-industry linkages.

Technological inter-connections among various sectors of the economy could evolve from structural and spatial interdependence of the production processes of the sectors. The rational response to inducements and incentives propel the inherent capabilities of factors of production to be transmitted into technological relationships. This leads to increase in the level of activities of sectors of the economy in a self-reinforcing manner. The expansion of activity in a given industry leads to increase in demand for inputs from the sector(s) and the supplying sector(s) respond to the stimuli of increased demand by expanding production. The embodying expansionary effects of inter-industry linkages provide opportunities for economies of scale, which could translate into lower per unit cost of production.

The input-output model, based on the pioneering work of Wassily Leontief (1936), is a basic tool for analysing inter-industry linkages. The input-output table, which is anchored on double-entry structure with all industries presented in both horizontal rows and vertical columns, reveal the fabric of the economy by showing how the various sectors/industries of the economy are weaved together. The vertical column of a basic input-output table states the inputs of each of the various goods and services that are required for production in each of the respective industries. This is presented in the form of outlays of all sectors within the economy and the totals of these outlays reflect the total production for the economy (within the year under consideration). The horizontal rows represent outlays of the inputs of sectors/industries to various sectors of the economy. The total of the outlays for the columns is the total output of the economy while the total for the rows represents the extent of the supply of inputs by each of the sectors in the row. The final demand element of the vertical column usually illustrates the gross national product (GNP), which is a measure of the productive activities and by implication economic growth.

The changing pattern of inter-industry linkages, which describes inherent dynamic properties, is useful for analysing the process of economic growth (see for instance, Leontief, 1986; 31 and Bulmer Thomas, 1982; 222). Also, the high linkage hypothesis (Hirschman, 1958) has gained tremendous analytical relevance by providing insights into the determination of high linkage sectors as the potential source of growth of the overall economy (Yotopoulos and Nugent, 1973 and 1976; Laumas, 1975 and 1976; Jones, 1976 and Cella, 1984). Strategic consideration of a large activity sector identified as a key sector with high linkage relevance to other sectors can lead to gradual diffusion of value-adding activities across sectors of the economy to ensure efficient utilisation of resources and generate economic growth. Endogenous growth theory and the leading sector strategy of economic growth (Currie, 1974 and 1997) give additional credence to this conception of economic growth process.

1.3: RESEARCH OBJECTIVES

The main objectives of the research are:

(1) To establish a conceptual link between inter-industry linkages and the process of economic growth.

(2) To determine the levels of inter-industry linkages in the Nigerian economy and the impact of the oil and gas industry.

(3) To analyse the economic growth implications of oil and gas activities and evaluate the performance of the oil and gas industry and the growth performance of the Nigerian economy.

1.4: METHODOLOGY

1.4.1: Analytical Framework

The theoretical expositions of the standard theories of economic growth and the implication of natural resource utilisation for inter-industry linkages and economic growth is the analytical platform with which this research evaluated the contribution of the oil and gas industry to the growth of the Nigerian economy. The levels of inter-industry linkages within the economy illuminate the extent of value-adding activities in the oil and gas industry and other sectors of the economy. Additional inferences have been drawn from the building blocks of the economic growth models as well as the implication of natural resource utilisation. A contextual analysis on the Nigerian oil and gas industry and economy is carried out with reference to such related issues as technology input, production externalities, intergenerational equity, optimal depletion strategies and sustainability. It postulates that the relationship between oil revenue derived from the industry and the fiscal behaviour of government is a crucial determinant of the performance of the economy. Basically, the efficiency of the functions of government in harnessing domestic resources is a prerequisite to the effective contribution of the oil and gas industry to the growth of the economy.

1.4.2: Type and Sources of Data

Data were sourced from publications of the Central Bank of Nigeria (CBN), the Nigerian National Petroleum Corporation (NNPC), the Federal Office of Statistics (FOS) in Nigeria, as well as reports of commissioned studies and publications on the Nigerian economy by various authors, national and international agencies such as the World Bank, International Monetary Fund (IMF) and the United Nations Development Programme (UNDP). The input-output data used for the computation of inter-industry linkage coefficients were sourced from the FOS while other sources provided additional data/information for the research.

1.4.3: Method and Instrument of Analysis

Theoretical and empirical imperatives of economic growth and the implications of natural resource utilisation is the background for analytical inferences. The link between inter-industry linkages and economic growth process formed the perspective and provided insights into the expected role of the oil and gas industry in stimulating inter-industry linkages that could facilitate the process of efficient utilisation of resources. Thus a triangular analytical building block comprising of economic growth theory, inter-industry linkage analysis and the "keyness" of a natural resource sector such as oil and gas is developed as the research platform. After reviewing the methodological strands of inter-industry linkages, the values of various inter-industry linkage coefficients are computed and used for empirical discussion of inter-industry linkages in the Nigerian economy.

To complement the inter-industry linkage inferences and deductions, a qualitative analysis of the economic implications of oil and gas activities is carried out based on which the contribution of the oil and gas industry to the growth of the Nigerian economy is evaluated using such macroeconomic indicators as output of the industry, revenue contribution, contribution to GDP and value-adding activities of the downstream sector of the oil and gas industry. The significance of sound macroeconomic management in the provision of social and economic services towards the emergence favourable investment climate; government policies on upstream and downstream sub-sectors of the oil and gas industry; and government policies towards domestic production are regarded as critical determinants of the contribution of the oil and gas industry to economic growth.

Given the high revenue potential of the oil and gas industry, efficiency in government expenditure could have expansionary multiplier effects with far-reaching impact on economic growth. According to the Smith-Young-Currie exposition of endogenous growth (see for instance Currie, 1997 and Sandilands, 2000), economic growth is spurred by the opportunities for increased productivity that depends much on the extent of increased specialisation that is, in turn, hinged on the increasing size of the market. This exposition is considered to be relevant to the process of oil and gas industry driven growth of the Nigerian economy. That is, a larger output multiplier for the economy, over and above the direct input-output linkage effects can be attained if the income earned from oil are expended in a pattern that creates increasing markets for goods and services that are domestically produced by industries that absorb oil and gas resources in their production processes. Considering that activities in both the downstream and upstream sectors of oil and gas generate both positive and negative externalities, regulatory and macroeconomic policy challenges arise based on the need to mitigate the negative externalities while taking opportunities of the positive externalities for attaining sustainable economic growth.

1.4.4: Chapter Outline

The outcome of this research is presented in nine chapters organised as follows:

- *Chapter 1* introduces the issues pertaining to the research comprising the concepualisation of the three angles of the research; economic growth, natural resource and inter-industry linkages, methodology, relevance and limitations of the research among others.

- *Chapter 2* is a theoretical review of the literature, comprising mainly survey of standard economic growth models with inferences on policy implications and the relevance of inter-industry linkages in the major arguments. Different variants of the two broad classification of economic growth models; neoclassical and endogenous is considered while highlighting their convergent points especially as they relate to the critical determinants of economic growth. This is extended to capture the essence of natural resources in economic growth.

- *Chapter 3* dwells on theoretical literature on the impact of natural resources on economic growth as well as a discussion of all the aspects of economic growth analysis including the standard models reviewed in chapter 2 based on accessible empirical literature. The usefulness of inter-industry linkages is also brought to the fore and a context for analysing the Nigerian oil and gas industry and economy emerged to set-out a perspective for the core issues of the research.

- *Chapter 4* provides an overview of the Nigerian economy, tracing its origin from pre-colonial period and the evolutionary stages it has gone through. It highlights the drastic transformation of the structure and composition of the economy brought about by the discovery of oil and the resultant huge revenue earnings from oil exports.

- *Chapter 5* delves into the anatomy of the Nigerian oil and gas industry dating back to the initial discovery of oil. Issues covered include the nature and processes of oil extraction, the regulations in the industry, contractual models adopted (JVC, PCS etc), investment and productive activities in the downstream sector and agencies of the industry and their responsibilities.

- *Chapter 6* reviews the different methods of inter-industry linkage analysis that have emerged over time. Two broad classifications; traditional and new generation approaches of inter-industry linkages are identified and their relationship with economic growth processes are highlighted.

- *Chapter 7* is an empirical discussion of inter-industry linkages in the Nigerian economy. Previous inter-industry linkage analysis on the Nigerian economy (Ajakaiye, 1990 and Falokun, 1998) is cursorily discussed followed by the presentation and analysis of the various linkage measures computed for the Nigerian economy. The *Type 1and 2* output multipliers; employment, income and value-added effects and multipliers as well as forward linkage indicators *(Types 1 and 2)* are computed and analysed for 33 sectors of the Nigerian economy for five years (1997-2001). The *Hypothetical Extraction* method is used to determine the stimuli and impacts of the oil and gas industry on other sectors of the economy. To underline the cruciality of downstream activities in stimulating inter-industry linkages, a policy simulation of oil refining activities is carried out by imposing a 25 per cent increase in activities of the Oil Refining sector. The results indicates that there is a mismatch in the increase in inter-industry linkages and output of other sectors with the 25 percent increase thus suggesting a structural weakness and low level of absorptive capacity of the sectors and the economy as a whole. The empirical inter-industry linkage discussion is complemented by qualitative analysis carried out in chapter 8.

- *Chapter 8* used such qualitative data as trends in growth rates of GDP, growth rates of revenue, domestic production and consumption of petroleum products and capacity utilization of refineries to evaluate the contribution of the oil and gas industry to the growth of the Nigerian economy. A context for the potential contribution of the industry to economic growth is derived from theoretical and empirical ideas. The growth performance of the economy in terms of the nature and processes of contribution to GDP by different categorization of the activity sectors of the economy followed.

- *Chapter 9* comprise of a diagnosis of the Nigerian oil and gas industry and the economy as well as the summary and conclusion of all the issues covered by the research. The diagnosis attempts to explain the reasons for the low levels of inter-industry linkages, as well as the stimuli and impact of the oil and gas industry, the logical effect on the contribution of the industry to economic growth and by extension the impact of these on the growth performance of the economy. Regulatory and operational issues in the oil and gas industry and macroeconomic policy and management issues are examined. The summary reflects on what the research has done from chapter 1 up to chapter 9 while the conclusion prescribes what needs to be done to improve on the levels of inter-industry linkages and the stimuli and impacts of the oil and gas industry towards an inclusive sustainable process of economic growth.

1.5: RELEVANCE, SCOPE AND LIMITATION

The Nigerian economy is worth studying for two main reasons. First, Nigeria is the most populous African country with an estimated population of 140 million. Considering that globalisation is gradually integrating economies of different countries of the world, the standard of living of the 140 million people, which is a function of the growth of the domestic economy, could have implication for the global economy. Second is the fact that Nigeria is 8th largest world and 6th OPEC member exporter of crude oil and with very large deposits of liquefied natural gas. Considering the significance of oil and gas in the contemporary world economy, it can be helpful to understand the possible and actual relevance of oil and gas to an oil and gas abundant country like Nigeria.

It also generates additional insights into the possibility of oil and gas driven process of economic growth and the detrimental effect of lack of cohesive industry specific and macroeconomic policies on the efficient utilisation of resources. It establishes the basis for relevant policy direction for investments in oil and gas to contribute to economic growth. The potential contributions of the oil and gas industry to economic growth is very enormous, but for an economy to optimise the benefits from the oil and gas industry to its growth process, the regulatory policies and operational standards need to be robust to be in tandem with the requisite conditions.

The scope of inter-industry analysis covers the period for which previous studies of inter-industry-linkages have been carried out such as Ajakaiye (1990); 1973-1977 and Falokun (1998); 1973-1990 in addition to extensive discussion of inter-industry linkage coefficients computed by this study for the period 1997-2001. However discussion of other aspects of the Nigerian economy and the oil and gas industry, is all encompassing, covering pre-independence to date. The literature, from which theoretical and empirical inspirations and inferences were drawn, covers a wide spectrum of relevant issues and time horizons.

The research encountered some limitations, one of which was difficulties in obtaining information relating to technology input, which could have enriched the research. However by broadening the scope of the research and tracking the trends of output performance and other operations of the industry, inferences on technological change are considered to be appropriate. Also, while data gathering was not much of a problem, it was difficult to obtain input-output data for several years for the Nigerian economy because the Federal Office of statistics (FOS) in Nigeria did not have a sustained tradition for publishing input-output tables.

1.6: PREVIEW OF THE LITERATURE

The literature review comprises of a survey of the various models of economic growth, the analytical expositions of the effects of natural resource utilisation on economic growth and perspectives on the Nigerian oil and gas industry and economy. Intermittently, the relevance of inter-industry linkages to the essential arguments of the economic growth theories is highlighted. This is also reflected in the discussion of the synthesis of the economic growth literature and perspectives on the Nigerian economy. The rationale for this approach is to develop a chain of various arguments on economic growth and natural resource utilisation so as to establish a channel of interrelated ideas that are relevant to the research. The various growth models have similarities in their analytical perspectives despite their different strands of argument. Therefore, surveying these models provide insights into the intricate issues that are embedded in the conceptualisation of economic growth and the critical role of natural resources in the attainment of economic growth. A synthesis of the ideas of the models created a fulcrum that was relied upon by the research to draw inferences to articulate the possibility of natural resource-driven process of sustainable economic growth. A perspective on the Nigerian economy and the oil and gas industry emerged from theoretical literature and certain salient empirical issues.

From the theoretical literature, economic growth process is based on intricate interaction of variables relating to the basic components of the economic system. The main arguments of modern growth theories emanated from classical economists such as Adam Smith (1776), David Ricardo (1817), Thomas Malthus (1798), Frank Ramsey (1928), Allyn Young (1928), Frank Knight (1944) and Joseph Schumpeter (1934). The basic ideas of modern growth theories are based on competitive behaviour and equilibrium dynamics, diminishing returns and its relation to the accumulation of physical and human capital, the interplay between per capita income and the growth rate of population, the effects of technological progress as increased specialisation of labour and discoveries of new goods and methods of production and the role of market structure (monopoly and/or competition) as an incentive to technological advancement.

Ramsey's (1928) classical article ignited the trend of modern growth theory, which is regarded as the watershed in contemporary economic growth analysis. The application of household optimisation using intertemporal utility function to economic growth analysis started with Ramsey. Attempts by Harrod (1939) and Domar (1946) to integrate Keynesian analysis with elements of economic growth based on a production function with little substitutability among inputs did not lead to a coherent economic growth theory. However, the contributions of Solow (1956) and Swan (1956) provided a significant turning point in modern economic growth analysis.

The Solow-Swan model explains economic growth process using neoclassical specification of the production function, based on the assumption of constant returns to scale, diminishing returns to each input and positive elasticity of substitution between inputs. Combining these with a constant saving rate provide a basis for general-equilibrium model that predicts a conditional convergence towards a long-run steady-state level of growth. The Solow model, as it is mostly referred, takes technological progress as given and investigates the effects of the division of output between consumption and investment on capital accumulation and growth. However, technology, which is taken as given (not endogenously determined) is the only factor that can change per capita long-run growth rate of the economy. The Ramsey-Cass-Koopmans (RCK) model, which is a fusion of Ramsey's (1928) earlier work with later contributions of Cass (1965) and Koopmans (1965), brought Ramsey's analysis of consumer optimisation into the stream of neoclassical growth analysis. Saving rate is endogenously determined by households' intertemporal consumption decision. The factors of production are paid their marginal products. The assumption of constant returns to scale is retained, and total income is exhausted by total products. The overlapping generation model (Diamond, 1965) differs with the RCK model only by the argument that the households are over time replaced by different set of households because some die and new ones are born, but the conclusions and the convergence properties are similar to the Solow and RCK models.

Endogenous growth analysis, pioneered by Arrow (1962), Sheshiniki (1967), Uzawa (1965), and subsequently projected by Romer (1986), Rebelo (1991) and others, attempts to fill the gap created by the neoclassical assumption of exogenous technology. Ideas are the root of technology, which can be obtained from the production process. As factors of production engage in production, they learn and get to know more about what they are doing and how to do it better. Apart from this possibility of learning-by-doing, investors will be driven by profit motives to perfect the quality and varieties of their products, so they tend to explore the avenue of research and development (R&D) and this forms the basis for technology acquisition and new products are designed in the process.

The inclusion of natural resources such as oil and gas in the analysis makes the possibility of steady state growth (a constant growth rate of variables of the model) uncertain. The persistent use of the essential natural resource leads to its depletion over time which could lead to decline in output and consumption. Sustainable growth is possible only if technological change occurs and there is substitutability between capital and labour on one hand, and the exhaustible resource on the other. Technological change will ensure increase in marginal product of capital as marginal product of the resource decreases. Solow (1974) and Hartwick (1974) contend that imposing a restriction on consumption and investing the rent from natural resource exploitation will ensure sustainability of consumption path, provide a basis for intergenerational equity and long-run steady state growth.

The critical relationship between consumptions, production and factors of production, which is the bedrock of economic growth process, as established by all the different strands of economic growth expositions, underlies the significance of inter-industry linkages as a cardinal condition for generating sustainable economic growth process. The neoclassical models did not conceive sustainability as an issue, but rather regarded the optimal consumption path determined by interactions of economic forces to be inherently sustainable. For a natural resource abundant, but technologically backward economy like Nigeria, operating within the confluence of a fast growing global economy, the temptation for complacent consumption, driven by the availability of substantial revenue from the export of crude oil could subvert the drive for efficient utilisation of resources that could undermine the essence of inter-industry linkages thereby inhibiting domestic resource utilisation and crippling the process of economic growth.

Chapter 2

REVIEW OF ECONOMIC GROWTH MODELS

2.1: THE NEOCLASSICAL MODELS OF ECONOMIC GROWTH

The analysis of elements of economic growth by Harrod (1939) and Domar (1946) to the effect that in a steady state, the product of the savings-output ratio and the output-capital ratio must be equal to the rate of growth of capacity of output, was submerged by the contributions of Ramsey (1928)[4], Solow (1959), Swan (1959), Cass (1965) and Koopmans (1965).Two main models of economic growth emerged from these cluster of contributions. These are the Solow[5] model and the Ramsey–Cass-Koopmans (RCK) model.[6]

2.1.1: The Solow Model

This model assumes four variables of production; output *(Y)* and three inputs; capital *(K)*, labour *(L)* and "knowledge" or the "effectiveness of labour" *(A)*. The production function, which is assumed to exhibit constant returns to scale, is specified as follows:

$$Y_{(t)} = F(K_{(t)}, A_{(t)}L_{(t)}) \tag{2.1}$$

where t denotes time and enters the production function through the inputs of production. A is technology and enters the production function through labour multiplicatively giving rise to labour-augmenting technological progress.[7] The economy is conceived in time dimension. At any given time the economy has some amounts of capital, labour and knowledge that are combined to produce a given level of output,

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[4] Ramsey's treatment of household optimization, which was much earlier than all the other contributions, was not considered significant in explaining economic growth until much later.

[5] Some refer to this model as Solow-Swan model in recognition of the fact that Swan's contribution during the same period was similar.

[6] Another model, owing to the contribution of Diamond (1965) is more or less seen as variant of the RCK model.

[7] The technological progress will be capital augmenting if it enters the production function through capital i.e *Y=F(AK, L)* and is Hicks-neutral if it enters the production function directly in the form *Y=AF(KL)*

implying that changes in input over time leads to changes in output correspondingly. Multiplying (2.1) by *1/AL*, using the constant returns to scale assumption, gives:

$$F\left(\frac{K_t}{A_tL_t},1\right)=\frac{1}{A_tL_t}F(K_t,A_tL_t)$$

Denoting $\frac{K_t}{A_tL_t}$ as k (capital per unit of effective labour) and $\frac{F(K_t,A_tL_t)}{A_tL_t}$ as y (output per unit of effective labour), leads to the intensive form of the production function as follows:

$$y_{(t)}=f(k_{(t)}) \qquad (2.2)$$

This expresses output per unit of effective labour, *y*, as a function of capital per unit of effective labour k[8]. In the form of Cobb-Douglass production function;

$$Y_{(t)}=F(K_{(t)},A_{(t)}L_{(t)})=K^{\alpha}(AL)^{\beta}=K_{(t)}{}^{\alpha}(A_{(t)}L_{(t)})^{1-\alpha} \quad \text{in which } \beta=1-\alpha$$

The production function retains its constant returns to scale assumption and other properties and the intensive form of the production function is:

$$f(k_{(t)})=k_{(t)}{}^{\alpha} \qquad (2.3)$$

which implies that $f'(k)=\alpha k^{\alpha-1}$ (the marginal product of capital) is positive and $f''(k)=-(1-\alpha)\alpha k^{\alpha-2}$, is negative, meaning that the marginal product of capital is declining as capital per unit of effective labour increases[9].

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[8] It is assumed that the first derivative of the intensive production function is positive ($f'(k_t)>0$) and the second derivative is negative ($f''(k_t)<0$), which implies that the marginal product of capital is positive, but declines as capital per unit of effective labour increases. It is also assumed that the intensive form production function exhibits the properties of Inada condition ; $\lim_{k\to\infty} f'(k_t)=0$ and $\lim_{k\to 0} f'(k_t)=\infty$ which says that the marginal product of capital is very large when the capital stock is sufficiently small and vice versa.

The initial levels of the variables are taken as given, but in a steady state, the growth rate of labour and knowledge over time is taken to be constant, thus:

$$\dot{L}_{(t)} = nL_{(t)}, \Rightarrow \frac{\dot{L}_{(t)}}{L_{(t)}} = n$$

$$\dot{A} = gA_{(t)} \Rightarrow \frac{\dot{A}_{(t)}}{A_{(t)}} = g$$

where n and g are the proportional rate of growth of labour and knowledge (technology) respectively, assumed to be constant and exogenous.

Output is partly consumed and partly saved at any given point in time and capital at any period of time (existing capital) depreciates at the constant rate, δ, so:

$$\dot{K}_{(t)} = sY_{(t)} - \delta K_{(t)} \tag{2.4}$$

The fact that the economy grows over time makes it easier to focus the analysis on capital stock per unit of effective labour, k, which equals K/AL. Using the chain rule of differentiation, the change in capital stock per unit of effective labour over time is given by:

$$\dot{k}_{(t)} = \frac{\dot{K}_{(t)}}{A_{(t)}L_{(t)}} - \frac{K_{(t)}}{\left[A_{(t)}L_{(t)}\right]^2}\left[A_{(t)}\dot{L}_{(t)} + L_{(t)}\dot{A}_{(t)}\right]$$

[9] Firms in the economy hires and pay workers wage, w for each unit of labour and pay rent, r to hire a unit of capital at any given time period, and thus maximizes profit: Max. $F(K, AL) - rK - wL$. At optimum, the prices of factors will be equal to their rental price : $w = \frac{\partial F}{\partial L} = (1-\alpha)\frac{Y}{L}$ and $r = \frac{\partial F}{\partial K} = \alpha\frac{Y}{K}$

$$=\frac{\dot{K}_{(t)}}{A_{(t)}L_{(t)}}-\frac{K_{(t)}}{A_{(t)}L_{(t)}}\frac{\dot{L}_{(t)}}{L_{(t)}}-\frac{K_{(t)}}{A_{(t)}L_{(t)}}\frac{\dot{A}_{(t)}}{A_{(t)}} \tag{2.5}$$

Substituting *K/AL* for *k*, $\frac{\dot{L}}{L}$ for *n*, and $\frac{\dot{A}}{A}$ for *g* in (2.5) leads to:

$$\dot{k}_{(t)}=\frac{sY_{(t)}-\delta K_{(t)}}{A_{(t)}L_{(t)}}-k_{(t)}n-k_{(t)}g=\frac{sY_{(t)}}{A_{(t)}L_{(t)}}-\delta k_{(t)}-nk_{(t)}-gk_{(t)}$$

Finally, using the fact that, *Y/AL=f(k)* to substitute leads to the fundamental equation of the Solow model :

$$\dot{k}_{(t)}=sf\left(k_{(t)}\right)-\left(n+g+\delta\right)k_{(t)} \tag{2.6}$$

which says that the rate of change of the capital stock per unit of effective labour at a given period of time, $\dot{k}_{(t)}$ is the difference between actual investment per unit of effective labour, $sf(k_{(t)})$ and the break-even investment, $(n+g+\delta)k$. The depreciation of existing capital and the fact that the quantity of effective labour is growing exogenously at a constant rate of $n+g$ are the two main reasons for the necessity of a break even investment so as to maintain the level of capital per unit of effective labour. For the break-even investment to be adequate to match this requirement, it must be equal to the sum of depreciation rate and the rate of growth of the quantity of effective labour $(n+g+\delta)$.The capital stock per unit of effective labour will be rising whenever actual investment per unit of effective labour, $sf(k)$ exceeds the break-even investment, $(n+g+\delta)$ and vice versa, and when the two are equal, k is constant. Denoting k at the point of equality between actual and break-even investment as k^*, it is obvious that if k is initially less than k^*, actual investment exceeds break-even investment, and so $\dot{k}$ (change in capital sock per unit of effective labour) is positive, meaning that k is rising. If k exceeds k^*, $\dot{k}$ is negative and if k equals k^*, then $\dot{k}$ is zero. This is the convergence property of the model, which states that regardless of where k starts, it converges to k^*, the point where actual and break-even investment are equal.

By assumption, labour and knowledge are growing at rates n and g respectively. The capital stock, K, can be represented as ALk (since k is constant at k^*, K is growing at the rate $n+g$ $(ie; \frac{\dot{K}}{K} = n + g)$. This means that both capital and effective labour are growing at the rate $n+g$ and given the assumption of constant returns to scale, it implies that output, Y, is also growing at the rate $n+g$ and both capital per worker and output per worker are growing at the rate g. Thus in the Solow model, the economy, regardless of its starting point, eventually converges to a balanced growth path, where all the variables grow at a constant rate and at this stage, the growth rate of output per worker, a key measure of economic growth, is determined only by the rate of technological progress.

In a Solow economy that is on a balanced growth path, an increase in the saving rate, s, will lead to an increase in the level of actual investment, $sf(k)$, above the break-even investment, resulting in an increase in k, capital per unit of effective labour, above k^*, the level of k that establishes the equilibrium between $sf(k)$ actual investment and $(n+g+\delta)k$, break-even investment. This situation implies that more resources are being devoted to investment than are needed to hold k constant, as such $\dot{k}$ (changes in capital per unit of effective labour) over time is positive. This will lead to a gradual and continuous rise in k until the excess resources over the requirement for sustaining k^* at its previous level is fully absorbed and a new (higher) level of k^* is reached where $sf(k)$ is equal to $(n+g+\delta)k$ to establish a higher level of balanced growth path where the growth rate of all the variables will be constant. A decrease in saving rate will lead to a lower level of the balanced growth path through similar channel.

This shows that in the Solow model, a change in the savings rate has a level effect but not growth effect, meaning that it changes the economy's balanced growth path but not the growth rate of the economy. It is only a change in technological progress that can lead to changes in the growth rate of the economy. Changes in all other variables of the model will only lead to a shift in the level of the balanced growth path. The effect of a change in savings rate on output per unit of effective labour, *Y/L*, capital per unit of effective labour, *k*, and a change in capital per unit of effective labour will be obviously in the direction of the change in savings, but it is not that obvious in the case of consumption per unit of effective labour. Consumption per unit of effective labour on the balanced growth path can be expressed as the difference between output per unit of effective labour, $f(k^*)$ and investment per unit of effective labour, $(n+g+\delta)k^*$. Since there is inverse relationship between consumption and savings, an increase in the rate of savings will lead to an instantaneous decrease in consumption, after which it will begin to rise. In the process of gradual adjustment of the economy towards a new balanced growth path, there will not be a definite pattern of consumption behaviour. Whether consumption will continue to rise above its initial level or not will depend on whether the marginal product of capital, $f'(k^*)$ is larger or less than $n+g+\delta$. A rise in k requires a rise in investment per unit of effective labour by $n+g+\delta$ times the change in k for the increase to be sustained. Intuitively, if $f'(k^*)$ is less than $n+g+\delta$, then additional output from the increased capital is not enough to maintain the capital stock at its higher level, so consumption will be forced to fall to maintain the higher capital stock. But if $f'(k^*)$ exceeds $(n+g+\delta)k$ on the other hand, it means there is more than enough output to maintain k at its higher level, so consumption rises. If $f'(k^*)$ equals $n+g+\delta$, a change in s will have no effect on consumption in the long-run simply because consumption is at its maximum possible level, that is the "golden rule" level.

The main implication of the conclusion of the Solow model is that, differences in capital per worker *(K/L)* and differences in the effectiveness of labour are the two main sources of variations in economic growth over time and across countries. However, only the changes in effectiveness of labour can generate permanent growth. Thus, technological change is the key to economic growth. Significant changes in saving have only moderate effects on the level of output per unit of effective labour on the balanced growth path, but not on the growth rate of the economy. Saving and investment are not correlated in a multi-country context. Capital per worker influences output per worker, so a country that saves more of its output has more capital per worker and hence more output per worker. A country with higher population growth needs to devote more of its savings to maintaining its capital-labour ratio, which means that such a country will have less capital and output per worker. Countries that are rich enough to have converged on balanced growth path will experience no change in growth rates while those that are distant from the balance growth path will grow faster and eventually catch-up with the richer ones. This catch-up process is predicated on the lower rate of return on capital in countries with more capital per worker, which will lead to flow of capital from rich to poor countries and also that accessibility to knowledge or new technology by poor countries accelerates their process and rate of growth. However, Lucas Jr (1990) averred that, differences in human capital, external benefits of human capital and capital market imperfections render the prediction of flow of capital from rich to poor countries untenable.

The Solow model of economic growth recognises the crucial essence of the absorptive capacity of the economy by emphasising the nominal role of changes in variables such as savings and consumptions while pinpointing the critical role of technology and the possible adverse role of population growth if not matched by proportional increase in capital. The basic ingredient for the enhancement of the absorptive capacity is the level of intensity for the usage of outputs of different sectors by other sectors of the economy either as input or for direct consumption. This process of input-output, which creates the basis for inter-industry linkages, though not mentioned in the Solow model, constitutes the fundamental means by which effectiveness of labour and technology can be enhanced and these are the two critical variables of attaining higher rates of economic growth in the Solow model.

2.1.2: The Ramsey-Cass-Koopmans (RCK) Model

The main difference between the RCK model and the Solow model is the assumption of the RCK model that, instead of an exogenous and constant saving rate, the path of consumption and hence saving rate are determined by the intertemporal optimizing behaviour of firms and households, through competitive market interactions. Savings is thus endogenous and the dynamics of economic aggregates are determined at the microeconomic level. The model assumes the existence of large number of identical firms that rent capital and hire labour in competitive factor market, produce and sell output in a competitive product market. The firms maximise profit and are owned by households, so profits earned by firms accrue to households. The model also assumes the existence of a large number of identical households that grows at a constant rate of $(n = \dot{L}/L)$, but with each household supplying a unit of labour at each point in time and rents whatever capital it owns to firms. Each household has an initial capital holding of $\frac{K_{(0)}}{H}$, where $K_{(0)}$ is the initial amount of capital in the economy and H is the number of households. The depreciation rate of capital is set to zero for analytical simplicity, not as a strong assumption of the model (i.e. δ=0) and the household divides its labour income and capital income (profits it receives from firms) at each point in time between consumption and saving to maximise lifetime utility over an infinite horizon.

Each of the firms has access to the production function, $Y_{(t)} = F(K_{(t)}, A_{(t)}L_{(t)})$ with the same assumptions as in the Solow model.

The household's utility function is of the form;

$$U = \int_{t=0}^{\infty} e^{-\rho t} u(C_{(t)}) \frac{L_{(t)}}{H} dt \qquad (2.7)$$

where $C_{(t)}$ is consumption of each member of household at time t, $u(C_{(t)})$ is the instantaneous utility function, which takes the form;

$$u(C_{(t)}) = \frac{C_{(t)}^{1-\theta}}{1-\theta}, \ \theta > 0, \rho - n - (1-\theta)g > 0$$

This utility function is known as a constant-relative-risk aversion utility function because $\theta\left(=-\frac{Cu''(C_{(t)})}{u'(C_{(t)})}\right)$ is the coefficient of risk aversion and independent of *C*. The attitude of the household towards risk is irrelevant since there is no uncertainty, but θ determines the willingness of the household to shift consumption between different periods[10]. Using the intensive form of the production function and the fact that in a competitive market, capital earns its marginal product, and because there is no capital depreciation, the real rate of return on capital equals its earnings per unit of time:

$$r_{(t)} = f'(k_{(t)}) \tag{2.8}$$

and the marginal product of labour, which equals the wage rate at time *t*, is; $A_{(t)}\left[f(k_{(t)}) - k_{(t)}f'(k_{(t)})\right]$

and the wage rate per unit of effective labour is $w_{(t)} = f(k_{(t)}) - k_{(t)}f'(k_{(t)})$

In line with the competitive nature of the economy, the paths of *r* and *w* are taken as given by household. The budget constraints of the household are that the present value of lifetime consumption cannot exceed its initial wealth plus the present value of its lifetime labour income.

The household's budget constraint is[11] :

$$\int_{t=0}^{\infty} e^{R(t)} C_{(t)} \frac{L_{(t)}}{H} dt \le \frac{K_{(0)}}{H} + \int_{t=0}^{\infty} e^{R(t)} W_{(t)} \frac{L_{(t)}}{H} dt \tag{2.9}$$

where: $C_{(t)}$ is the consumption of each member of household at time t

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[10] The smaller is θ, the more slowly marginal utility falls as consumption rises and more willing the household is to allow consumption to vary over time. The closer θ is to zero, the more utility of the consumer tends towards C linearly and the elasticity of substitution between consumption at any two periods in time is $1/\theta$. If θ is less than one, $C^{1-\theta}$ is increasing in C and vice versa, hence dividing $C^{1-\theta}$ by $1-\theta$ ensures a positive value for marginal utility of consumption, irrespective of the value of θ. The utility function simplifies to lnC when θ approaches one. The assumption that $\rho - n - (1-\theta)g > 0$ ensures that the lifetime utility does not diverge.

$L_{(t)}$ is the population at time t

H is the number of households

$K_{(0)}$ is the initial capital

$W_{(t)}$ wage rate at time *t*.

This budget constraint reflect the fact that the household has $\frac{L_{(t)}}{H}$ members as such its labour income at t is $W_{(t)}\frac{L_{(t)}}{H}$ and its consumption expenditures are $C_{(t)}\frac{L_{(t)}}{H}$ while its initial wealth is *1/H* of total wealth at time *0*, or $\frac{K_{(0)}}{H}$

The limiting behaviour of household's capital holdings, permits the expression of the household budget constraints in limit form as

$$\lim_{s\to\infty} e^{-R(s)}\frac{K_{(s)}}{H} \geq 0$$

This simply means that the present discounted value of household's asset holdings cannot be negative in the limit and also implies a no-ponzi-game condition[12].

To maximise lifetime utility, the household chooses the path of $C_{(t)}$ (i.e. consumption at any given point in time, subject to its budget constraints, hence the household's optimal consumption path is based on the maximization of the Langragian :

$$\Omega = B\int_{t=0}^{\infty} e^{-\beta t}\frac{C_{(t)}^{1-\theta}}{1-\theta}dt + \lambda\left[K_{(0)} + \int_{t=0}^{\infty} e^{-R(t)}e^{(n+g)t}w_{(t)}dt - \int_{t=0}^{\infty} e^{-R(t)}e^{(n+g)t}C_{(t)}dt\right] \qquad (2.10)$$

the solution of which gives the Euler equation:

$$\frac{\dot{c}_{(t)}}{c_{(t)}} = \frac{r_{(t)} - n - g - \beta}{\theta} \quad \text{or} \quad \frac{\dot{c}_t}{c_t} = \frac{r_t - \rho - \theta g}{\theta} \qquad (2.11)$$

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[11] The budget constraint can be expressed in various ways.

[12] A detailed procedure for deriving the budget constraints in the limit form is skipped for convenience. A ponzi game is a situation where an economic agent consistently rolls over debt to fulfill its economic obligations. This situation does not permit it.

where $\beta = \rho - n - (1-\theta)g$

$\frac{\dot{c}_{(t)}}{c_{(t)}}$ is the growth rate of consumption per unit of effective labour and g is the growth rate of knowledge, A. Since consumption per worker, $C_{(t)}$ is $c_{(t)}A_{(t)}$, the growth of C is equal to the growth of consumption per unit of effective labour, c plus the growth rate of A (*i.e.* g). So consumption per worker grows at the rate $\frac{[r_{(t)} - \rho]}{\theta}$. This means that consumption per worker is rising if the real return exceeds the rate at which the household discounts future consumption and falling if otherwise. A smaller θ means less changes in marginal utility as consumption changes and the larger the changes in consumption in response to differences between the real interest rate and the discount rate. The Euler equation also describes the evolution of c over time given an initial value $c(o)$[13].

The Euler equation can be written as;

$$\frac{\dot{c}_{(t)}}{c_{(t)}} = \frac{f'(k_{(t)}) - \rho - \theta g}{\theta} \tag{2.12}$$

Using the fact that $r_{(t)} = f'(k_{(t)})$

if $f'(k)$ equals $\rho + \theta g$, $\dot{c}$ will be zero. Denoting k^* as the level of k that ensures this condition, it will imply that when k exceeds k^*, $f'(k)$ is less than $\rho + \theta g$ and so $\dot{c}$ is negative (falling). Also, when k is less than k^*, $\dot{c}$ is positive (rising), and constant when $k = k^*$.

Change in capital stock per unit of effective labour, k, as in the Solow model, equals actual investment minus break-even investment, which is $(n+g)k$ and actual investment is $f(k) - c$,

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13. If c evolves in a different way, then the household can rearrange or re-optimise its consumption to raise its lifetime utility, such as choosing $c(o)$ to be too low and lifetime wealth will not be exhausted.

$$\dot{k}_{(t)} = f(k_{(t)}) - c_{(t)} - (n+g)k_{(t)} \tag{2.13}$$

Consider a point where consumption equals the difference between actual investment, $f(k_{(t)})$ and break-even investment, then k will be zero since the level of consumption that implies $k=0$ is given by $f(k)-(n+g)k$. The value of c will be increasing as k increases until the golden-rule level of k is reached where $f'(k) = n + g$ and c will be decreasing. K will be falling when c exceeds the level that yields $k=0$, and will be rising when c is less than this level. A sufficiently large value of k will ensure that the break-even investment exceeds total output, and k will be negative for all positive values of c.

Given an initial value for k, the initial value for c must be determined along the saddle path of the economy and both c and k must evolve over time to satisfy household's intertemporal optimization condition given by the Euler equation. For any positive initial value of k, there is a unique initial level of c that is consistent with household's intertemporal optimization, given the dynamics of the capital stock, the household's budget constraints, and the requirement that k is not negative. In welfare terms, the representative household has the highest possible utility among households consistent with the welfare theorem of Pareto efficiency.

The RCK model economy, like in the Solow model, converges to a balanced growth path, where capital, output and consumption per unit of effective labour are constant. The saving rate $\frac{(y-c)}{y}$ will also be constant since y and c are constant. The total capital stock, total output and total consumption grow at the rate $n+g$, and capital per worker, output per worker and consumption per worker grow at the rate g. However the RCK model differs from the Solow model in the balanced growth path analysis of golden-rule behaviour, in that it is not possible for the capital stock to be above the golden-rule level in the RCK model.

The inclusion of government does not change the basic results of the RCK model. Government purchases are assumed not to affect both utility from private consumption and future output. Assuming that government purchases are financed with current taxes only, which means investment becomes the difference between output and the sum of private consumption and government purchases, the equation for change in k, becomes;

$$\dot{k}_{(t)} = f(k_{(t)}) - c_{(t)} - G_{(t)} - (n+g)k_{(t)}$$

and the budget constraints becomes;

$$\int_{t=0}^{\infty} e^{-R(t)} c_{(t)} e^{(n+g)t} dt \leq K_{(0)} + \int_{t=0}^{\infty} e^{-R(t)} \left[w_{(t)} - G_{(t)}\right] e^{(n+g)} dt$$

Using this to form the langragian and optimising will yield the Euler equation. A permanent change in government purchases, G, will lead to a corresponding change in consumption per unit of effective labour by the same proportion, but other variables will remain unchanged. In the case of temporary change in G, c will not fall by the full amount of the rise in G.

2.1.3: A Note on the Diamond model

The Diamond model, also referred to as the ***overlapping-generations*** model assumes a turnover in the population. That is, there is no fixed number of infinitely lived households as in the RCK model; rather, new ones are being born while old ones die. Each individual lives for two period, supplies one unit of labour. Population grows at a constant rate, *n*, with $L_t = (1+n)L_{t-1}$, and thus $L_{t-1} = \frac{L_{(t)}}{(1+n)}$. In the first period, the individual divides his resulting labour income between present consumption and savings, and in the second period, consumes what has been saved plus interest accrued. Denoting C_{1t} and C_{2t} as consumption in period 1 (for young) and period 2 (for old) respectively, the utility of an individual born at *t*, denoted U_t depends on C_{1t} and C_{2t+1}. The assumption of constant-relative-risk-aversion utility, leads to the utility function:

$$U_t = \frac{C_{1t}^{1-\theta}}{1-\theta} + \frac{1}{1+\rho}\frac{C_{2t+1}^{1-\theta}}{1-\theta}, \theta > 0, \rho > -1 \tag{2.14}$$

All other assumptions are similar to the RCK model and the production function is similar to the Solow and RCK, so $A_t = [1+g]A_{t-1}$.The old consume both their capital income and their existing wealth while the young divide their labour income, $w_t A_t$, between consumption and saving, which they carry forward to the next period.

The consumption of an individual in the second period is given by;

$C_{2t+1} = (1+r_{t+1})(w_t A_t - C_{1t})$, so the budget constraints is $C_{1t} + \frac{1}{1+r_{t+1}} C_{2t+1} = A_t w_t$

and the individual's behaviour is described by;

$$\frac{C_{2t+1}}{C_{1t}} = \left(\frac{1+r_{t+1}}{1+\rho}\right)^{\frac{1}{\theta}} \tag{2.15}$$

The capital stock in period *t+1* is the amount saved by young individuals in period *t*,

$$K_{t+1} = s(r+1)L_t A_t W_t \tag{2.16}$$

and $k_{t+1} = \frac{1}{(1+n)(1+g)} s(f'(k_{t+1}))[f(k_t) - k_t f'(k_t)]$ (2.17)

which implicitly defines k_{t+1} as a function of k_t, and therefore determines how k evolves over time given its initial values. No matter where k starts, it converges to a balanced growth path level, k^*, where the saving rate is constant, output per worker grows at the rate, g. The capital-output ratio is constant and the model exhibits all the other convergence properties of the Solow and RCK models.

The main point of divergence between the Solow model and the RCK (and the Diamond) model is the different assumptions about the savings rate. In the Solow model, saving rate is exogenous and constant, which means that economic decision of households will not affect economic growth, since they only abide by a given saving rule. In the RCK model and the Diamond model on the other hand, households determine their level of savings based on their consumption preferences between different periods of time, which makes saving endogenous. However, this divergence does not lead to different conclusion concerning the driving force of economic growth. All the neoclassical models contend that increase in the effectiveness of labour is the crucial source of persistent growth in output, and economic growth. They also differ in the balanced growth path analysis in terms of the golden-rule behaviour of the capital stock. The Solow model accommodates the possibility of higher consumption as a result of a sufficiently high saving rate conforming to the balanced growth path. The fact that in the RCK and Diamond models saving is derived from the behaviour of household, and is inversely related to consumption without externalities makes it impossible for the economy to sustain an equilibrium on a path where higher consumption can be attained at all times. If this is possible, households will reduce their saving to take advantage of the opportunity. A change in the discount rate in the RCK and Diamond model has basically the same effect as change in saving in the Solow model.

The central proposition of the of the RCK and the Diamond models of economic growth gravitates around the relationship between the lifetime consumption expenditure of households and the productive activities of firms while recognising the needed complementary role of government policy. This nexus of the RCK and the Diamond models is the cradle of inter-industry linkages. An input-output process, which is the bedrock of inter-industry linkages, is based on four basic economic activities; production, consumption, accumulation and trade, and these constitute the key components of the RCK and Diamond models of economic growth. In the input-output framework, production involves industry and commodity sectors producing goods and services; consumption represents purchases of goods and services by both industries and domestic final users comprising mainly households and governments; accumulation involves all capital transactions including all fixed investment expenditure and stock exchange while trade involves imports and exports. To the extent that the RCK and the Diamond models are built around these basic economic activities, inter-industry linkages through the process of input-output, is significant in the mutation of the theoretical propositions embedded in the RCK and the diamond models.

2.2: ENDOGENOUS GROWTH MODELS

The neoclassical models only identified the "effectiveness of labour" (knowledge or technology) as the crucial determinant of economic growth but left the issue of how it could be attained hanging on exogenous assumption. It is this unexplained source of exogenous technology that elicited the emergence of endogenous growth models. Given the critical significance of technology in attaining growth, the basis for policies towards attaining growth cannot be determined if the source of technology is ambiguous. The endogenous growth models seek to resolve the technology puzzle arising from the neoclassical exposition. Technology, according these models, evolves from the interplay of economic forces. The main thrust of endogenous growth theory involves a two way interaction between technology and economic life: that is technology is a by product of innovation, which is nurtured by rational economic behaviour; but technology also transforms economic life in turn. The endogenous growth models extrapolate on the evolution of technology within the mechanics and operations of the economy's production process and the motivation for more ideas to be brought to bear, so as to enhance the benefits arising from production. Thus, technology, the key to economic growth is endogenous because it evolves from the operations of the economy, rather than coming from an unknown source outside the economy (exogenous) as espoused by the neoclassical models. Endogenous growth analysis is hinged on positive effect of saving rate and public policy on long-run constant (none exploding) growth.

The perspectives of economic growth resulting from ideas and mechanism of the production process were first advanced by Arrow (1962) and Sheshinski (1967). Subsequent works by Romer (1986), Lucas (1988), Rebelo (1991), Aghion and Howitt (1992) among others, led to a class of economic growth models that seek to explain long-run growth by endogenous processes of the economy such as physical and human capital accumulation, learning-by-doing, government expenditure and research and development (R&D) . For analytical purposes, they are categorised into models of endogenous growth and models of endogenous technological change.

2.2.1: Models of Endogenous Growth

The endogenous growth models assume the absence of diminishing returns to capital, which makes it possible for per capita growth to occur in the long-run even without exogenous technological change. The implication is that per capita output growth is sustainable in the long-run even in the absence of technological progress simply because there are no diminishing returns to capital accumulation and savings rate positively affects long-run growth rate. There are different mechanisms for motivating the productive process to enhance the effective utilisation of resources that leads to endogenous growth of the economy, which has given rise to different versions of the endogenous growth models.

The physical and human capital version of endogenous growth model makes the broad interpretation of capital as encompassing physical and human capital more explicit. There is one-to-one relationship between output and inputs due to constant returns to scale. One unit of either physical or human capital input leads to one unit of (additional) output. Competitive firms pay rental prices equal to the marginal products of factors and earn zero profit. Economic growth is endogenous because of inbuilt regeneration features of the composite capital goods arising from non-diminishing marginal product of capital. This analogy is anchored on "*AK*" production function;

$$Y_t = A_t K_t \tag{2.18}$$

A is a positive constant reflecting the level of technology.

In intensive form, $y_t = Ak_t$ where $y_t \equiv \frac{Y_t}{L_t}$, $k_t \equiv \frac{K_t}{L_t}$ (2.19)

The "*AK*" model violates the Inada condition[14] and this violation, constitute the key element of the process of generating endogenous growth.

K is conceived broadly to encompass physical and human capital, knowledge and public infrastructure. Output per worker is $y_t = Ak_t$ the average and marginal products of capital

[14] $f'(k) = A$ as $k \to 0$ or ∞

will be constant at the level $A>0$.The growth rate of investment per unit of effective labour is (based on the Solow model with exogenous saving rate);

$$\frac{\dot{k}_t}{k_t} = \frac{sf(k_t)}{k_t} - (n + g + \delta) \tag{2.20}$$

The assumption of constant saving rate implies that:

$$\dot{K}_t = sY_t \tag{2.21}$$

That is change in capital stock, $\dot{K}_t$ (investment) is a fixed proportion of output that is saved, sY_t. The marginal product of capital is:

$$\frac{\partial Y_t}{\partial K_t} = A \tag{2.22}$$

Using (2.19) and (2.20), $\frac{\dot{K}_t}{L_t} = sy_t$ (2.23)

and, since $y_t = Ak_t$

$$sy_t = sAk_t \tag{2.24}$$

and $\frac{\dot{K}_t}{L_t} = \frac{\dot{K}_t}{K_t}\frac{K_t}{L_t} = \frac{\dot{K}_t}{K_t}k_t = \left(\frac{\dot{K}_t}{K_t} - n + n\right)k_t = \left(\frac{\dot{k}_t}{k_t} + n\right)k_t$ [15] (2.25)

Substituting (2.24) and (2.23) into (2.25) yields:

[15] (2.25) is obtained by making use of $\frac{K_t}{L_t} = k_t$ or $\ln K_t - \ln L_t = \ln k_t$, which upon differentiating with respect to t, leads to $\frac{\dot{K}_t}{K_t} - n = \frac{\dot{k}_t}{k_t}$

$$\left(\frac{\dot{k}_t}{k_t}+n\right)k_t = sAk_t \tag{2.26}$$

Implying that: $\dot{k}_t = sAk_t - nk_t$ (2.27)

Substituting $\frac{f(k_t)}{k_t} = A$ into (2.22) will yield

$$\frac{\dot{k}_t}{k_t} = sA - (n + g + \delta) \tag{2.28}$$

If there is no technological progress and capital does not depreciate, (2.28) becomes:

$$\frac{\dot{k}_t}{k_t} = sA - n \ . \tag{2.29}$$

where: sA *is* assumed to be constant and per capita output growth rate is $g_y = g_k = sA - n$.

The implication is that per capita output growth is sustainable in the long-run even in the absence of technological progress simply because there is no diminishing return to capital accumulation and savings rate, *s*, positively affects long-run growth rate.

Consider the Euler equation of the RCK model with *g=0*:

$$\frac{\dot{c}_t}{c_t} = \frac{r_t - \rho}{\theta} \tag{2.30}$$

The profit maximizing condition of firms is that the marginal product of capital equals its rental price. From (2.22) marginal product of capital is *A*

$$\frac{\partial Y_t}{\partial K_t} = A - r_t = 0 \Rightarrow r_t = A$$

Substitute this into (2.30) to obtain:

$$\frac{\dot{c}_t}{c_t} = \frac{A-\rho}{\theta}, A > \rho \tag{2.31}$$

The model exhibits constant and equal growth rates in per capita output (g_y), per capita investment (g_k) and per capita consumption (g_c) hence:

$$\frac{\dot{c}_t}{c_t} = \frac{\dot{y}_t}{y_t} = \frac{\dot{k}_t}{k_t} \tag{2.32}$$

Sustainable per capita growth occurs in the long-run, even without exogenous technological change; because of the elimination of diminishing returns to capital accumulation and the saving rate have positive effects on long-run growth while the population affects long-run growth negatively.

The production function is generalized without time *(t)* for analytical convenience:

$$Y = F(K, H) \tag{2.33}$$

And in Cobb-Douglas form:

$$Y = K^{\alpha} H^{1-\alpha} = \left(\frac{H}{K}\right)^{1-\alpha} K \tag{2.34}$$

where: K = physical capital

H = Human capital

The assumption of one-to-one relationship between output and the inputs due to constant returns to scale and the other assumption that firms pay rental prices equal to the marginal products of factors and earn zero profits leads to the arbitrage condition:

$$\Pi = K^{\alpha} H^{1-\alpha} - R_K K - R_H H \tag{2.35}$$

The first order conditions (FOCs) are:

$$\frac{\partial \Pi}{\partial K} = 0 \Rightarrow \alpha\left(\frac{H}{K}\right)^{1-\alpha} = R_K$$

$$\frac{\partial \Pi}{\partial H} = 0 \Rightarrow (1-\alpha)\left(\frac{K}{H}\right)^{\alpha} = R_H$$

R_K and R_H are rental prices of physical and human capital respectively.

Perfect substitutability of the two factors ensures that rates of return to owners of capital are $R_K - \delta_K$ and $R_H - \delta_H$ where δ_K, and δ_H are depreciation rates of physical and human capital respectively. The process of factor accumulation follows[16]:

$$\dot{K} = s_K Y - \delta_K$$
$$\dot{H} = s_H Y - \delta_H$$

Equating the rates of return gives:

$$R_K = R_H \Rightarrow \alpha\left(\frac{H}{K}\right)^{1-\alpha} = (1-\alpha)\left(\frac{K}{H}\right)^{\alpha}$$

$$= \frac{H}{K} = \frac{1-\alpha}{\alpha} \qquad (2.36)$$

The rate of return on capital equals the interest rate so:

$$r = R_K - \delta = R_H - \delta \qquad (2.37)$$

Substituting (2.36) into (2.34) yields:

$$Y = \left(\frac{1-\alpha}{\alpha}\right)^{1-\alpha} K, \qquad (2.38)$$

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[16] s_K is a fixed fraction of output saved and invested in physical capital and s_H is a fixed fraction of output used to augment the stock of human capital such as buildings, teachers, laboratories etc, $1 > s_K + s_H > 0$ and δ is a common rate of depreciation of *K* and *H*.

Denoting $\left(\frac{1-\alpha}{\alpha}\right)^{1-\alpha}$ as A transforms (2.38) into an AK production function.

Growth rate will be given by:

$$g_k = s_K \frac{Y}{K} - \delta = s_K A - \delta \qquad (2.39)$$

Marginal product of capital $MP_K = \alpha\left(\frac{H}{K}\right)^{1-\alpha} = \alpha A$ does not diminish because of human capital accumulation. K is a proxy for a composite of capital goods that includes physical and human components. This has the same properties as the "AK" model and economic growth is endogenous because of inbuilt regeneration features of the composite capital goods arising from non-diminishing marginal product of capital.

In the **Learning-by-doing** version of endogenous growth, investment and production makes use of ideas and also obtains additional ideas through the positive effect of production experience, thereby eliminating the tendency for diminishing returns. Knowledge creation is an unintended by-product of investment. A firm that increases its physical capital learns simultaneously how to produce efficiently. Technical knowledge is thus embodied in new capital goods. Each time a capital good is produced, the experience of producing it generates new insights to both the particular production sector and to the economy in general. This positive externality prevents the marginal product of capital from diminishing. Consider the neoclassical production function:

$$Y = F(K_i, A_i L_i) \qquad (2.40)$$

There are several firms that engage in investment based on this production function. An increase in a firm's capital stock leads to a parallel increase in its stock of knowledge through learning-by-doing. Each firm's knowledge is assumed to be a public good, so other firms can gain access to it at zero cost. This implies that knowledge spills over onto the entire economy so each firm's discovery of new knowledge (change in technology, A_i) is a reflection of the level of technology of the overall economy and is therefore proportional to the change in the aggregate capital stock, K[17]. The assumption of learning-by-doing and knowledge spillovers makes it possible for the production function to be written in the form;

$$Y = F(K_i, K.L_i) \tag{2.3.41}$$

Replacing A_i with K.

Each firm will face diminishing returns to K_i if K and L_i are constant, as in the neoclassical model, but if each firm, in the process of production, expands K_i, then K rises accordingly and provides a spillover benefit that raises the productivity of all the firms, thereby generating endogenous growth. The production function is homogenous of degree one in K_i and K for given L. If K_i and K expand together, there will be constant returns to capital at the social level. The assumption of constant working population and constant number of price-taking competitive firms leads to the production function:

$$Y_j = AL_j^{1-\alpha}K_j^{\alpha}, \qquad A = \left(\sum_{j=0}^{N} K_j\right)^{\eta} \tag{2.42}$$

η measures the degree of learning-by-doing effect.

$\eta = 0 \Rightarrow$ no learning-by-doing effect,

$\eta > 0 \Rightarrow$ existence of positive learning-by-doing effect

$\eta < 0 \Rightarrow$ existence of negative learning-by-doing effect

(This is irrelevant to the analysis of the model because the effect of production on technology cannot be detrimental).

The competitive profit condition of firms will be given by:

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[17] Even if firms have incentives to maintain secrecy of their discoveries and inventions, either through patency or other means, competition among firms will lead to knowledge spillover since secrecy of new products cannot be maintained infinitely.

$$r = \alpha A k_j^{-(1-\alpha)}, w = (1-\alpha) A k_j^{\alpha} \tag{2.43}$$

A representative consumer maximizes intertemporal utility given his constraint, on a consumption path that satisfies:

$$\frac{\dot{c}_t}{c_t} = \frac{r_t - \rho}{\theta} \tag{2.44}$$

All firms are assumed to be the same so there is symmetry, hence;

$$\frac{K_j}{L_j} = \frac{K}{L}, \qquad \therefore A = \left(NK_j\right)^{\eta} = K^{\eta} = L^{\eta} k^{\eta}, \tag{2.45}$$

Substituting (2.43) for r and (2.44) for A gives:

$$\frac{\dot{c}_t}{c_t} = \frac{\alpha L^{\eta} k_t^{\eta-(1-\alpha)} - \rho}{\theta} = \frac{\alpha L^{\eta} k^{\eta+\alpha-1} - \rho}{\theta} \tag{2.46}$$

If $(\eta+\alpha) <1$, the level of externality will be small, the growth rate will be decreasing asymptotically towards zero, because the externality effect is too small to prevent diminishing returns. If $(\eta+\alpha)>1$, there will be a large externality. This will result in explosion of growth as the large externality leads to increases in the marginal product of capital over time. The externality effect is too large to keep growth at a constant rate. If $(\eta+\alpha) =1$ or $\eta= (1-\alpha)$, then the strength of externality is just enough to generate constant growth rate, since this will imply that

$$g_c = \frac{\dot{c}_t}{c_t} = \frac{\alpha L^{1-\alpha} - \rho}{\theta} \tag{2.47}$$

The perception of private firms is that the production function exhibits diminishing returns to capital accumulation. They cannot influence A, so they take it as given. At the social level however externality effect permeates and the social planner sets the growth rate of consumption in accordance with the average product of capital. The planner recognizes that each firm's increase in its capital stock adds to aggregate capital stock, and hence contributes to the productivity of all other firms in the economy. The externality effect, through learning-by-doing and spillover effects offsets the diminishing returns of the private firms, and hence the returns become constant at the social level and social marginal product of capital equals the average product, which becomes the determinant of the growth rate where $(\eta+\alpha)=1$. The social planner sets the growth rate of consumption in accordance with average product of capital whereas the private firms in a decentralized economy relates the growth rate to the private marginal product of capital, which falls short of average product and thus leading to sluggish growth. There is therefore a slow growth in the decentralized equilibrium and a higher growth when social planning is involved. The reason why the social optimum is higher than the decentralized system is that private firms do not internalise the knowledge effect of their own investment decisions, thereby making private returns from capital accumulation to be too low, but the social optimum can be attained even in the decentralized system through subsidies on purchases of capital goods and/or subsidies on production, to be financed basically by lump-sum tax in order to avoid distortions. The assumption of constant L implies that increases in L over time will lead to increase in growth rate over time to establish a constant balanced growth path. Learning-by-doing and knowledge spillover generate scale effect on growth rates because of the constant returns to K at the firm's level and increasing returns to K and L at the social level. Scale effect can be eliminated by arguing that A_i in the basic production function depend on the economy's average capital per worker, K/L, rather than average capital stock such that;

$$A_t = \left(\frac{1}{L}\sum_{j=0}^{N} K_{tj}\right)^{\eta} = \left(\frac{NK_{tj}}{L}\right)^{\eta} = k^{\eta} \qquad (2.48)$$

The government activity or public expenditure version of economic growth argues that the functional activities of government such as provision of infrastructure services, the protection of property rights and taxation policies could affect the level of baseline technology, A, and thus affects the long-run per capita growth rate. Assuming there is no population growth and based on the activities of government, the aggregate production function will be in the form:

$$Y_t = AL_t^{1-\alpha}K_t^{\alpha}G_t^{1-\alpha} \tag{2.49}$$

This exhibits constant returns to scale in the private inputs, L and K. For a fixed G *(government expenditure),* the model exhibits diminishing returns to capital accumulation, K, except if G rises along with K. There will be endogenous growth in the economy because diminishing return does not arise. This implies that public services are complementary with the private inputs in the sense that an increase in G raises the marginal products of L_i and K_i. The exponent of G, (1-α), is critical in determining the impact of G on growth. For instance, if the exponent of G is less than (1-α), there will be diminishing returns to K_i and G and this will rule out endogenous growth. If it is greater than (1-α), then growth rate will not remain constant but will tend to rise over time. A special case of the exponent of G is when it is exactly (1-α), which implies a constant returns to K_i and G and thus ensures that the economy is capable of generating endogenous growth. The government taxes final output at a rate, say $\tau>0$ so $G_t = \tau Y_t$ and the expenditure ratio, G/Y is assumed to be constant over time.

Substituting for G_t in (2.49) leads to:

$$Y_t = (A\tau L)^{\frac{1-\alpha}{\alpha}} K_t \tag{2.50}$$

which is of AK form where $(A\tau L)^{\frac{1-\alpha}{\alpha}}$ is A.

It is assumed that government purchases a portion of private output, which it uses to provide free public services, G, that is non rival and non excludable. Firms benefit from this and thus maximises profit according to:

$$\pi_t = (1-\tau)L^{1-\alpha}K_t^{\alpha}G_t^{1-\alpha} - r_tK_t - w_tL \tag{2.51}$$

By equating the wage rate, which equals the after tax marginal product of labour, with the rental rate, which equals the after tax marginal product of capital, the aggregate output of the economy becomes:

$$Y_t = Lk_t^{\alpha} G_t^{1-\alpha}$$

$$G_t = (\tau L)^{\frac{1}{\alpha}} k_t \qquad (2.52)$$

$$\alpha L^{\frac{1-\alpha}{\alpha}} (1-\tau)\tau^{\frac{1-\alpha}{\alpha}} = r_t$$

If L and τ are constant, then the after tax marginal product and the rate of return, r, is invariant with K and increasing with L. There are two channels of the effects of government on economic growth; the term $1-\tau$ represents the negative effect of taxation on the after tax marginal product of capital and the term $\tau^{\frac{(1-\alpha)}{\alpha}}$ represents the positive effect of public services on the marginal product; $1-\alpha$ is the distortionary effect of taxation; while τ captures the positive effect of government expenditure on the marginal product of capital, MP_K. The efficiency condition for the size of government is:

$$\tau = 1-\alpha, \qquad \text{ie } \frac{\partial G}{\partial Y} = 1$$

Substituting r_t into the Euler equation;

$$g_c = \frac{\dot{c}_t}{c_t} = \frac{\alpha L^{\frac{1-\alpha}{\alpha}} (1-\tau)\tau^{\frac{1-\alpha}{\alpha}} - \rho}{\theta} \qquad (2.53)$$

Government maximises the representative consumer's intertemporal utility based on (2.53), which is the social optimal growth of the economy. There is a scale effect in the model in that an increase in L raises the after tax marginal product of capital and expands the social marginal product in a parallel way, which in turn, leads to higher per capita growth rates. However, congestion on government services affects production and retards growth[18]. Consider a production function in which G, government activities, serve as input, and thus:

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[18] If a public good is used by more than necessary number of firms, congestion sets in and this leads to inefficiency of the production process.

$$Y_i = AK_i f\left(G/Y\right) \quad (2.54)$$

$f'>0$ and $f''<0$ and G/Y is government services relative to output. This is a modified AK production function. An increase in G, relative to aggregate output Y, leads to expansion in aggregate output and vice versa. The efficiency condition, $\frac{\partial G}{\partial Y}=1$, (which removes the diminishing returns to K) is necessary to maintain a social optimum growth rate. Other government activities such as national defence, courts, etc towards the protection of property rights are not captured by the production function but provide incentives for production and capital accumulation.

2.2.2: Models of Endogenous Technology Change

Technological progress can be attained through Research and Development (R&D). Firms, driven by profitability, invest their resources in R&D, which leads to either quality improvement or variety expansion. Technology is regarded as a private product, so investors enjoy some level of preservation either because of the possibility of secrecy or acquisition of patent rights. Innovation leads to new products either in quality or variety, so innovators exploit some form of monopoly power. It is assumed that there are no bounds to new ideas, so there is no diminishing return in the creation of technology.

According to the neo-Schumpeterian approach, the amount of resources devoted to R&D is determined by private firms, motivated by profit incentives in conditions of monopolistic competition. The final output and the R&D sectors as well as the labour market are assumed to be competitive, but the intermediate goods sector that provides inputs to the final goods sector based on blueprints derived from R&D (knowledge) is monopolistic. Population, labour (workers) and consumers are the same and assumed to be fixed. Each member of the population supplies one unit of labour per unit of time. Infinitely lived and risk-neutral consumers maximise utility based on;

$$U = \int_0^{\infty} e^{-\rho t} c_t \, dt \quad (2.55)$$

The aggregate production function is;

$$Y_n = A_n \chi_n^{\alpha}, 1 > \alpha > 0 \qquad (2.56)$$

Y_n =aggregate output

χ_n =the amount of innovative goods which are used as intermediate inputs (perishable)

A_n = the level of quality of innovative goods (a measure of productivity).

As a result of quality innovation at a given period, an existing product, say A_0 is replaced by A_1 and in the next period A_1 is replaced by A_2, rendering it obsolete[19]. This process continues over an infinite horizon in a manner described by Schumpeter as *"Creative Destruction"*. This is also referred to as *"Quality-Ladder—Model"*. The replacement phenomenon is due to successes in R&D, which leads to a new *"state-of–the-art"* version of the product. Since the newly invented product will be available in the market, other researchers can examine its characteristics and learn knowledge embodied in it and use it for further research that could lead to further innovation of an improved version of it. This is a case of knowledge spill-over, which brings to the fore, the non-rivalry and non-excludability attribute of knowledge.

The process of quality improvement is taken to follow a geometric progression exponentially in accordance with the Poisson distribution with an arrival rate of δR_n where δ>0 and R_n is the number of workers in the R&D sector and δ is R&D productivity. The time interval between the n^{th} and the $(n+1)^{th}$ innovations, which is assumed to be exponentially distributed, is expected to be $1/\delta R_n$. As R_n increases, the expected time length between the n^{th} and the $(n+1)^{th}$ innovation falls. The investor in the intermediate goods sector faces a derived demand function for his product based on (2.56). Firms maximise profit based on equating marginal product with price;

$$\frac{\partial Y_n}{\partial \chi_n} = A_n \alpha \chi_n^{\alpha-1} = P_n \qquad (2.57)$$

The profit will be given by;

$$\pi_n = \frac{1-\alpha}{\alpha} w_n \chi_n \tag{2.58}$$

The α measures the degree of monopoly power. The smaller α is the higher the monopoly power, and the higher the level of profit and vice versa.

The main objective of investors in conducting R&D is to maximise the sum of expected present value of future profit flow given by:

$$V_{n+1} = \frac{\pi_{n+1}}{\rho + \delta R_{n+1}}$$

or (2.59)

$$\rho V_{n+1} = \pi_{n+1} - \delta R_{n+1} V_{n+1}$$

If A_{n+1} does not become obsolete with new inventions, $V_{n+1} = \frac{\pi_{n+1}}{\rho}$ and δR_{n+1} lowers the value of innovation. There is a negative correlation between current and future R&D so when V_{n+1} is low, R_{n+1} will be low and thus will discourage R&D for the subsequent period. This will generate a trend of fluctuations in the level of per capita income until stochastic steady state equilibrium is reached, where:

$$\delta V_{n+1} = w_n \tag{2.60}$$

Combining all the conditions yield:

$$\frac{1}{\delta} = \frac{\gamma \frac{1-\alpha}{\alpha} x}{\rho + \delta R} \tag{2.61}$$

A higher demand for manufacturing goods will lead to higher demand for manufacturing workers, x and higher level of profits, which in turn will create incentives for R&D and hence higher demand for R&D workers. Full employment condition is as follows:

$$L = R + x \tag{2.62}$$

[19] Grossman and Helpman (1991) argued that a product becomes absolute not necessary because it is inferior in quality to the new product.

If more workers are used in manufacturing, then less will be used in the R&D sector and vice versa. The role of human capital endowment is very significant in this model. If different economies have the same consumer preferences, the same amount of R&D activities and technology, differences in human capital endowment could lead to divergence in growth rates. The model assumes scale effects, in that the rate of growth (and hence technological progress) is positively related to the size of the economy.

Scale effects have limited impact on the long-run growth of the economy[20]. This limitation weakens the process of endogenous growth by R&D investments. Semi-endogenous growth, based on R&D provides a basis for growth to be generated endogenously but long-run growth rate of the economy depends on exogenous parameters. Assuming two R&D products, *A*(quality) and *B*(variety), where the final output is according to the production function;

$$Y_t = \left(\int_0^{\beta} \chi_{it}^{\alpha} \right)^{\frac{1}{\alpha}} \tag{2.63}$$

Y= final output

χ_i = the amount of intermediate goods of variety

β_t = the quantity of innovative goods (variety)

An increase in β_t raises productivity of final output of producers through specialisation and thus variety increases according to:

$\dot{\beta}_t = bL_t$ $\quad$ $1>b>0$ is the proportion of workers engage in the type *B* R&D

The production function for the i^{th} intermediate goods will be:

$$\chi_{it} \equiv \chi_t = A_t(1-a)\frac{(1-b)L_t}{\beta_t} \tag{2.64}$$

The $(1-b)L_t$ is the proportion of workers available for A-type R&D and production of intermediate goods,

$\frac{(1-b)L_t}{\beta_t}$ = number of workers used for A type R&D and production of each intermediate goods since the production function is symmetric.

1-α is the proportion of workers in manufacturing in each variety and A_t is the level of technology in each variety.

A_t increases according to

$$\dot{A}_t = \delta a \frac{(1-b)L_t}{\beta_t} k_t \tag{2.65}$$

$k_t = A_t$ is the stock of knowledge.

Long-run growth in equilibrium will be given by

$$g_y = \frac{1-\alpha}{\alpha} g_B + g_A \tag{2.66}$$

g_A and g_B are constant, hence a and b must be constant, so $g_B = b\frac{L_t}{\beta_t}$,

which implies that $g_B = n$, $$g_A = \delta a \frac{(1-b)n}{b} \tag{2.67}$$

g_B is pinned down by population growth while g_A is a function of population growth but not pinned down by it, since it is affected by a and b, which are determined endogenously within the model, specifically by private incentives for R&D and consumers' preferences. This makes g_y endogenous, to the extent that g_A is endogenous and public policy and consumers' preferences affects g_y.

If both g_A and g_B are pinned down by population growth, then the model becomes semi-endogenous.

$$\dot{\beta}_t = bL_t k_t^{\beta}, \qquad k_t^{\beta} = A_t^{\phi\beta} \beta_t^{\eta\beta}$$

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[20] Jones (1995) illustrates in detail the limitation of scale effects in this model.

As ideas continue to bring new innovations, A_t, technology becomes more sophisticated, making the creation of previous level of technology more and more difficult. This is negative externality and inter R&D spill-over occurs in a manner captured by $A_t^{\phi\beta-1}$ and $\beta_t^{\eta A}$. The balanced growth rate will ensure constant g_A and g_B as well as a and b and thus;

$$g_B = \frac{bL_t}{A^{1-\phi\beta}\beta^{1-\eta\beta}} \tag{2.68}$$

$$g_A = \delta A \frac{(1-b)L_t}{A^{1-\phi A}\beta^{1-\eta A}} \tag{2.69}$$

g_A and g_B are pinned down by population growth so k=A,B are assumed to be policy invariant. These processes generate semi-endogenous growth.

Thus, population growth is a fundamental driving force for output growth but not for long-run growth of output per capita. The reasoning of this model is hinged on the perception of economic growth as dependent on the creation of new ideas, derived from human capital drawn from the pool of population of a country. In the basic Solow neo-classical model, the steady state growth rate is equal to the population growth plus exogenous technological progress so in the absence of technological progress, the growth rate of GDP is equal to the growth rate of population and the growth rate of income per capita will be equal to zero. Invariably, ideas do not automatically emanate from population. Certain processes are needed to trigger the inclination towards ideas. The argument of scale effect, which presupposes a positive correlation between population growth and economic growth, is thus empirically weak. In other words it cannot be proved that countries with high growth rates are those with high population growth. The model is therefore more applicable to advanced economies, where to a large extent, the requisite condition for generating ideas exist.

Some other economies can grow through the transfer of existing ideas across countries but technology transfer among advanced countries can vastly complicate cross-country inference, in that a direct linkage between population and economic growth can be obscured by potentially large flow of exchange of ideas between countries (Jones, 1995). Therefore, the effective number of researchers, rather than the population, is the significant focus for the production of ideas and generating economic growth. However, scale effects have some bearing on the process due to the fact that having more people to draw on to create ideas is a significant advantage that can be appropriately used to foster the emergence of ideas. The monotonic implication of scale effects in R&D driven growth analysis is not strong enough. The semi-endogenous R&D-based growth emphasizes the fact that seemingly policy invariant parameters, such as population could be significant in spearheading the process of growth of an economy. Economic growth is tied to increase in productivity, which, in turn, depends on new ideas (designs) through R&D, which is dependent on an exogenous variable, the labour force or population.

The recent experiences of China and India, the fastest growing economies in the world, both of which have very high level of population could explain the relevance of scale effects to the process of endogenous economic growth. The attractiveness of manufacturing activities due to favourable labour supply sets the pace for physical and human capital development, which necessitates appropriate government responses to growing need for infrastructure and requisite policies as enunciated by the government activity version of economic growth. This gives rise to learning-by-doing and R&D activities. The Quality-ladder mechanism occurs and all aspects of endogenous growth process permeate to enhance the value-adding capabilities of the factors of production in a sustainable manner. Thus a well managed high level of population could be a trigger for sustainable economic growth. The imperative role of the households as consumers and suppliers of labour, which are the essential ingredients for a viable productive economy as ascribed by both the neoclassical and endogenous growth theories, gives additional credence to the significance of level of population to level of economic growth.

By and large the core of all the variants of the endogenous growth models reflects the essentialness of input-output and the interconnectedness of different economic activities (sectors or industries) to each other. The emphasis on consumption, the productivity of the competitive firms and the continued recourse for innovation and technological improvement by firms, driven by the urge to gain from markets are intertwined with the increase in the absorptive capacity of industrial production processes and this is fundamental in the input-output process. Endogenous technological change, expected to be the by-product of increasing absorptive capacity, culminates from increasing demand for goods and services produced by different sectors of the economy either by other industries as inputs or as final goods and services by consumers. It is therefore significant to point out that, even though not explicitly expressed, the endogenous growth theories, like the neoclassical growth theories, are hinged on inter-industry linkages.

Chapter 3

NATURAL RESOURCES AND ECONOMIC GROWTH

Solow (1974,1986,1991,1993), Hartwick (1976,1977, 1978, 1990, 1992), Heal(1981), Stiglitz (1974a and 1974b), Pezzy (1992,1996,1997), Rawls (1974), Dasgupta and Stiglitz (1981), Dasgupta and Mitra (1983), Houthaker and Solow(1973), among others have led to a large and robust literature on natural resources and economic growth.

3.1: NATURAL RESOURCE IN THE GROWTH MODELS

Consider a neoclassical production function

$$Y = F(K, L) = Lf(k) \tag{3.1}$$

$k = \frac{K}{L}$ and Y is the net output.

Suppose the model is extended to incorporate natural resources so that

$$Y = F(K, L, R) \tag{3.2}$$

R is the rate of flow of natural resource extracted from an existing pool. The natural resource, R is said to be essential if output is nil without it. Thus if $Y=0$ when $R=0$, then R is essential, otherwise it is inessential[21]. In Cobb-Douglas form,

$$Y = AK^{\alpha}R^{\beta}L^{1-\alpha-\beta} \qquad 0 < \beta \geq 1, \alpha + \beta \leq -1 \tag{3.3}$$

A is a Hicks-neutral index of exogenous technological change that multiplies the entire production function. The production function exhibits constant returns to scale in K, R *and* L together. Population and technology grow at constant exogenous rates

$$\frac{\dot{A}}{A} = g, \quad and \quad \frac{\dot{L}}{L} = n$$

Capital accumulates according to;

$$\dot{K} = sY - \delta K \qquad (3.4)$$

In a steady state growth, the capital output ratio, *K/Y* will be constant. The pool of resources available is finite so the growth rate of total output along a balanced growth path g_Y is given by:

$$g_Y = g + (1 - \overline{A})n \qquad (3.5)$$

where, for notational convenience:

$$g \equiv \frac{g_A}{1-\alpha}, \quad \overline{A} \equiv \frac{\beta}{1-\alpha}$$

The growth rate of output per worker will be

$$g_y = g - \overline{\beta} n$$

If β=0, then *R* plays no role and $g_y = g$. Long-run growth rate of the economy depends not just on the rate of technological change, but also on the significant role of natural resource, measured by β, and the rate of population growth in a relationship interpreted by Jones (2002) as a classic race between technological progress and the diminishing returns introduced by the finite natural resource, S_0. If *g=0,* meaning that there is no technological progress, the production function will exhibit diminishing returns to capital and labour since constant growth rate of population will lead to increasing pressure on the pool of resources, as a result of which marginal product of labour will fall to the extent that accumulation of capital cannot fully offset. There will be negative per capita growth in output per worker at a rate proportional to the population growth rate, and the level of per capita income declines to zero. Technological progress will make labour, capital and the resource utilization more productive and can possibly offset the population pressure to ensure sustained growth in per capita income. This implies that, technological progress can alleviate the depletion of natural resources. However the effect of exogenous technological progress on production will be diluted by the diminishing returns to capital and labour.

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[21] Perman *et al* (1999) highlights some other meanings and dimensions of essentiality.

The more the natural resource is used, the more the resource stock is depleted. Thus

$$\dot{S}_t = -R_t, \tag{3.6}$$

or

$$S_t = S_o - \int_{\tau=0}^{\tau=t} R_t d\tau \tag{3.7}$$

Assuming a single homogenous resource stock[22], the total exhaustive use of resources over time must equal the fixed initial stock. In a competitive context, the time path for R will be determined by the interactions between its marginal product and price. In the long-run, a constant proportion of the stock of resources, denoted as $\gamma(= R/S)$ is used in production. The declining rate of the resources will be

$$\frac{\dot{S}}{S} = -\gamma \tag{3.8}$$

The behaviour of the stock will exhibit negative exponential growth at the rate,γ so that

$$S_{(t)} = S_o e^{-\gamma t} \tag{3.9}$$

Since $R = \gamma S$, the amount of resources used in each period is given by

$$R = \gamma S_o e^{-\gamma t} \tag{3.10}$$

The fact that the remaining stock of the resource declines over time implies that the amount of the resource used in the production also declines over time. The production function can be written in terms of capital-output ratio as follows:

$$Y = A^{\frac{1}{1-\alpha}} \left(\frac{K}{L} \right)^{\frac{\alpha}{1-\alpha}} \left(\gamma S_o e^{-\gamma t} \right)^{\frac{\beta}{1-\alpha}} L^{1-\frac{\beta}{1-\alpha}} \tag{3.11}$$

The negative exponential term in (3.11) measures the depletion of the resource. The utilization intensity,γ, plays a dual role as such it enters the function twice; first, multiplying the stock and second as a rate of depletion, illuminating the fact that more intensive use of the resources increases current output, Y, by raising $R(= \gamma S_0 e^{-\gamma t})$ directly

[22] This implies that there is no backstop resource in any form.

while on the other hand it leads to the depletion and decreases the remaining stock to be used in subsequent period of time. The trade-off between current and future use of natural resources extends to current and future consumption. Given that the natural resource is essential, output will be decreasing along with the stock depletion over time. Thus the presence of natural resources in production reduces the long-run rate of economic growth.

The growth rate of total output along a balanced growth path is;

$$g_Y = g - \bar{\beta}\gamma + (1-\bar{\beta})n \tag{3.12}$$

The growth rate of output per worker along the balanced growth path is

$$g_y = g - \bar{\beta}(\gamma + n) \tag{3.13}$$

An increase in the depletion rate reduces the long-run growth rate of the economy, since as resources are used up more quickly, a smaller resource stock would be left and therefore lower output at each time, hence there is a trade-off between using resources today and in the future. The term γ (the intensity of resource use) is analogous to rate of investment (in this case disinvestment) and changes in investment rate in neoclassical context affects the level of income along the balanced growth path, rather than growth rate itself. However, a permanent increase in the depletion rate reduces the long-run growth rate of the economy since higher output today means less output tomorrow. The long-run growth rate of the economy can be increased, by reducing the depletion rate permanently and accepting a lower level of income today. The rate at which the natural resource declines is the depletion rate as illustrated by the equation of law of motion[23] (3.6). The limited availability of natural resource therefore constitutes a constraint to the growth potential of the economy in the long-run. There is therefore the need for an optimal depletion and population policy in order to forestall the adverse effect of declining stock of natural resources on economic growth.

[23] The law of motion here refers to the balanced relationship between the use of resources and the remaining stock of the resources available.

Hartwick (1977 and 1978) argued that sustainability, in terms of steady state consumption path, can be attained by saving and investing rents derived from non-renewable natural resource in reproducible (physical) capital. Solow (1974a) concurred with the Rawlsian ethical argument of intertemporal distributive justice, which ensures intergenerational equity not merely on consumption, but on utility. According to Dasgupta and Heal (1974), optimal policies advanced by Koopmans assumes a constant population size and the planning horizon is regarded as a choice variable, giving rise to an optimal depletion policy within an optimal survival period that contains a given fixed population[24]. An intertemporal planning based on intergenerational equity is conceived as the basis for optimal utilization of natural resources and sustainable economic growth. Optimal growth is attainable in conjunction with the set of efficient paths along which consumption grow at a constant rate. If per capita consumption is taken to be c, and the pure rate of time discount to be δ, the optimal intertemporal consumption of the representative consumer will be based on the criterion:

$$\text{Max} \int_0^\infty U(c_t)e^{-\delta t}dt \qquad \text{subject to: } \frac{dU}{dt} = c_t \tag{3.14}$$

Heal (1990) distinguished between utility discounting and consumption discounting. The consumption rate of discount is the rate at which the value of a small increment of consumption change as its date is delayed, and is given by:

$$\frac{\frac{d}{dt}\left(U'(c_t)e^{-\delta t}\right)}{U'(c_t)e^{-\delta t}} \tag{3.15}$$

If this rate is negative, then an increment of consumption has higher value at an earlier date. The second –order approximation to $U(c_t)$, which is:

$$-\delta + \frac{U''\dot{c}}{U'} = -\delta + \eta\frac{\dot{c}}{c}$$

[24] There are some analysis that are based a growing population. For example, see Solow (1974). However, the discussion here will be confined to fixed population.

gives the utility discount rate. A liner utility function implies that the consumption and utility discount rates are the same. A fall in consumption is an indication that the consumption discount rate is less than the utility discount rate. For analytical simplicity, it is assumed that the consumption and utility discount rate are the same, so the utility function is approximated by a linear function. The economy's optimal resource depletion policy thus follows:

$$\text{Max} \int_{=0}^{\infty} U(c_t)e^{-\delta t}dt \qquad \text{subject to: } \int_{-0}^{\infty} c_t dt = S_0 \tag{3.16}$$

A solution of which satisfies:

$$U'(c_t)e^{-\delta t} = \text{Constant}$$

The consumption rate of discount satisfying this condition is zero, which conforms to the Hotelling rule for optimal depletion of an exhaustible resource. If the economy uses the resource as production input, the consumption rate of discount tends asymptotically to the marginal product of capital (MP_K), i.e.:

$$\lim_{t\to\infty}\left(\frac{\frac{d}{dt}\left(U'(c_t)e^{-\delta t}\right)}{U'(c_t)e^{-\delta t}}\right) = MP_K \tag{3.17}$$

The higher the rate of discount the faster the resource is used up. The rate of growth of the economy increases with increases in the rate of technical progress, decreases with the pure rate of time discount and with the elasticity of marginal utility.

3.2: OPTIMAL UTILIZATION OF NATURAL RESOURCES[25]

The assumption that non-renewable resources exists in finite quantity makes it impossible to use constant and positive amounts of them over infinite horizon. The extent to which the finite resource is essential determines the level at which sustainability is possible. The degree of essentialness of natural resource can be either absolute or relative depending on the elasticity of substitution between the natural resource and other factors of production; labour (L), capital (K) and the "effectiveness of labour" or technology (A). The elasticity of substitution is the proportionate change in the ratio of an input, say capital (K) to the resource as a result of a proportionate change in the ratio of the marginal products of capital. The extent of substitution possibilities has a significant bearing on the feasibility of attaining a steady growth rate. The higher the coefficient of elasticity of substitution which ranges between 0 and 1, the more the possibility of attaining constant growth rate and vice versa. Stiglitz (1974) argued that technical change, the substitution of man-made factors of production (capital) for natural resources and returns to scale can offset the limitations of natural resources in generating economic growth.

There is an increasing tendency for the price of the natural resource to rise over time relative to other factor inputs because depletion reduces the stock continuously and leads to resource Scarcity. If the magnitude of the resource substitutability (coefficient of elasticity of substitution) is high, it will be possible to offset the negative effects of resource scarcity by increasing the quantity of other inputs by a relatively smaller proportion, but if otherwise, resource scarcity will have serious adverse effects since the possibility of replacement by reproducible substitutes is limited. A zero coefficient of elasticity of substitution means that there is absolutely no possibility for replacement. Perman *et al* (1999) averred that uncertainties regarding the ecosystem, population growth, the exact quantity and features of natural resource availability and the future of technology make the determination of magnitude of substitutability difficult. Following

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[25] The analysis could be for either non-renewable or renewable resources, but the focus here is on non-renewable resource.

Perman *et al* (1999) the social welfare function (SWF), which, is assumed to be utilitarian is:

$$W = W(U_0, U_1, U_2, \ldots\ldots\ldots, U_T) \tag{3.18}$$

The utilitarian intertemporal SWF will be of the form:

$$W = \alpha_0 U_0 + \alpha_1 U_1 + \alpha_2 U_2 + \ldots\ldots\ldots\ldots + \alpha_T U_T \tag{3.19}$$

where $\alpha_{t=0,1,2\ldots\ldots T}$ are the weights. Utility in each period is a concave function of the level of consumption in that period only, $U_t = U(C_t)$ for all t. The relationship between consumption and utility is the same in all periods. The weights can be interpreted as discount factors, related to a social utility discount rate, ρ assumed to be fixed, so the SWF can be expressed as

$$W = U_0 + \frac{U_1}{1+\rho} + \frac{U_2}{(1+\rho)^2} + \ldots\ldots\ldots + \frac{U_T}{(1+\rho)^T} \tag{3.20}$$

which can be re-expressed in continuous time in the form:

$$W = \int_{t=0}^{t=\infty} U(C_t) e^{-\rho t} dt \tag{3.21}$$

The first constraint of the economy is

$$S_t = S_0 - \int_{\tau=0}^{\tau=t} R_\tau d\tau \tag{3.22}$$

The resource stock to be extracted and used by the end of the horizon *t*, (S_t) is equal to the total initial stock (S_0), less what has been extracted and used up to time *t*

$$(\int_{\tau=0}^{\tau=t} R_\tau d\tau)$$

The second constraint is that output is either consumed or saved, and the portion that is saved results in capital stock change in the form:

$$\dot{K} = Y_t - C_t$$

but $Y_t = F(K_t, R_t)$,

$$\text{so,} \qquad \dot{K}_t = F(K_t, R_t) - C_t \tag{3.23}$$

The socially optimal intertemporal allocation of the resource is obtained by maximising the economy's social welfare function subject to the two constraints[26]. The Hamiltonian is given by

$$H_t = U(C_t) + P_t(-R_t) + \omega_t(Y_t - C_t) \tag{3.24}$$

P_t and ω_t are the shadow prices of resource and capital respectively and the optimal solutions are given by

$$U_{ct} = \omega_t \tag{3.25a}$$

$$P_t = \omega_t Y_{Rt} \tag{3.25b}$$

$$\dot{P}_t = \rho P_t \tag{3.25c}$$

$$\dot{\omega} = \rho \omega_t \tag{3.25d}$$

(3.25a) and (3.25b) are the static efficiency condition which requires that the marginal value of the services of a resource (in this case marginal utility) should be equal to the marginal value of that resource (given by its shadow price). This condition ensures that the marginal net benefit (or marginal value) of the resource to the society is the same in all its possible uses. (3.25c) and (3.25d) satisfies the dynamic efficiency condition which requires that each asset or resource earns the same rate of return, which should also be the same at all points in time and equal to the social rate of discount. The growth rate of consumption can be obtained from (3.25a) and (3.25d) as

$$\frac{\dot{C}}{C} = \frac{Y_K - \rho}{\eta} \tag{3.26}$$

η must be positive based on the underlying assumptions of the utility function and therefore:

$$\frac{\dot{C}}{C} > 0 \Leftrightarrow Y_K > \rho$$

implies that marginal product of capital exceeds the discount rate (ρ), so consumption is growing over time along an optimal path.

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[26] Perman et al (1999) provides a detailed and incisive analysis of the procedure for obtaining the optimal solutions. Only the basic results are presented and analysed here.

$$\frac{\dot{C}}{C} = 0 \Leftrightarrow Y_K = \rho$$

implies that marginal product of capital equals discount rate, so consumption is constant.

$$\frac{\dot{C}}{C} < 0 \Leftrightarrow Y_K < \rho$$

implies that marginal product of capital is less than discount rate, so consumption is decreasing.

The Hotelling's rule[27], which is described by (3.25c), regarded as the intertemporal efficiency condition to be satisfied by efficient process of resource extraction, is expressed as:

$$\frac{\dot{P}_t}{P_t} = \rho \qquad (3.27)$$

meaning that the rate of change in the (shadow) price of resource should be equal to the discount rate of consumption. Another interpretation of this rule is based on expressing (3.27) as:

$$\dot{P}_t = \rho P_t$$

Integrating yields:

$$P_t = P_0 e^{\rho t}$$

Discounting P_t (the undiscounted price of resource) at the social utility discount rate ρ gives:

$$P_t^* = P_t e^{-\rho t} = P_0$$

P^* is the discounted resource price.

[27] The Hotelling's rule, which says that the discounted value of the resource should be the same at all dates, was developed by Clawson (1959) and Clawson and Knetsch (1966) based on Hotelling's (1947) letter to the US Park Service (see Perman *et* al, 1999).

This says that the discounted price of the resource is constant along an efficient extraction path. The discounted value of the resource should be the same at all time. The higher ρ is, the faster the rate of growth of the resource price.

Hotelling's rule is a necessary, but not sufficient condition for optimal resource extraction since it does not ensure a unique price path. For an efficient optimal extraction, all the initial conditions and the maximisation conditions (3.25a)-(3.25d) must be satisfied. If the initial price of the resource stock is too low, the utilization intensity will be high, depletion will be faster and resources will be exhausted within a relatively shorter period of time. If on the other hand, initial price is too high, utilization intensity will be small, depletion will be relatively low and exhaustion will take a relatively longer period of time.

Extraction cost can be incorporated to reflect the fact that, in reality, extraction of resources cannot be at zero cost. Intuitively, the cost of extraction, G will be influenced by the quantity of the resource extracted at time t, and the existing (remaining) amount of the resource stock, S_t, so the cost function will be given by :

$$G = (R_t, S_t) \tag{3.28}$$

The optimal solutions in this case will be based on maximising

$$W = \int_{t=0}^{t=\infty} U(C_t)e^{-\rho t}dt \tag{3.29}$$

Subject to the constraints:

$$\dot{S}_t = -R_t, \tag{3.30}$$

The solutions will be:

$$U_{ct} = \omega_t \tag{3.31a}$$

$$P_t = \omega_t Y_{Rt} - \omega_t G_{Rt} \tag{3.31b}$$

$$\dot{P}_t = \rho P_t + \omega_t G_{st} \tag{3.31c}$$

$$\dot{\omega} = \rho\omega - Y_{K_t}\omega \tag{3.31d}$$

(3.31a) and (3.31d) are similar and have the same interpretations but (3.31b) and (3.31c) are different. (3.31b) is an expression for the net price of the resource[28], which is also referred to as "royalty" or "rent".

The Hotelling rule can be modified, based on the behaviour of competitive profit maximising firms into:

$$\dot{P} = \rho P + G_s\omega \tag{3.32}$$

$G_s = \dfrac{\partial G}{\partial S}$ is negative since it is more costly to extract resources if the remaining stock is small, so efficient extraction over time implies that the rate of increase of the resource net price should be lower where extraction costs depend upon the resource stock size. Dividing by the resource net price gives;

$$\rho = \frac{\dot{P}}{P} - \frac{G_s\omega}{P} \tag{3.33}$$

which indicates that the social discount rate should equal the rate of return from holding the resource. (3.33) can be rearranged as follows:

$$\rho P = \dot{P} - G_s\omega$$

which leads to the interpretation that the marginal cost of not extracting an additional unit of the resource (ρP) must be equal to the marginal benefit from not extracting an additional unit of the resource. Thus, at an efficient and optimal rate of resource use, the marginal costs and benefits of resource use are balanced at each point in time. The introduction of costs related to the level of resource extraction raises the gross price of the resource above its net price, but has no effect on the growth rate of the resource net price whereas a resource stock size effect on extraction costs will slow down the rate of growth of the resource net price. It implies that resource net price will be initially higher, but will ultimately be lower than it would have been in the absence of stock effect, resulting in slow down of the rate of extraction at the early stage, conserving greater stock for future extraction, in the later stage of the time horizon.

If the decision-making mechanism is based on perfect market conditions, rather than a social planner *per se*, the optimality condition and the Hotelling's rule will still hold and the outcome will be the same. Consider an economy with *m* competitive firms with equal and constant marginal costs of extraction, and facing the same fixed selling price at all times. The market royalty, P_t, will be identical over firms and each firm will choose an amount to extract and sell R_{jt} to maximise profits;

$$Max \int_0^T \Pi_{jt} e^{-it} dt \tag{3.34}$$

Subject to; $$\int_0^T \left(\sum_{j=1}^{m} R_{jt} \right) dt = \bar{S} \tag{3.35}$$

where $\Pi_j = P.R_j$ is firm *j's* profit and *i* is the market interest rate

The stock constraints is binding on all firms, profit-maximising extraction rate condition is when each firm extracts R_{jt} so that its discounted marginal profit will be the same at any time *t:*

$$M\,\Pi_{jt}\, e^{-it} = \frac{\partial \Pi_{j,t}}{\partial R_{j,t}} e^{-it} = \frac{\partial PR_{jt}}{\partial R_{jt}} e^{-it} = P_t e^{-it} = \text{Constant} \tag{3.36}$$

where $M\,\Pi_j$ is firm *j's* marginal profit function.

$$\begin{aligned} &P_t e^{-it} = p_{0,}, \\ &or \\ &P_t = P_0 e^{it} \end{aligned} \tag{3.37}$$

If this condition does not hold, firms could increase their profits by switching extraction between time periods so that more extraction takes place when discounted profits are high and vice versa. Two efficiency conditions are thus established:

$$\frac{\dot{P}}{P} = \rho \tag{3.38a}$$

[28] Net price (P_t) =Gross price $(\omega_t Y_R)$ -Marginal cost $(\omega_t G_R)$.

$$\frac{\dot{P}}{P} = i \tag{3.38b}$$

(3.38a) is obtained from maximizing social welfare while (3.38b) is obtained from private profit maximization. These two conditions are the same and thus lead to the same outcome.

Under a monopoly market condition the result will be different. The objective of the monopolist is to maximise its discounted profit over time, selecting net price, P_t and chooses the output R_t.

$$Max \int_0^T \Pi_t e^{-it} dt \tag{3.39}$$

$$\text{subject to:} \qquad \int R_t dt = \overline{S} \tag{3.40}$$

$$\Pi_t = P(R_t)R_t$$

To maximise profit, R_t will be allocated such that the discounted marginal profit will be the same at any time:

$$M\,\Pi_t\, e^{-it} = \frac{\partial \Pi}{\partial R_t} e^{-it} = \text{Constant} = M\,\Pi_0 \Rightarrow M\,\Pi_t = M\,\Pi_0\, e^{it} \tag{3.41}$$

The reason why the solution in perfect competitive markets differ from that of the monopoly is that the market price is exogenously fixed under perfect competition so each firm is a price taker, marginal cost equals price condition holds, but under monopoly, price is not exogenously fixed and the necessary condition for profit maximisation is that marginal profits (and not the net price or royalty) should increase at the rate of interest, i, in order to maximise the discounted profits over time.

The interest rate decision-rule dimension of the production activities of non-renewable natural resources stems from the fixity of extractable reserves. If extraction of natural resources is carried out continuously over time, the current level of profits from the sale of the extracts must be able to generate income enough in perpetuity throughout the period when the threshold of depletion is reached. This means that the current price of the extracted mineral should not only pay for exploration and extraction costs, it must be sufficient to meet the user cost of depletion, which is equal to the profits that could have been earned if the resources were extracted in a future time (Kula, 1992). While the exploration and extraction costs components of the price are easy to determine, the cost of the natural resource component is a function of the time-value of the extraction which cannot be easily evaluated. The basic concern therefore is generating enough profit from the extraction so as to make adequate provision for the time when the resource would have been exhausted.

The intuition of this classical proposition is that, the production decision-rule entails the comparison of the net price of resources with the market rate of interest or rate of commercial returns on investment so that if net price of the resources is less than the market rate of interest, the resource owner should extract and sell his resource endowment and place the proceeds in investment since he will make investment gains over time. In contrast, it is rational to leave the reserve underground when the net price is more than the current market rate of returns on investment, and is expected to remain so over time. This neoclassical decision rule amplifies the recourse to momentary gains as a basis for natural resource extraction while ignoring the fundamental requisites of economic growth processes and the potential stimulant role of the natural resource sector. It is therefore untenable in economic growth perspectives. While profit gain is important in synergising the innovative efforts of competitive firms towards technological change, the process of economic growth is an evolving process that cannot be based on static decision rule. Besides, as Akpan (2000) argued, the classical decision-rule does not cater for the situation where the owner of the resource is a government of a country such as Nigeria whose developmental needs are different from the needs of private persons. The funding requirement of development might demand the exploitation of the resources with little regard to the market valuations. For a government controlled extraction, the expected returns might be greater than the private returns since in addition to pure private returns, there are pure social returns. In the case of government controlled extraction, it is maximisation of the present value of the social gains from the depletion of the mineral endowment overtime that matters. The social profit function will involve the net pure economic returns plus the pure social profit function. The pure gains function contains variables on good governance, environmental purity index, and equitable distribution of the gains to the population and quality of life index that can be attained using revenue from the exploitation of natural resources. For a developing economy like Nigeria therefore, the underlying assumption of equilibrium level of investment is not tenable, basically because the prevalence of information asymmetry leads to differential returns even in the same line of investment within the same location and time. The low level of intra and inter industry investment further accentuates this trend of disequilibrium.

The expositions of the impact of natural resource utilisation on the economic growth process tend to emphasise the need for steady state consumption path based on intertemporal utility maximisation. Essentially, the central argument of steady state consumption pattern requires that consumption is not monolithically determined by natural resource availability but the use of natural resources to generate a stream of economic activities that could lead to the production of various goods and services. In this sense, the availability of natural resources provide a critical input for a chain of productive activities in different sectors of the economy leading to higher and increasing levels of output by the productive sectors thereby ensuring the availability of different goods and services for direct consumption and for further absorption by other sectors of the economy in a regeneration process. The natural resource extraction process also requires inputs from other sectors of the economy, giving rise to a chain of interdependence in input-output process that leads to the production of not only the natural resource but also several different goods and services with associated positive externalities that leads to technological change and improvements in the production processes as well as in quality and quantity of goods and services. This provides the contour for the utility maximisation functions in (3.18), (3.19) and (3.20). In other words, extraction of available natural resource alone does not provide sufficient conditions for steady state consumption and economic growth and cannot satisfy the conditions for utility maximisation. To create a sufficient condition for steady state consumption and growth, the natural resource needs to be transformed by a process that generates multiplier effects into the economy. Sectoral interdependence propels the productive fibre of each of the sectors. Input-output mechanism and by extension, inter-industry linkages, are therefore significant in the transmutation of natural resource as an essential cylinder in stimulating the process of economic growth.

3.3: PERSPECTIVES AND POLICY IMPLICATIONS

The surveyed economic growth models illuminate the essence of the effective use of factors of production as the veritable mechanism for attaining economic growth. A given level of natural resource requires the use of labour, capital and the "effectiveness of labour" (technology) to spring-up a production process. This basic analogy is inherently ascribed by virtually all the strands of analysis of the models. All the economic growth models recognise the imperative of consumption as the main activity of households and a source of demand that facilitates a production process, and the households are in turn, the source of labour input that is crucial in production. The endogenous growth analysis in particular considers that the process of production is not only useful to the limit of output and providing goods and services for household consumption but also the cardinal source of technological progress, which is by convergence among all the models, the catalyst for economic growth. However, there are variant propositions and predictions of these models that could hardly withstand empirical test.

The prediction that the economy converges towards a balanced growth path and the argument of an exogenous effect of technology, the hallmark of the neoclassical models, imply that the rate of growth cannot be influenced by the activities within the economy. Consumers' preferences, production processes and policy changes within the economy cannot influence the growth rate of the economy with capital, output and consumption per unit of effective labour being constant. On the contrary, it is the value-adding capabilities of the factors of production as a result of their effective use by the production process that generates growth of the overall economy. While not discounting the overbearing effect of technological change as the only source of growth per capita of the economy, which is the fundamental conclusion of the neoclassical models, it is worth pointing that technology cannot exclusively generate economic growth without a matching level of capital and labour. So a technological change have limited impact on an economy without a commensurate level of change in capital and labour to match the level of absorption required in making effective use of the change in technology.

The different assumptions of constant and endogenous saving rate by the Solow and the RCK models respectively do not alter the conclusions of the neoclassical models. However the golden-rule analysis of the RCK model does not permit the capital stock to exceed its golden rule level, while it is possible in the Solow model but will eventually adjust to the golden rule value. This is counterintuitive. Barro and Salai-Martin (1995) contend that this argument of the golden-rule makes it difficult to determine a desirable level of saving rate and that it will be inefficient for the saving rate to exceed the golden-rule level forever because higher quantities of per capita consumption could be attained at all points in time by reducing the saving rate.

McCallum (1996) posits that the neoclassical models tend to either suggest the same growth rate for all economies or that growth rates are determined by unexplained factors, arguing that experience has shown that different economies have maintained different per capita growth rates over a long period of time. Transitional growth rates will differ among economies based on differences in the ratios of capital to effective labour. The perspective of convergence also implies that if all economies have the same parameters for taste, technology and population growth rate, then they should have the same steady state level of per capita income. Low income economies will grow more rapidly than high income economies and per capita income levels of different economies will converge to a common level[29]. Economies with lower ratios of capital to effective labour relative to the steady state values will grow faster. Variation in countries' growth rates is as result of variations in distances from steady state and by the rate of decrease of returns to capital. As a country approaches steady state level of capital per unit of effective labour, diminishing returns to investment will cause a decline in growth rate. Dowrick and Rogers (2002), argued in line with Bernard and Jones (1996) that technology transfer and catch-up race among economies could be adduced as explanation for the convergence prediction of the neoclassical models. However, this logic is overshadowed by

[29] This convergence principle is based on a condition of equal parameters, which does not exist *ipso facto;* hence it is more appropriately termed conditional convergence. McCallum (1996) provides a technical and detailed analysis of this convergence condition, further stressing that average growth rates among countries tend to be positively correlated with shares of total income devoted to investment, rather than consumption as espoused by the neoclassical models.

differences in human capital, external benefits of human capital and capital market imperfections, which renders the prediction of catch-up and a convergence of all economies on a steady state growth path untenable. Economies with inherent demand and supply distortions tend to stultify growth in a sustained manner and leads to a cyclical trend of slow growth of such economies. In an empirical cross-country study, Salai-Martin, Dopperlhofer and Miller (2004) discovered, among several variables tested, that the ones that are significantly related to economic growth are human capital development, average price of investment goods, the initial level of per capita GDP and fraction of GDP in mining.

The basic implication of the endogenous growth models is their "knife-edge" character, arising from the arbitrary assumption of exactly constant returns with respect to the producible inputs. Slight increasing returns would lead to explosive growth and a slight decreasing return leads to shrinking growth, except if some exogenous factor, population, grows. Both the capital accumulation and the technological progress models subscribe to this knife-edge property. According to Groth and Schou (2002), this is an indication that the models are not amenable to endogenous variables and as such lack robustness. In the absence of population growth, the strictly endogenous models transform into instability problems which give credence to the weakly endogenous growth (Groth; 1992) or semi-endogenous growth (Jones,1995), in terms of growth in per capita consumption in the long-run at a constant positive rate, even without any exogenous technological change, in contrast to the emphasis on increasing returns and population growth for stable positive per capita growth and constant positive growth rate of per capita consumption in the long-run, as in the strictly endogenous models.

The attainment of never-ending growth requires never-ending increase in human capital, but human capital is not monolithic, since human skills are peculiar and cannot be automatically transferred to succeeding generations. The assumption of scale effect is therefore mundane, without a discernible analysis of human capital and stock of knowledge that is owned by society in general. Knowledge-in-use, not human capital *per* *se* can provide a basis for never-ending growth through incentives for R&D and spill over effects that lead to chain of innovations over time in quality and variety. Li (2001), in consonance with Jones (1995a and 1995b) averred that the possibility of inter R&D knowledge spillovers leads to semi-endogenous growth where technological change, which requires real resources, is endogenous while long-run growth is exogenous as in the neoclassical models, which weakens the impact of scale effects.

Natural resources such as oil and gas have a double-edge effect on economic growth, in that the more intensive such resources are used the higher the level of output and the higher the depletion rate as well. Given that natural resources are essential in production, growth rate can be constant only if a mechanism for maintaining constant level of output is ensured. A combination of Hartwick rule of investing the rents derived from efficient extraction, the Hotelling's rule of efficient intertemporal resource extraction and the acquisition of backstop technology, have been emphasized as means by which adverse effects of resource depletion can be alleviated. The principle of maximising the utilitarian social utility is a basis for obtaining optimal resource utilisation. The backbone of these expositions is the constant returns to scale assumption relative to technology, which brings the analysis close to endogenous growth models[30]. Groth and Schou (2002) asserted that, a one-sector model including non-renewable resource as production inputs does not generate endogenous growth due to the fact that the strain of extracting successfully smaller amounts of the resource can offset the impact of increasing returns to producible inputs, arguing that this will breed instability unless there is population to spearhead the economy semi-endogenously. The rationale for their argument is that the diminishing resource use is a drag on growth in that it inhibits the usual steady growth process. The process of semi-endogenous growth is hinged on increasing returns to capital and labour combined with population growth above some minimum to offset the counter-balancing effect of diminishing use of the non-renewable natural resource use (Groth and Schou, 2002, 408).

[30] Allyn Young conceives economic growth based on increasing returns to scale and cumulative causation that leads to self-sustaining growth due to market size which provides opportunities and incentives for innovation.

The significant deduction from the models and the analysis so far, is the indication that, there is coalescence on the crucial role of technology as the catalyst for economic growth based on the stimulating and complementing role of production and consumption, as a necessary condition for sustainable growth. Production is meant to provide for consumption, which originates from the urge of the household to consume to attain welfare. Since utility is a function of quantity and quality, the insatiable motivation to improve on the variety (quantity and quality) of consumption leads to discoveries of more sophisticated methods of production, through which technology is derived and acquired to provide the catalyst for economic growth. The models analysed diverge only on the sources of technology, but not on its role as the "engine of growth". A co-ordinated institutional motivation for effective utilisation of resources is therefore a fundamental condition for generating sustainable growth path.

This implies that, in a situation where consumption is not significantly linked to the process of production, technological progress will be undermined and economic growth, measured by increase in per capita output induced by the enhanced value-adding capabilities of factors of production (technology) will be retarded. This situation can describe the effects of natural resources on economies endowed with abundant natural resources. If rents, derived from the activities in the natural resource sector are used to facilitate complacent consumption to the detriment of production, the value-adding ability of the factors of production will be crippled and thus thwarting the process of economic growth. Sachs and Warner (1997), in an empirical investigation, established a negative relationship between natural resources and economic growth, reasoning that wealth leads to sloth with the consequence of expansion in non productive sectors while the manufacturing sector, a vital source of growth (through learning-by-doing) shrinks. This is the "Dutch Disease" effect which can be a source of chronic slow growth. The absence of "backward and forward linkages" and learning-by-doing effects leads to socially inefficient economic structure that leads to decline in growth of the economy. This stultifies the effective use of other resources, weakens the ability to use positive externalities generated within the economy, and therefore cripples the chances of growth.

While the service sectors could be productive enough to generate economic growth, the manufacturing sector exhibits more attributes of productivity in that it possess inherent potentials for learning-by-doing and higher absorptive capacity. An economy that is becoming more oriented towards services (as in the case of most developed economies) tends to have a slower growth potential than less developed but industrialised countries, although inadequacies in current statistical measures of service sector performance could hinder a more precise analysis.

The declining effect of the use of natural resource over time implies that output and consumption will also decline over time. The economy's ability to sustain a level of output and consumption over a long period of time is intertwined with its ability to grapple with the essentials of sustainability. Perman *et al* (1999) captured sustainability in six basic interwoven dimensions; non-declining consumption (utility); maintaining (constant) production opportunities over time; non declining natural capital stock; maintaining a steady yield of resource services; stability and resilience of the ecosystem through time and the development of capacity for consensus building. To fulfil these conditions of sustainability requires not only efficient management of resources but also ethical and moral standards. This is because some of these conditions are constraints to efficiency. The overall essence of sustainability is to maintain a given level of social welfare at a constant level. A strategy that ensures optimal utilisation of resources requires providing incentives for investments that makes use of natural resources as intermediate goods to be transformed into finished goods by a manufacturing production process, which is the fountain of inter-industry linkages. The rents derived from a portion of these natural resources can be used to provide requisite institutional and infrastructural base for investments that enhances the value-adding capabilities of factors of production. This will create the condition for learning-by-doing and provide incentives for R&D, all of which evolves into technology acquisition and the attainment of economic growth.

The fundamental role of government services was not given appropriate analytical reference by the neoclassical models. The government activity version of endogenous growth model crystallised the pivotal role of government expenditure in the process of economic growth. Production activities by all sectors of the economy is possible only if basic infrastructures and the rule of law that guarantees property rights (patents and copy right laws) are in existence. In addition, human capital formation, which is the bedrock upon which all aspects of economic growth processes are hinged, requires to be nurtured by services that are provided by non-profit making principles. These essential services (provision of infrastructure, the rule of law and human capital formation) are needed by both firms and households but their non-excludability character on one hand, and the competitive profit making objectives of firms on the other, prevent firms from engaging in the provision of these services. Furthermore, given the significant relationship between consumption and production and input-output mechanism needed to drive this relationship, an effective coordination is necessary to ensure the behavioural adherence to the requirements of the economic growth processes. The essential service and coordination functions can only be undertaken by government based on its non profit and welfare provision disposition. Thus without the ability of government to perform its welfare and coordination functions, all the building blocks of economic growth analysis ("effectiveness of labour", capital, technological change, R&D etc) will be non existent or dysfunctional. Beside, natural resource sectors which are the roots upon which economic growth processes germinates requires legal and institutional framework of operations and this can only be provided by government institutions. Effective governance, through the proper functioning of institutions and the implementation of robust policies, is therefore a crucial prerequisite to the attainment of economic growth.

Two significant interrelated issues arise. One is that the key assumption of a responsible government appreciating its crucial role and discharging its functions in accordance with perfect objectivity and rationality may be untenable. Secondly the possibility of trade-off between the implementation of economic growth enhancing policies on hand and the social welfare and intergenerational equity policies on the other give rise to difficult policy choices. A properly balanced combination of the equity-economic growth policy implementation then becomes the fundamental challenge of governance, which could address the difficulties involved in rational and objective behaviour of government in propelling economic growth, rather than a "black box" expectation of government behaviours that emphasises on generating absolute growth of the economy.

The "leading sector" strategy of economic growth (Currie, 1974 and 1997) illustrates how a sector that is inherently a viable source of large scale economic activities but strangulated by institutional and related policies can be liberated to spring up an impetus for economic growth. This strategy argues that the most effective way to raise the overall rate of growth in both output and employment is not to rely on aggregate demand, spontaneous innovations, cost reductions, tax incentives or direct government investment in general but rather to remove barriers or provide incentives to investment in sectors in which there is actually a large but *latent* demand that can be exploited, so that an increase in investment and consequent output can find a market without resulting in a depression in prices and incomes in the sector. In this case, the sectors are regarded as "leaders" in which it is possible to generate a rise in the overall rate of growth. There are two main characteristics of sectors that qualify to be considered as viable to provide a lead for overall growth of the economy; first there must exist an unexploited or *latent* demand that can be actualised, the size of which must be large enough to have significant impact on the whole economy if it is actualised; second is that an increase in the sector's growth can be exogenous and occur independently of the current overall rate of growth of the economy.

A synthesis of the endogenous growth models (see for instance, Sandilands, 2000) points to the fact that the existence of industrial production on one hand, and demand for the products of the industries on the other hand, creates opportunities for market expansion, competition and specialisation. Through a favourable "forward linkage" effects, an endogenous self-perpetuating process of growth emerges and feeds on it almost automatically. By the prompting of internal and external economies of scale, the process of industrial production evolves into higher and more sophisticated levels of production, giving rise to further specialisation, new products and quality improvements, leading to technological acquisition and economic growth. Adaptation to a growing market, widened by international trade, stimulates industrial production and provides additional impetus to the attainment of economic growth. The export-led economic growth hypothesis is hinged on the stimulation of production as a result of larger demand arising from international trade, which induces economies of scale, a hypothesis inspired by much earlier trade-led growth expositions by classical economists such as Adam Smith and David Ricardo. Thus, industrialisation-driven resource utilization process is the key to economic growth, in that industrialisation ensures production and generates positive externalities for sustainable economic growth path. Increasing competition towards markets and investments arising from the process of globalisation intensifies the policy challenges facing underdeveloped economies (like Nigeria) in nurturing an industrialisation process that could engender economic growth.

Inter-industry linkages has an essential role in engendering the process of economic growth since it creates a basis for increasing the absorptive capacity of industries through interdependence for goods and services produced by the cluster of existing industries. This appropriately fits into the analytical stream of all the economic growth expositions. Considering that a functional (effective) government sector exists, each producing sector will use a given level of inputs to be able to produce and its products needs to be absorbed either by direct consumers (the households sector) or intermediate consumers (other productive sectors). A baseline technology input requirements, which could be exogenous provide an initial condition for appropriate mix of factor inputs for production. The increasing interdependence among sectors of the economy leads to expansion in production due to increasing demand. The intensity of this interdependence generates high level of learning-by-doing, prompts the need for innovation, which leads to R&D activities and positive technological change occurs to expedite the process of economic growth. For a natural resource abundant economy, the availability of natural resources can be a drive for inter-industry linkages. The versatile character of such natural resources as oil and gas enhances the formidability of inter-industry linkages that inspire the process of technological progress and the attainment of sustainable economic growth.

Considering that Nigeria is endowed with abundant oil and gas resources, which invariably dictates the fortunes of the Nigerian economy, the main challenge is evolving a cohesive policy thrust that is principally focused on efficient use of the available oil and gas resources to generate formidable inter-industry linkages within the economy. A key strategy will require heavy investments that have expansionary effects on the economy. Complementarily, a robust household sector that provides effective market and supply labour services is critical to the self-perpetuation process inherent in the inter-industry chain mechanism. The manufacturing sector, due to its large scale value-adding attributes should be the route from which the spillover effects of a flourishing oil and gas industry is transmitted to other sectors of the economy. With a bourgeoning income earning household sector that seeks to satisfy its consumption needs, effective market with potential for expansion emerges to facilitate inter-industry linkage processes. These are the essential conditions for fostering a sustainable growth process that is internally generated even with declining public funds from sale (export) of crude oil. The entire economy can systematically achieve persistent growth that springs up from this strategy based on policy multiplier effect.

A robust macroeconomic policy framework is critical to the size of policy multipliers as such there is the need for regulatory policies in the Nigerian oil and gas industry to meet the inherent macroeconomic requirements of its economic growth aspirations. However the objective function of global economic dispensation is usually at variance with the strategic economic growth objective function of domestic economies. Akpan (2000) suggests that the most favourable policy direction is market-oriented indirect government participation while using fiscal measures both as a way of raising revenue and as regulatory measures, the reason being that it is less costly to operate; alleviates the political and social stress associated with direct government investment, and that inefficiency and resulting losses to government are minimised. Furthermore, conflict of interest will be removed since government direct participation could hinder its ability to impose the Pigouvian tax on itself. Iwayemi (2002) averred that deregulating the downstream sector of the Nigerian oil and gas sector is a necessary condition for ensuring rational production and consumption behaviours and through that achieve the fundamental objective of efficiency in the entire operations of the sector.

The essential need of the Nigerian economy is the institutionalisation of a virile and viable fiscal system to generate and sustain economic growth. For such a fiscal system to fulfil this growth driven requirement, public expenditure should be tailored towards deriving the advantage of endogenous technology and learning-by-doing that is anchored on a large-scale investment in human capital. As Adenikinju and Olofin (2000) emphasised, the human resource base for most African economies, including Nigeria, has a positive impact on manufacturing and economic growth. This should be complemented by inter-sectoral "backward and forward linkages". The crucial input is the revenue derived from sale of oil and gas products, referred to as rent, or Hotelling *rent*.

Following from the expositions of the "leading sector" strategy and drawing inspirations from the synthesis of the endogenous growth models, a theoretical conceptualisation for the contribution of the Nigerian oil and gas industry to the growth of the Nigerian economy is intertwined with the expansionary effect of productive activities in the oil and gas industry that are tailored towards inter-industry linkages. Positive externalities such as ideas or technology, to be derived from the chain of activities of the sector such as seismic, exploration, drilling, production and decommissioning, all of which makes use of the factor inputs (labour, capital, technology or "effectiveness of labour") could have significant impact on the value adding capabilities of factors over time through learning-by-doing. Endogenous technology and economic growth can be attained from this process. Considering the increasing interdependence of economies of the world, the efficacy of optimal policies for natural resource driven economic growth requires circumventing the impeding adverse effects of externalities of the global economy. For a natural resource abundant economy like Nigeria therefore, strategies for growth should take cognisance of the detrimental effect of the "Dutch Disease" syndrome, as well as the dynamics of global economic intricacies. The economy is likely to benefit from strategic policies that provide incentives for investments in the oil and gas as well as the manufacturing sectors of the economy. This should aim at removing the institutional bottlenecks to supply responses and actualise and even expand the demand for goods and services from the two strategic sectors of the economy. An overview of the Nigerian economy is the focus of the next chapter.

Chapter 4
AN OVERVIEW OF THE NIGERIAN ECONOMY

4.1: EVOLUTION

The pre-colonial economy of Nigeria was characterized by abundant natural resources in the form of arable land, which provided the basis for wide variety of crops for both consumption and trading. Farming, fishing and hunting were largely practiced as the main economic activities and formed the basis for the trading activities that ensued during the period. The economic system was indigenous and had no external influence. The bulk of the population were engaged in agriculture but other activities such as mining, pottery, arts and crafts emerged with time, and spurred manufacturing activities. The trans-Saharan trade of the period boosted these economic activities with textile materials as the major items of trade. It was a self-sufficient economy in the sense that the indigenous populations were catered for by these economic activities. The economic agents imbibed rational economic behaviours as reflected in their use of land (e.g. shifting cultivation), the resort to cost effective labour, the use of more efficient farm implements and amenability to new crops. The pre-colonial economy of Nigeria nurtured and developed an extensive exchange network system. Items used as currency such as salt and cowries functioned prominently within the economy. A transportation system evolved to facilitate the exchange network. The economy was a market constraints economy in the sense that it exhibited low man-land ratio as a result of low population density, low purchasing power due to low income and high cost of transportation emanating from deficiencies of the exchange system. All these implied that the pre-colonial economy of Nigeria operated below its capacity and thus the potential of the economy was not fully exploited.

The colonial economy of Nigeria strived to remove the market constraints and ensured the transformation of the economy towards increased capacity utilisation. The introduction of legitimate trade by the colonial administrators provided marketing outlets for the products of the indigenous economy such as palm-kernel, rubber, pepper, cotton, groundnut and cocoa. This was achieved through market opportunities provided by the activities of expatriate firms such as John Holt, the Niger-Delta Company (now Lever

Brothers) which formed the bedrock of the formation of United African Company (UAC). The products of the economy became exposed to broader spectrum of consumers outside the enclave economy. This encouraged large scale production, and led to increased productivity, employment, income and, invariably, standard of living. This period also witnessed the industrial revolution in Europe, which led to high demand for raw materials. Farmers cultivated more agricultural land, increased their working hours and made adequate use of borrowing institutions established by the expatriates. There was expansion of production (output) to match the new demand pressure, which in turn, improved the earning capacity of the farmers. In the process, new products were introduced, especially for local consumption (mostly imported from abroad) like textiles, tobacco, etc.

The principles of *laissez-faire* were introduced by the presiding colonialists to ensure a free enterprise economy, with minimum government intervention. The colonial economy was an open economy characterised by heavy reliance on the external sector for growth. The crucial role of the expatriate firms in the disposition of the economy, coupled with the fact that the economy depended on income generated from the sale of exported products made the external sector the key determinant of economic growth. The economy became gradually characterised by lopsided trading through commercial policies of the colonial administration, which ensured the exportation of primary agricultural commodities and the importation of finished consumer goods. Quotas, tariffs and custom duties were put in place to facilitate the trading policies that embodied the economic order of the colonial administration. The strict adherence to balanced budgets; incorporation of the Nigerian monetary system to that of the British; unfettered indigenous land control system; labour policies and the provision of infrastructural facilities (like the railway, ports etc.) were additional measures for sustaining the colonial trading and economic policies. By the late 1950s, the colonial economy had reached its peak in terms of capacity absorption and utilisation. The weak structural base of the economy became evident by the reliance of backward technology and distorted production structure in the sense that export of cash crops were emphasised as such much of agricultural production were cash crops rather than food crops. Indigenous industries were underdeveloped. The standard of living began to deteriorate which led to disaffection among the populace, and added to the pressure of agitation for self-rule that culminated into the termination of colonial rule in 1960.

The focus of development efforts on the newly independent state of Nigeria in the 1960s after colonial rule was the transformation of the Nigerian economy to a more vibrant, productive and industrial economy. This was meant to be achieved through several measures enunciated by the development plan of the time. The major thrust of the early development plans was the stimulation of economic growth and development. According to Mbanefo (1995), there existed at independence an ideological and structural foundations for the formation of an independent economy and the systematic weakening of the nascent capitalist mode of production, which entrenched a peripheral capitalist economy that was characterised not only by neo-colonialism, but also by combined factors of external dependence, the domination of critical sectors of the economy by foreign capital and the subordination of local to foreign monopoly capital. Import-substitution measures were adopted as means of acquiring industrial plants and skills that could ensure a viable manufacturing sector for effective industrial take-off.

By the mid 1960s, the systematic planning in the economy had taken root and the strategy for industrial development of the Nigerian economy was articulated as part of the planning process. Industrial projects were conceived and listed in the various plans, which was the main document for interested partners in the industrialisation drive. Donor countries, international agencies and foreign investors came to consider the plans as the major indicators of government direction. Between 1960 and 1965, the annual growth rate of the industrial sector was 15.5 per cent. In spite of the high growth rate, the industrial sector appears to have lagged behind some other sectors of the economy. For instance, mining and quarrying sectors grew at the rate of 15.8 per cent per annum while building and construction grew at the rate of 19.4 per cent per annum for the same period. The share of processing industry increased from about 25 per cent in 1950 to 50 per cent in 1959 before falling approximately to 25 per cent in 1965.This implies that export-processing industries declined in their share of the sector after independence. Domestic production of previously imported goods, protected by duties and quantitative restrictions, facilitated the changing structure of the industrial sector within the period of the 1960s and the 1970s. A clear implication of this is that the low level of technology required for import substitution industries confined the sector to very low absorption of technological innovations. Low technology import substitution industries contributed over 50 per cent of the value-added by the entire manufacturing sector in the sixties (60s) and the seventies (70s).

The agricultural sector began to decline in its contribution to GDP and in output during this period. From accounting for 60.96% of GDP in 1964, the agricultural sector accounted for 48.23% in 1970, and further declined to 18.00% in 1980. This could have been as result of fast growth of other sectors but Usman *et a*l (1985) averred that the decline in agricultural productivity was as a result of disruption of pre-colonial pattern of integration between areas of food production and areas of food consumption. The disruption of network of economic interaction of pre-colonial Nigeria and its loss of profitability meant that food producers either lost markets for their food products altogether, or that the food products declined in relative importance as a means of wealth accumulation. Even though, agriculture continued to play its significant role in the Nigerian economy, through to the 1960s, the discovery of oil and its eventual rapid production changed several aspects of the economy. The share of agriculture in total export value declined significantly. Agricultural export stood at N304.0 million in 1964, accounting for 70.8% of total export value. By 1970, agricultural export had declined to N286.8 million, accounting for 32.38% of total export value. In 1979, agriculture accounted for only 4.6% of export value, amounting to N498.5. This worsened the food situation of the country, with an estimated food deficit of 5538.0 thousand metric tones in 1982 and 6,758 thousand metric tones for 1985 (Usman *et al*, 1985).

The oil boom of the 1970s which led to sharp increases in foreign exchange earnings and government revenues had a pervasive effect on the growth and development of the Nigerian economy. It affected not only the investment, production and consumption patterns of the country but also socio cultural values, political aspirations style, economic management and policies. The import-dependent consumption pattern of the economy became further entrenched. Nigeria earned a total of US$67,047 million export revenues from 1981 to 1985 and its imports for the same period totaled US$64,078 million. Even though this points to a positive trade balance, it reflects a substantial decline in the trade balance and most of the imports were for direct consumption goods and/or raw materials for producing consumption goods. High earnings from foreign trade were due to high foreign exchange earnings from oil exports. The resultant rapid transformation from agriculture-led economy to a heavily-oil-dependent economy rendered the economy vulnerable to external shocks. A large public sector was created in the area of social, physical and economic infrastructure, as well as industrial projects. The dependency culture of the economy in terms of import-dependent consumption led to gradual decline in activities in the productive sectors such as agriculture and manufacturing while the non-tradable activities in the service sectors continued to increase. This created structural imbalances in the economy by stultifying agriculture and undermining domestic manufacturing industries. The agricultural sector, which has been predominantly rural based, traditional, mostly private and characterised by small-scale poor farmers and traders, further dwindled. The formal capital intensive sector is dominated by few multinational firms, some small local industries and by government in most areas of economic activity became afflicted by the inordinate transformation of the economy and the loss of competitiveness of the domestic economy. This gave rise to a dualistic economy with a large and bourgeoning public sector and a shrinking private sector. Domestic policies recognised the essence of investments in human and physical capital and technological requirements for effective use of resources but the pursuance of capital intensive programmes coupled with public sector inefficiency led to project failures and crippled the achievements that could have been attained by evolving technological capabilities. Domestic manufacturing activities became subdued by unfavourable terms of trade due to declining purchasing power in the domestic economy and loss of competitiveness in international trade.

The World Bank[31] (1996) averred that the positive oil shocks of 1973 and 1979 multiplied the terms of trade more than five times between 1973 to 1981 and spending of the oil revenues drove real per capita income in 1987 prices up from N1, 300 in 1972 to nearly N2, 900 in 1980 (in current US$ of the time, from US$280 to US$1,100). After the collapse of oil revenue as a result of sharp decline in international prices of petroleum, real per capita income dropped drastically and economic activities within Nigeria declined. However, the real effective exchange rate continued to appreciate, the agriculture sector remained weak and large scale food imports continued. The decline in economic activity through to the mid-1980s made it difficult to absorb the fast increasing labour force, with a sharp increase in urban unemployment; from 7 percent in 1983 to 10 percent in 1986. From a net exporter of agricultural products in the 1960s and early 1970s (e.g. the world's largest exporter of groundnuts and second largest exporter of cotton, and a major exporter of crops such as cocoa, palm oil and kernels, and rubber), Nigeria became a net importer of agricultural commodities, especially food. Fueled by the large increase in oil revenues and heavy public investment, the manufacturing sector grew at an annual average rate of 12 percent per annum during the 1970s. However manufacturing output declined at 6 per cent per annum during 1982-85, with output in 1985 only 75 percent of its 1982 level. Industrial promotion efforts yielded some results up to the early 1980s but the non-viability of the import-substitution strategy that was adopted manifested during the collapse of oil prices. Only with a highly overvalued exchange rate and heavy protection of final goods, was it profitable to operate import intensive assembly activities. Total factor productivity declined steadily during the 1970s and mid-1980s while capital stock increased continuously. Overall, many of the government's investments were largely unprofitable, and few were in labour intensive production, thus creating relatively little employment. Real wages declined throughout the period 1974-94, especially in urban areas and in the industrial sector as increases in the labour force exceeded the demand.

[31] The World Bank published a report of a comprehensive study of the Nigerian economy in collaboration with agencies of the Nigerian Federal Government and with assistance from ODA and UNICEF.

Thus while the high oil revenues were potentially very positive, their management proved very destructive in terms of the negative impact of policies implemented on domestic production, mismanagement of the oil revenues and their detrimental impact on the generation of domestic employment and domestic incomes. By 1985, the distortions in the economy manifested in exchange rate distortions, import licenses crisis and the inefficiencies of the marketing boards. The halving of oil prices in early 1986, which further exposed the vulnerability of the economy, precipitated the introduction of the Structural Adjustment Programme (SAP) in the late 1986.

4.2: THE PERIOD OF STRUCTURAL ADJUSTMENT PROGRAMME (SAP)

The Nigerian economy began to face serious difficulties in the early 1980s, as a result of the collapse of oil prices in the international oil market brought about by the global economic recession of 1979-1982, and more fundamentally as a result of the distortions and structural imbalance that has caught up with the Nigerian economy due to mismanagement of the proceeds of the oil boom. The resultant recession and economic deterioration in Nigeria manifested in fiscal crisis, foreign exchange shortage, balance of payments and external debt crisis, a high rate of unemployment and economic stagnation. Other adverse economic indicators included a high backlog of uncompleted projects, especially in the public sector, factory closures, acute shortage of essential commodities and galloping inflation. Table 4.1 shows the key macroeconomic indicators of the Nigerian economy for the period 1970 to 2000. The rate of inflation undulated from 13.8 per cent in 1970 to 33.9 per cent in 1975, to 5.4 per cent in 1986, and 72.8 in 1995. The gradual drift of the Nigerian economy was recognised earlier and measures put in place to control it. The "green revolution", austerity and counter trade measures were conceived[32]. In April, 1982, the federal government promulgated the economic stabilisation act of 1982, in order to arrest the deterioration of the economy through more stringent exchange rate control measures and import restrictions supported by appropriate monetary and fiscal policies. In October, 1985, the federal government declared a 15-month economic emergency period in pursuit of further economic stabilisation, followed by the withdrawal of 80% of petroleum products[33] subsidy in January 1986. Ayagi (1990) argued that the deep rooted dependency culture has engulfed the Nigerian economy so much so that it was difficult for the economy to be transformed to a productive and industrial based economy, which created room for international financial institutions (IMF and the World Bank) to penetrate the system. Consequently, Nigeria resorted to borrowing from these institutions to finance the lopsided, distorted and import-dependent

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[32] The green revolution was the tag referred to a determined policy of a fundamental revival of agriculture in Nigeria so as to boost food production and reduce substantially the foreign exchange pressure. The austerity measure was a general reduction in government expenditure to curtail waste while the counter-trade was a policy of exchanging commodities for commodities with countries that agree on terms with Nigeria for exchange with Nigerian oil.

[33] Domestic prices of refined petroleum products were fixed lower than their presumed average cost of production in form of subsidy to domestic consumers of the products.

economic disposition. Due to the entrenched mismanagement and inefficiency of the public sector, the loans were not rationally used for viable and sustainable investment that could stimulate economic growth. Borrowing to finance import-dependent consumption continued until Nigeria could no longer borrow from the international creditors because it has over borrowed and was not in the position to pay its previous debts. Ayagi (ibid) illustrated the drastic transformation of Nigerian economy thus: from the pre-oil boom period when the economy did not have the "absorptive capacity" to borrow; to the oil boom period when the economy was "under-borrowed" (meaning not borrowing enough); to the post oil boom situation when the economy is enmeshed in foreign debts which it cannot repay[34].

It was in the wake of the deepening economic crisis, manifested by chronic foreign exchange shortages, deteriorating balance of payment position and mounting debt burden that gave rise to the introduction of Structural Adjustment Programme (SAP) in 1986, the main thrust of which, as conveyed in the presidential address to the nation, was to restructure the economy towards the path of self-reliance. The presidential address stated *inter alia*:

> *"Our structural adjustment involves new uses of wealth, new property relations, new products and production processes, new attitude to work, new consumption habits, and new interactions with the rest of the world. It seeks to harmonise what we consume with what we produce using our own domestic endowment of human and material resources"*

It further stressed that:

> *"We are determined, more than ever before to harness our own home grown efforts to solve our problems and chart a new path for our future....each and every one of us must be ready and willing to make additional sacrifices"*

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[34] This situation pushed the economy into deeper crisis that resulted into the debt entrapment. Ayagi (1990) remarked that "a debt-trapped economy is an enslaved economy and for any people, such enslavement is worse than colonialism".

The main objectives of SAP reform policies as enunciated by the government were, among others, restructuring and diversification of the productive base of the economy; achieving favourable fiscal and balance of payment equilibrium; laying the foundation for sustainable growth and divestment of the public sector so as to inject efficiency and growth in both public and private sectors. Additional measures were put in place to: rectify foreign exchange distortions, through the second tier foreign exchange market (SFEM); ease external debt burden and provide incentives for investment to achieve net inward flow of foreign capital while putting a choke on foreign loans; rationalisation of tariff reform and excise duty and the elimination of the incompetence of the public sector as well as adopting trade liberalization policies. There were such strategies as decrease in consumption through wage freeze and the removal of real or imagined subsidies on petroleum products, education, health care, transportation, electricity and communications.

In order to take advantage of trade liberalization, export promotion programmes were adopted to ensure the marketing of agricultural products in particular, and other domestically produced commodities to the outside world. Additional measures include debt-equity swap, anti-smuggling devices, changes in internal price regimes, reform in the financial sector through the review of the Banking Act of 1969 and the enterprise promotion Act of 1972 and 1977. The exchange rate and trade regime reforms involved the replacement of the fixed exchange rate with a floating, market-determined exchange rate. From N1 to $1 at the beginning of 1986, the exchange rate moved to N3.2 to $1 by the end of the year. Import and export licensing was abolished in 1986. Several import bans were replaced with tariffs, the average nominal tariff level was lowered from 33 percent to 23 percent and the tariff structure was simplified. Price decontrol policies were put in place with the exception of petrol and fertilizer. As an export incentive measure, the agricultural marketing boards, which tend to purchase commodities at below market prices, were abolished.

The impacts of SAP policies on the economy are mixed. Even though, trends of selected macroeconomic indicators as presented in Table 4.1, tend to show an appreciable increase in their nominal values, the general health of the economy, in terms of ability to absorb shocks towards a sustainable and self-reliant pattern of economic growth and development deteriorated. Olaniyan (1996) revealed that the gross domestic product (GDP) at 1984 factor cost for instance, increased from N71.08 billion in 1986 to N94, 53billion in 1991 but growth rate of the economy declined from 5.3 per cent to 4.2 per cent during the period. Gross national savings (GNS), which averaged at 6.1 per cent from 1981 to 1985 (before SAP) increased to 18.7 per cent in 1986 to 1990 (Olaniyan, ibid). Institutional savings rose from 6.0 to 20.9 percent of GDP in 1990. However, gross foreign investment (GFI) showed a gradual decline from average of 48.5 in the pre-SAP period to 13.8 per cent of GDP in 1988, and rose marginally to 16.2 per cent in 1990. The growth in savings during the period was, however, not translated into investment that could facilitate economic recovery. The index of industrial production between 1987 and 1992 recorded an average annual increase of 6.9 per cent *vis-à-vis* 2.4 per cent between 1982 and 1986. The manufacturing sector recorded a marked increase of 12.9 per cent in 1987 as against 3.9 per cent before the introduction of SAP. Manufacturing grew at an average of 5.1 per cent between 1986 and 1991, the share of finance and insurance in the GDP increased from 3.11 per cent in 1986 to 8.72 per cent in 1991. Merchandise export recorded a boost from $6.5billion in 1986 to $ 13.5billion in 1990, due primarily to oil export. Non oil export decreased from $557million in 1985 to $106million in 1990. Crude oil contribution to total revenue was 77.3 per cent as against 3.6 per cent for non oil exports. Table 4.1 illustrates this trend.

Even though one of the key objectives of SAP was to stop further borrowing and reschedule outstanding foreign debts, the country's debt stock rose from US12 billion in 1985 to US$33.7 billion in 1991. A combined strategy of debt buy-back and collateral per bonds, which could have led to reduction of the debt profile were overshadowed by new borrowings, increases in foreign interest rates, capitalisation of unpaid interests' charges as well as the appreciation of exchange rates of various European and Japanese currencies against the dollar, which was then depreciating[35].

The dominance of petroleum export in the fiscal operation of the Federal Governments continued to increase, with a rise from an average of 71.2 per cent to 76.9 per cent of the total generated revenue during the SAP era, 1986 through to 1991. The Federal collectible revenue rose from N12.3billion in 1986 to N88.2 billion in 1991. Two main factors were responsible for this; increased demand for petroleum products internationally, i.e. rising dollar price of oil, and the stepwise depreciation of the naira which the government monitored to yield more naira value (Olaniyan, 1996). As can be deduced from Table 4.1, manufacturing capacity utilization, which began to decline before the implementation of SAP, declined further from an average of 56.33 percent before SAP (1980-185) to 41.28 percent during SAP (186-1991) and 33.59 percent after SAP (1992-2000). It also shows that balance of payments continued to deteriorate, external debts as a percentage of GDP rose to very high levels during SAP period from 23.3 per cent in 1985 to 56.7 percent in 1986, 92.6 per cent in 1987, 92.2 percent in 1988, 106.9 per cent in 1989, 114.6 percent in 1990 and began to decline in 1991 to 101.4 percent, and thereafter to 99.0 percent in 1992, 90.8 in 1993 and 70.9 in 1994. Also the table indicates that the economy though began to operate negative fiscal balance before SAP, the levels of negative fiscal balance were significantly very high during the SAP period. Gross fixed capital formation (GFCF), a measure of the level of investment in the economy, were very low during SAP period. Real GDP declined from 9.38 in 1985 to 3.13 in 1986, deteriorated further to -0.47 in 1987 but rose sharply to 9.91 in 1988 and declined continuously thereafter.

The objectives of SAP were consistent with the aspirations of any modern economy but policies and implementation strategies adopted did not take into cognisance the fundamental weaknesses of the economy such as distorted production relationships,

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[35] Debts owed other countries are quoted in their respective currencies by such countries but Nigeria quotes its debts to all countries of the world in dollar. Therefore a depreciation of the dollar against currencies of countries to which Nigeria is indebted will automatically raise the debt profile of the country.

fragmented and dysfunctional policy making machinery, entrenched consumerism with weak production structures, large scale capacity underutilization and inefficient public sector that is riddled with corruption. These features of the economy rendered the SAP policies ineffectual in achieving its main objective of transforming the economy towards self-reliant growth path. Instead, it contributed in deepening the crisis of the economy by intensifying rent seeking behaviour thereby undermining real productive activities that could ensure effective utilization of resources and the enhancement of the value-adding capabilities of factors of production.

4.3: THE NIGERIAN ECONOMY AFTER SAP

The economic policies of the 1990s tended to reverse the SAP policies, but there was no fashionable economic programme in the mould of SAP as alternative but rather policy formulation and implementation were guided by exigencies. Economic policy challenges of the period were strained by the political economy of the survival of the fledging regime against domestic and international opposition, which adversely affected the ability of the economy to attract capital and foreign direct investment (FDI). Some of the initiatives adopted were tight fiscal and monetary policies, elimination of foreign exchange controls, reduction of import tariffs and elimination of controls on foreign investment. Diversification of the economy away from over-reliance on oil and stimulate the effective utilization of domestic resources was a key policy priority. Corollary to this, the Nigerian Export Promotion Council (NEPC) and the Nigerian Export-Import Bank (NEXIM) were established in the early 1990s to drive the promotion of non-oil exports. The achievements of the Asian economies provided the necessary inspirations against the backdrop of increasing internationalisation of production and marketing mechanisms. The encouragement of non government participation in the export of commodities, which started during the SAP period, was further enhanced in order to boost private sector participation in production activities. Foreign exchange conservation principles were emphasised more than foreign exchange generation in appreciation of the fact that a production based economy needed to be nurtured over time before reaping benefits. To enhance the success of the non-oil export policy, the exchange rate overvaluation which was regarded as huge tax on exports was redressed; export activities were privatised in order to stimulate the profit-driven potential of entrepreneurs; there was a general review of trade (liberalisation) policies; there was greater reliance on the market for the allocation and use of resources and the stimulation of the real sectors of the economy. In addition, a set of export incentives were provided including diverse tax concessions and import duty waivers, cash grants and special export financing schemes such as Rediscounting and Refinancing Facility and risk bearing (insurance) guarantee facilities for export being provided by NEXIM. Export Processing Zones were conceived and established in various export strategic towns in the country. Specific Agricultural policies such as subsidies on inputs (e.g. fertilizer and seeds) and increased funding of agricultural projects; River Basin Development Authorities and the National Agricultural Land Development Authority (NALDA) were implemented which yielded some positive results in the sector. However Olaniyan (1996) argued that the inefficiencies of the public sector undermined the realization of the potential impact of the agricultural policies.

The overall impact of the policy measures implemented, as in the case of SAP, are mixed. Poor implementation of the policies due to the difficulties associated with the nature of the economy undermined the attainment of significant successes. Despite the pursuit of tight fiscal and monetary policies, fiscal behaviour deteriorated further and coupled with uncontrolled monetary expansion in a highly regulated interest rate regime led to unfavourable interest rates that worsened an already bad investment climate. According to Dalil (1996), appreciation in the real official exchange rates discouraged non-oil exports while foreign exchange transactions attracted large sums of potential investment funds due to wide margins between official and parallel exchange transactions. The virtually risk-free foreign exchange market with quick returns flourished due to wide margins between official and parallel market rates tended to reduce working capital holdings substantially.

Macroeconomic indices continued to be dismal even though some improvements over the SAP period were recorded in some indicators. External debt stock, which rose from US$8.9 billion in 1980 to US$33.6 billion in1990, reduced to US$27.0 billion in 1997. Real GDP increased by 2 percent between 1992 and 1995 and real per capita private consumption fell by 1 percent. In terms on non-oil exports, the performance of the SAP years was better. For instance, foreign exchange receipts from non-oil exports between 1992 and 1994 averaged at US$244.40 million in each of the these years in contrast to a peak of US$607.80 million in 1988 and reasonable level of US$542.19 million in 1987. This can be attributed to the inability to effectively remove certain constraints to exports such as bottlenecks at the ports of shipment, numerous taxes and levies and poor basic social infrastructure. The negative impacts of these constraints on exports could have overshadowed any positive effect of the export promotion incentives that were implemented. The productive base of the economy remained weak so the extent to which production activities can support and sustain the volume of exports to achieve remarkable foreign exchange earnings by non-oil exports is minimal. The profitability of commerce far outweighs that of manufacturing or production ventures so the momentum of trade is higher than that of production. Furthermore, considering the weak production structures of the economy, domestically produced commodities could not withstand international competition

Earnings from non-oil exports continued to be dominated by primary commodities with little improvement in the proportion of semi-manufactures and manufactures. For example from 3.3 percent of total non-oil exports in 1987, manufactures grew to 14.40 percent in 1994. Semi-manufactures also grew up to 1990 before a decline set in as a result of difficulty to transform the productive base of the Nigerian economy. Most industries in Nigeria were established on the basis of import-substitution strategy as such they need to retool to be able to compete for international markets. Thus the numerous constraints to investment such as poor infrastructure, public sector corruption and general insecurity has significant implication for cost of production which leads to loss of competitiveness.

On May 29, 2004, a new blueprint in the mould of SAP, the National Economic Empowerment and Development Strategy (NEEDS) was launched as an economic policy reform agenda for transforming the Nigerian economy. The key objectives of NEEDS revolve around improving public sector efficiency; enthronement of sound fiscal behaviour; prompting the private sector towards dominant role in economic activities; and the reliance on the market forces as the basis of economic and public service activities. Implementation strategies adopted include privatization of government investments, raising the minimum capital base in the banking sector thereby reducing the number of banks to a small size but with large operating capital; the formation of a mega corporation, *Transcorp*, to engage in the production of all types of consumer and capital goods and services, among others. The implementation of NEEDS is still unfolding at a nascent stage as it is difficult to assess its effectiveness in transforming the economy towards sustainable growth path. However, the International Monetary Fund (IMF) estimates real GDP growth for the Nigerian economy in 2005 to be 6 per cent stemming largely from higher growth in the non-oil economy, in particular agriculture and some aspects of manufacturing and services. Foreign Direct Investment (FDI) increased by about US 2billion largely in the non-oil economy such as food processing, leather goods, power, and telecommunications. Employment growth remained sluggish, and the cost of doing business in Nigeria continued to be high while private sector demand growth was low in respect of non-oil GDP.

It can be inferred from this brief overview that the Nigerian economy since pre-colonial, through colonial to its post-colonial trajectories, have been struggling to define a sense of direction without successfully evolving a cohesive economic structure and systems that can form the basis for periodic policy adjustments for effective macroeconomic management for attaining economic growth. The growth and development aspirations of the economy have all along being well defined in consonance with universal aspirations of contemporary modern economies but there has been persistent difficulties in matching these aspirations with the establishment of fundamental structures that can spearhead the process of attaining economic growth and development. Steady progress were made in 1960s and 1970s by building on the structures of the colonial economy but the discovery of oil and the resultant huge revenues earnings arising from the bourgeoning world economy, contributed in disrupting the process of nurturing a coherent economic system with established production structures that thrives on industrial production for the attainment of industrialisation as route towards economic growth and development. With appropriate mix of policies and implementation strategies the oil and gas sector could stimulate productive activities in the economy through robust inter-industry linkages that ascribe to effective and efficient utilization of resources that could propel the economy towards self-perpetuating and sustainable growth path. Before analysing the inter-industry relevance of the sector, an anatomy of the Nigerian oil and gas industry is considered in the next chapter.

Table 4.1: TRENDS OF SELECTED MACROECONOMIC INDICATORS OF THE NIGERIAN ECONOMY (1970-2000)

Years	Real GDP Growth (%)	GFCF (% of GDP)	Inflation rate (%)	Fiscal Balance (% of GDP)	External Debt (% of GDP)	Domestic Debt (% of GDP)	Net Domestic Credit (% growth rate)	Net Credit to Government (% growth rate)	External Reserves ($million)	Balance of Payment($million)	ManufacturingCapacity Utilisation
1970	-	-	13.80	-8.70	3.40	18.00	-	-	146.44	65.24	-
1971	21.35	-	15.60	2.60	2.70	19.10	-	-	190.22	168.80	-
1972	5.48	-	3.20	0.80	3.70	13.90	-	-	291.23	86.94	-
1973	6.42	-	5.40	1.50	2.50	9.70	-	-	366.32	300.20	-
1974	11.74	-	13.40	9.80	1.80	6.90	-	-	4941.26	4924.91	-
1975	-2.96	23.28	33.90	-2.00	1.60	7.80	-	-	5488.07	255.72	-
1976	11.08	29.70	21.20	-4.00	1.40	9.60	-	-	4880.45	-541.10	-
1977	8.15	28.77	15.40	-2.40	1.10	14.20	-	-	3898.86	-815.34	-
1978	-7.36	26.01	16.60	-7.80	3.50	16.60	-	-	777.77	805.48	-
1979	2.44	21.08	11.80	3.40	3.70	15.50	-	-	5108.61	3137.32	-
1980	5.48	21.30	9.90	3.90	3.70	16.20	21.70	4.40	9966.33	4396.41	70.10
1981	-26.81	24.10	20.90	-7.70	4.60	22.10	50.80	84.10	3975.08	-4952.13	73.30
1982	-0.34	21.10	7.70	-11.80	17.10	28.70	34.70	59.30	1525.49	-2078.02	63.60
1983	-5.37	14.20	23.20	-5.90	23.30	38.90	28.70	50.30	1079.55	416.10	49.70
1984	-5.10	8.50	39.60	-4.20	23.90	40.40	10.50	15.00	1495.36	463.98	43.00
1985	9.38	7.70	5.50	-4.20	23.30	38.60	5.00	4.30	1836.09	390.58	38.30
1986	3.13	10.00	5.40	-11.30	56.70	38.90	12.70	2.50	1775.41	-388.15	38.80
1987	-0.47	9.80	10.20	-5.40	92.60	33.80	27.40	10.30	1155.65	39.62	40.40
1988	9.91	8.50	38.30	-8.40	92.20	32.40	22.20	28.40	721.38	-505.68	42.40
1989	7.39	8.20	40.90	-6.70	106.90	20.90	-14.10	-33.50	1820.59	1180.77	43.80
1990	8.20	11.80	7.50	-8.50	114.60	32.30	17.70	14.90	4348.59	2301.40	40.30
1991	4.73	10.90	13.00	-11.00	101.40	35.90	45.30	82.90	4465.37	601.40	42.00
1992	2.98	10.70	44.50	-7.20	99.00	29.40	65.00	136.70	808.89	-3773.29	38.10
1993	2.65	6.20	57.20	-15.50	90.80	38.90	74.70	103.20	3011.88	609.85	37.20
1994	1.31	5.80	57.00	-7.70	70.90	37.30	8.10	-8.70	1391.56	-1947.51	30.40
1995	2.15	6.00	72.80	0.10	36.60	17.40	8.10	8.70	1842.87	-8919.65	29.30
1996	3.39	5.10	29.30	1.60	22.50	12.50	-25.40	-58.00	7964.41	-2428.57	32.50
1997	3.16	9.00	8.50	-0.20	21.00	12.70	-3.30	188.90	11980.14	49.18	30.40
1998	2.31	6.70	10.00	-4.70	22.90	19.40	51.20	32.01	10358.33	-100825.71	32.40
1999	3.05	5.29	6.60	-8.40	77.20	23.80	30.10	-162.30	5847.64	-3537.20	35.90
2000	3.64	-	6.90	-2.90	86.40	24.90	-23.10	95.16	10242.60	3116.51	36.10

Source: Compiled and Computed from *CBN Statistical Bulletin,* Vol. 11, No 2 (Dec. 2001) and Vol. 14 (Dec. 2003)

Chapter 5

ANATOMY OF THE NIGERIAN OIL AND GAS INDUSTRY

5.1: THE MAKING OF THE OIL AND GAS INDUSTRY

The Organisation of Petroleum Exporting Countries (OPEC)[36] describes Crude as a naturally-occurring substance found trapped in certain rocks below the earth's crust. It is a dark, sticky liquid which, scientifically speaking, is classed as a hydrocarbon. This means, it is a compound containing only hydrogen and carbon. Crude oil is highly flammable and can be burned to create energy. Along with its sister hydrocarbon, natural gas, crude oil makes an excellent fuel. Crude oil is measured in barrels. When crude oil first came into large-scale commercial use in the United States in the 19th century, it was stored in wooden barrels. One barrel equals 42 US gallons, or 159 litres. World crude oil reserves are estimated at more than one trillion barrels, of which the 11 OPEC Member Countries hold more than 75 per cent. OPEC members currently produce around 27 million to 28 million barrels per day of oil, or some 40 per cent of the world total output, which stands at about 75 million barrels per day.

Burning crude oil itself, however, is of limited use. To extract the maximum value from crude, it first needs to be refined into other products. The best-known of these is gasoline, or petrol. However, there are many other products that can be obtained when a barrel of crude oil is refined. These include liquefied petroleum gas (LPG), naphtha, kerosene, gas oil and fuel oil. All of these are fuels. Other useful products which are not fuels can also be manufactured by refining crude oil, such as lubricants and asphalt (used in paving roads). A range of sub-items like perfumes and insecticides are also ultimately derived from crude oil. Several of the products that are derived from crude oil, such as naphtha, gas oil, LPG and ethane, can themselves be used as inputs or feed stocks in the production of petrochemicals. There are more than 4,000 different petrochemical products, but those which are considered as basic products include ethylene, propylene, butadiene, benzene, ammonia and methanol. The main groups of petrochemical end-products are plastics, synthetic fibres, synthetic rubbers, detergents and chemical

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[36] http://www.opec.org

fertilizers. Considering the vast number of products that are derived from it, crude oil is a very versatile substance. The intrinsic versatility of oil and gas resources as reflected in the numerous products that are obtainable from them means that the oil and gas industry is potentially a reliable source of stimulating inter-industry linkages for an economy with abundant oil and gas resources.

In Part 1 of the Nigerian Petroleum Profit Tax Act 1959, petroleum is defined as:

> *"any mineral or relative hydrocarbon and natural gas existing in its natural condition in Nigeria but does not include liquefied natural gas, coal, bituminous shale or other stratified deposits from which oil can be extracted by destructive distillation".*

Similarly, the Act also defined petroleum operations as:

> *"the winning or obtaining and transportation of petroleum or chargeable oil in Nigeria....by drilling, mining, extracting or other like operations, not including refining at a refinery.......all operations incidental thereto and any sales of or any disposal of chargeable oil".*

From the above definitions, petroleum excludes petroleum products and petroleum operation excludes value-added activities in oil and gas. However, the actual scope of oil and gas activities includes both petroleum operations and value-added operations, which leads to petroleum products. Upstream activity is used to refer to petroleum operation while value-added operations are referred to as downstream activity. The stream analogy captures the chain feature of oil and gas activities while the adjectives (up and down) simply indicate the location of distinct activities on the oil and gas activity chain (Garba, 2000).

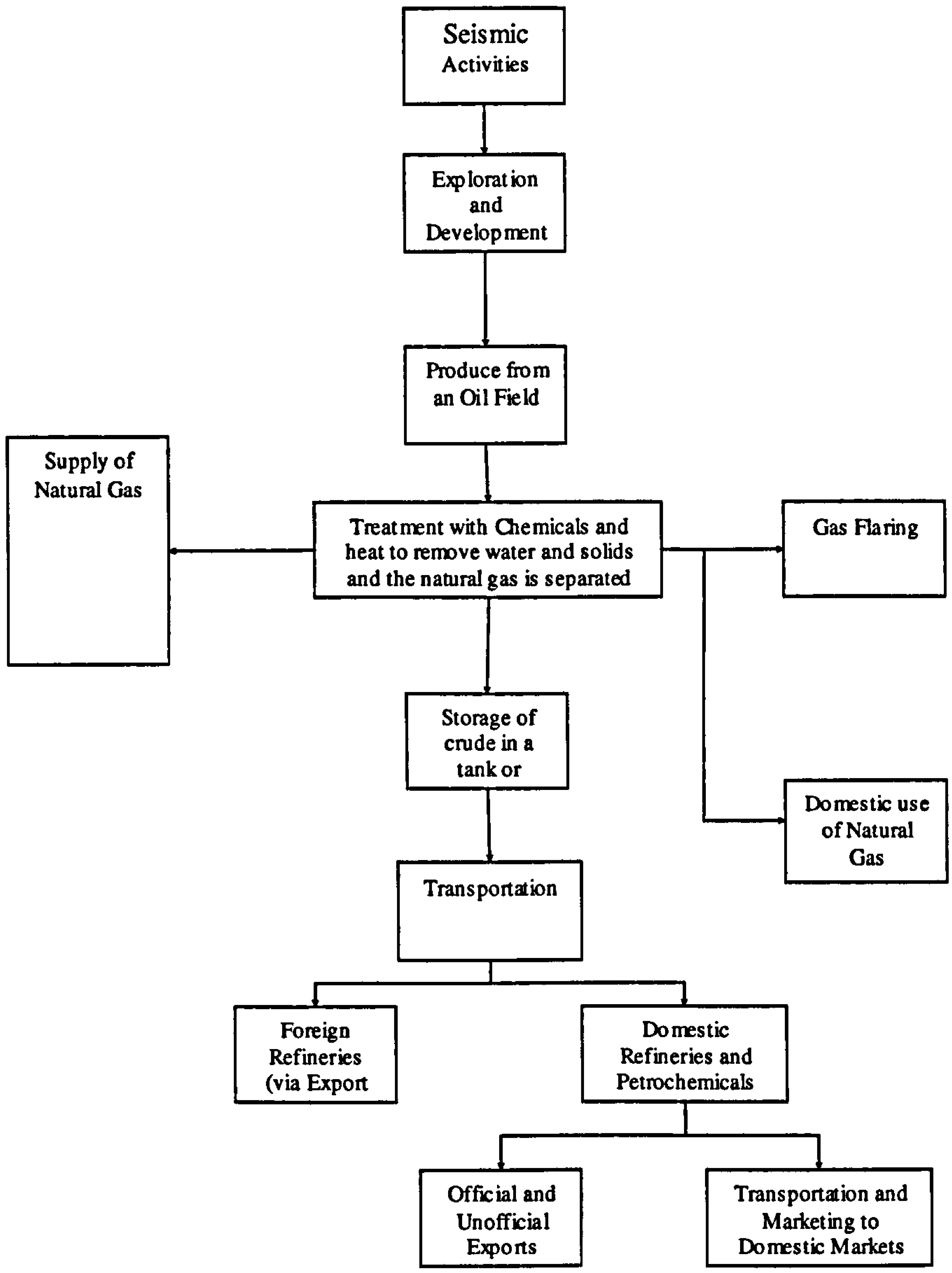

Chart 5.1: Chain Activities of the Oil and Gas Industry (Adapted from Garba (2000))

The classification of the Nigerian oil and gas industry into downstream and upstream sectors is in consonance with the structure of the international oil industry. The entire operations of the industry begin with Seismic Activities, which spirals into phases of activities such as exploratory drilling, production and decommissioning. Basically, seismic activities, exploration, appraisal and development, production and treatment of output from oil wells are the chain of activities involved in the process of winning and obtaining chargeable oil, which is the hallmark of upstream activities in the oil industry. The transportation and sale or disposal of chargeable oil to refineries is the end of the upstream activities and the beginning of the downstream activities. Chart 5.1 illustrates the chain of upstream and downstream activities of the oil and gas industry.

The chain of downstream activities of the oil and gas industry involves production, transportation and marketing of end petroleum products. It begins with the supply of crude oil to refineries for refining and ends with the marketing of final (refined) petroleum products (such as gasoline, kerosene, heating oil, lubricants, waxes etc.) and intermediate products (such as aviation fuel, industrial fuel, bitumen, asphalt, petrochemicals). Similarly, the gas chain begins with processing natural gas into final products such as cooking gas or intermediate products such as Liquefied Natural Gas and liquid gas. Natural gas is used as fuel by oil companies; converted into natural gas liquids or re-injected in crude oil recovery. According to Microsoft Encarta (1997) quoted in Garba (2000) "Before natural gas is used as fuel, heavy hydrocarbons such as butane, propane and natural gasoline are extracted as liquids and the residual is piped to domestic and industrial consumers for use as fuels or as intermediate products in the manufacture of plastics, drugs and dyes".

The chain activities of the upstream sector involve sophisticated technical and mechanical processes with the use of heavy machineries. The discussion below provides some insight into the processes involved in the chain activities of the sector.

Pre-Drilling (exploratory) surveying, the first activity chain, is a preliminary search and survey through surface geo-scientific mechanisms and geochemical methods of gathering empirical data. The survey could be either aerial or seismic. The derived geological information is applied to a geophysical survey and data analysis to determine the worthiness of further exploratory activities. For instance, where the results of the analysis are designated as "most probable", it will be considered worthwhile to commit more resources (risk or venture capital) for further exploratory activities, but if the results is designated as "likely", the likelihood of committing resources for further exploration activities will be weak. "Unless a company is lucky enough to strike oil, it may as well forget about recovering its risk investments; amortising investments at this stage is contingent upon a verifiable commercial discovery, otherwise, the company does not stand a chance" (Teolis, 1992, quoted in Abdullahi, 2002, 195).

The next stage in geological test processes is **Geological and Appraisal Drilling**, which aids the stratigraphic and geophysical analysis of the evidence gathered by reference to the rock formation of a basin in order to determine the appropriate drilling point within the block. The success of exploratory drilling paves the way for primary drilling of wells, a necessary step for ascertaining the size and extent of the field. If a commercial discovery is made, it will lead to the construction of steal casting and perforations from the surface deep down the entire length of the well to enable the oil to creep and seep in, and a Tubing chain of connected pipes will be run through the entire length of the well, which is then connected to the flow and control device at the surface for the purpose of extracting the oil. In case of failure to discover adequate commercial quantity of oil and gas deposits (dry hole), the drilling field will be abandoned. This is very rare considering the chronology of exploratory and geological activities and analysis that precedes actual drilling activities, which ensures that accurate information on the geological content of a field is obtained before getting to the drilling stage. Due to the seriousness of the economic consequences of failure to acquire and manage accurate geological data, economic agents (oil companies for instance) operating in the upstream sector of the oil and gas industry commits large resources to that aspect of the process and treats the results of geological and geophysical analysis with utmost secrecy and confidentiality in order to prevent any strategic counter move from competitors.

The Development of Well for Oil and Gas Production (Field Development) is the next major pre-drilling activity after the geological and appraisal drilling. The permeability of the geological formation of underground rock of the entire field is the determining factor for recovery from the field. Of the various geological approaches to oil recovery such as "Water Drive", "Solution Gas Drive", "Gas cap Drive", and "Gravity Drainage", the current practice indicates preference for pumping in all onshore and offshore fields[37]. Although the system processes are the same for both onshore and offshore fields, it is expected that more advanced technological demand and application is involved in offshore mining due to the complex geological characteristics of the terrain and the difficulties associated with offshore field development (Abdullahi, 2000). The conveyance or transportation of the oil from the producing well through the *Flow line* and the *Wellhead* to the Gathering Centre is the end of the upstream production process. On delivery of oil to the gathering centre, the oil is then separated from its water content and the gas content is flared into the air while the processed oil is transferred from the gathering centre through pipelines to storage tanks at the shipment terminal in readiness for export and/or passage to domestic refineries.

Decommissioning is considered a significant activity that follows after the end of the production phase. In particular, offshore oil installations and operations are associated with tremendous environmental effects arising from drilling and production processes[38]. The policy ramification of decommissioning depends on the nature of the terrain, the ecological setting, the cost factor and the technological disposition. However, decommissioning of offshore oil structures has both positive and negative environmental impacts; the positives being the potential for fisheries and the enhancement value of the structural elements left in place within the marine environment as a consequence of partial decommissioning; the potential adverse impacts include the associated navigational risks, pollution damage, and structural and physical damage to sites.

From the expositions of oil and gas drilling processes, it is obvious that the crucial input to oil and gas activities is technology, which is not very easily possessed or acquired. This has given rise to differences in ownerships and key operators of oil and gas resources across the world. To bridge the competing interests of these two, a mutually

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[37] IUCN, Exploration and Development (E&F) Forum, Oil and Gas Exploration and Production in Mangrove Areas (Switzerland), Cambridge, IUCN, 1993, p44.

[38] There has been a growing international concern over the environmental effects from oil and gas activities.

beneficial arrangement is necessary in order to ensure sustainable economic dividends to all parties. Over the years, four different types (models) of international petroleum (oil and gas) contracts have evolved (Abdullahi, 2002); *the concession agreements; the production sharing agreements; the joint venture agreements* and most recently, *the hybrid contracts*. The essence of these agreements is to establish the basis of partnership between multinational oil companies, who posses the requisite technology and countries endowed with (owners of) oil and gas resources. The choice of any particular model is a matter of policy predicated upon the peculiarities that vary from country to country. It is expected that a country will adopt a model that suits its circumstances in a manner that satisfies its long-term objectives of generating sustainable economic growth and development. The international petroleum contracts thus constitute a strategic regulatory instrument that could be used as safeguards to minimise and/or overcome the effects of technology deficiency that give rise to strategic disadvantage of countries endowed with oil and gas resources, as well as provide a basis for effective management of the trade-off between national interest and that of private multinational oil companies.

The Traditional Concession Agreement is the oldest form of international petroleum contract agreements, which has its roots in colonial style of administration that pervaded the 20th century. There is a widely held view among scholars that the greatest weakness of the traditional concession agreements is that they were originally "loose, superficial and had vague structures" (Smith, 1975,), which confers undue advantage to the multinational oil companies in a supposedly equal partnership between the companies and the host countries. For instance, the earliest concession agreement, the petroleum concession made by Colonel Edwin Drake at Titusville, Pennsylvania, USA in July 1859[39], has a clause such as;

> *"To bore, dig, mine, search and obtain oil, and take all, remove and sell such, for his own exclusive use and benefits, for the term of 15 years with the privilege of renewal for the same term"*

(Pennsylvania Rock oil company Vs Bouditch & E. L. Drake (1857)[40].

[39] Blinin, et al (eds) IPA (Euro Money Publications, 1987), page 40.
[40] Quoted in Abdullahi, S. (2002).

Abdullahi (2002) argued that the traditional concession agreements are reflective of the master-servant relationship that characterised colonial political institutions; as such it lacks the spirit of joint economic partnership and shared benefits. The Nigerian National Petroleum Corporation (NNPC) stressed that companies owned by or with the interests of officials of imperial government did not feel contractually obliged to pay royalties, even when they did, the amount involved called into question the integrity and the legitimacy of the fiscal structure of the contract regime. On average, every concession area could cover as much area as 200kms, and for every ton of crude oil lifted from the concession area, the companies paid four gold shillings royalties; the equivalent today is $1.65 (NNPC manuals, 1978, p.36). The lopsided perception of the traditional concession agreements is aptly captured thus;

> *"They consisted of a grant of large areas to be retained by the concessionaire for a long period even if part of these areas were not exploited, the exclusive right to explore for and exploit petroleum described as aright in and to the land which includes the right of ownership in the petroleum and in the reserves; the lack of any control by the state over the activities of the concessionaire, the unilateral determination of the petroleum prices (posted prices) by the concessionaire. In return, the concessionaire paid a royalty which constituted the principal financial basis of concessions"* (Abdullahi, 2002, 231).

Over time, there has been a shift away from the concession agreements to a more equitable and economic beneficial arrangement to the host countries as a result of attainment of independence and the perception of economic injustice about the concession agreement.

The Joint Venture Contract (JVC) emerged to be a model that addresses the limitations of the traditional concessions agreement. The JVC has no definite definition and encompassing prescription. It is hinged on operating circumstances, regulatory regimes, public policy and legal characteristics, but Michael P.G. Taylor, T. P. Windsor and Sally M. Tyne have jointly defined it as;

> *"A contract between two or more parties establishing and setting out terms of a joint venture between them under which Petroleum Exploration, Development and Production operations will be conducted. It is the constitution by which the joint venture is governed and performs essentially the same role as a Partnership Agreement or the Memorandum of Association of a company"* (Abdullahi, 2002, 243).

The cardinal issue behind the JVC concept is the sovereignty of the host countries over their natural resources. The JVC is to provide a basis for active participation of countries in the operations of the oil and gas activities along with the multinational oil companies so as to enable compliance with the strategic interests of the host countries. The JVC is like a Partnership Agreement that defines a framework for active and beneficial cooperation between an oil company and the sovereign nation that is endowed with the natural oil and gas resources. This provides a basis for joint collaboration on the basis of equity and non-equity Joint Venture Contracts in exploration and development between multinational oil companies and their host countries. The JVC model has taken the centre stage of international petroleum development.

The Production Sharing Contract (PSC) came into the scene as another form of contractual arrangement in oil and gas industry operations as a result of some inadequacies associated with the JVC arrangement. Even though the JVC is regarded as an improvement on concession contracts in meeting the legitimate national aspirations and contractual expectations of the oil producing states, it lacks specificity and thus susceptible to the influence of the stronger partner in negotiations and agreements. The PSC seeks to establish specific contractual obligations of the two parties in a manner that guarantees a return on the investment without pre-investment risk liabilities. It is more prominent with the Indonesian fiscal regime even though the idea itself preceded the Indonesian model. Originally, it was applied to agro-based industries. The pioneer Indonesian production-sharing contract was signed on 7th April, 1960 between *Pertamina* (The Indonesian National Oil Company) and *Kobayaship* Group, a Japanese consortium. Under the terms of the agreement, *Kobayashi* group was to provide *Pertamina* with a loan of $53 million in form of equipment and other technical facilities over a period of ten years while *Pertamina* would, in turn, repay the loan with oil on the basis of a 40 per cent increased production over a basic amount fixed at 35 million barrels of crude oil (Abdullahi, 2002, 254). The concept of PSC has gained tremendous goodwill in oil and gas operations since the 1960s when it emerged. It has been argued that the growing popularity of the PSC among developing countries in particular, is due to their desperate economic realities which make it impossible to fund exploration and production projects. The PSC has evolved over the years and is being adopted with modifications by different countries in accordance with their divergent domestic circumstances but most of its original features remain intact:

- The international oil company bears the sole responsibility of the exploration risks and other associated costs.

- The company is employed as a contractor in the contract areas under the control of the host country.

- In the event of a commercial discovery, it is entitled to recover its operating costs from the oil produced within the contract area (cost oil).

- After the cost oil deduction, the balance of the total production from the contract area is shared on an agreed fixed percentage production-sharing formula under the contract.

- The fiscal regime usually provides for taxation of income of the company. The ownership of the oil produced rests with the host country.

The Hybrid model of contractual arrangement is a combination of some elements of each of the concession, JVC and PSC in varying magnitudes that is usually determined by circumstances, relations between the contracting parties and the bargaining strength of each of the parties involved.

Given that requisite technologies for oil and gas industry operations come from multinational oil companies, they are most likely to exert strategic advantage in the operations. This could also strengthen their bargaining power under any of the international oil contractual arrangements. This implies that the disposition of operating multinational oil companies could have crucial impacts on the economic dividends of host countries that own the oil and gas resources. The macroeconomic policy process of a country that is endowed with oil and gas resources, with multinational oil companies as key operators, will inevitably be contingent on the disposition of the operators as well as other factors. Since the growth process of such an economy is basically influenced by implementation of effective macroeconomic policies, it follows that, for such an economy, it is necessary and essential for the oil and gas industry operations to be in tandem with the fundamentals of a virile and viable long-run economic growth process. The application of macroeconomic policy instruments to facilitate inter-industry linkage effects that derives stimulus from the oil and gas industry could mitigate the technological disadvantages of the domestic economy and propel the process of endogenous technological change and economic growth.

Considering the trade-off that exists between profit motivation of multinational oil companies as key operators on one hand, and the magnitudes of inter-industry linkages of the domestic economy, effective control of the operational mechanisms is very essential for enhancing the net benefits of the activities of the industry to the domestic economy. This requires robust regulatory framework and imposes additional tasks to macroeconomic policy formulations. Nigeria, like most countries endowed with oil and gas resources, recognises the trade-off and its implications and have devised several measures to ensure that the operations in the oil and gas industry generates a desired level of benefits to the domestic economy in terms of attaining sustainable economic growth and uplifting the standard of living of the citizenry. This takes the form of regulatory policies, choice of appropriate contracting arrangement and terms; as well as creating functional supervisory institutions.

5.2: REGULATION OF OIL AND GAS RESOURCES IN NIGERIA

The basic essence of regulatory policies in the oil and gas industry is to establish mechanisms of control over the economic and social conducts of the operators in the industry in order to maximise the economic benefits accruable to the Nigerian economy as well as ensure a safe and healthy environment. Thus, beside output, production, distribution and pricing objectives, regulatory policies in the Nigerian oil and gas industry should also aim at ensuring health and safety of workplaces and products; minimising or eradicating noise pollution and pollution externalities from drilling and other production activities. These additional objectives are important not only for what they represent but also critical to the fundamentals of attaining economic growth. In addition, targeting these objectives expands the scope of economic activities that could further enhance inter-industry linkages within the domestic economy.

The structure of regulatory powers embedded in the constitution of Nigeria as it affects the oil and gas industry has evolved over the years. The National Assembly, as the law making authority of the Nigerian state is responsible for enacting laws that binds oil and gas operations. Unless the National Assembly changes any of the laws, all existing laws are binding on the industry and all arms of government. The Executive arm of the Federal Government is in charge of administration of Government joint venture interests; all policies relating to concession, marketing of petroleum and petroleum products, conservation, control and inspection of the industry; development of hydrocarbon industry (natural gas, processing, refineries and petrochemicals); fixing of prices (of crude oil, natural gas, petroleum products and their derivatives); licensing of all petroleum activities; overall supervision of the industry; and relation with OPEC and other relevant agencies as well as overseeing the functions of domestic agencies such as the NNPC, Petroleum Equalisation Fund, Petroleum Technology Development Fund and Petroleum Training Institute. The Judiciary would adjudicate on matters before it by any interested party (private or public) on any dispute.

The regulation of petroleum (oil and gas) product activities in Nigeria predates the discovery of oil in Nigeria. The trading activities of such products were highly government regulated even though there was no direct government participation prior to the discovery of oil in Nigeria. The regulatory policies were reflected in legislations that specify the rules of importation, marketing, taxing and safe handling of petroleum products in Nigeria. As with other legislations during the colonial era, the petroleum laws were reflections of the British legislative and legal system that dwelled principally on guidelines on the powers of the Governor-General and the House of Representatives. Some of the laws enacted during the period include the Mineral Oil Ordinance of 1914; Motor Spirit (Returns) Ordinances of 1952 and the Mineral Oils (Amendment) Ordinance of 1958 and 1959.

Shell D'Arcy started exploration activities through a licence granted the company by the colonial government in 1937 to prospect for oil in the Niger Delta region of Nigeria as a normal private activity. The terms of the licence was typical of the traditional concession agreements; a massive concession area (the whole of Nigeria), the terms of engagement vaguely defined, and an absolute control vested in the multinational oil company. The discovery of oil in commercial quantity was not until in 1957 at Oloibiri, near Port Harcourt in the Niger Delta region of Nigeria. After the commencement of production in 1958 by Shell, oil prospecting licences were granted to five other companies to carry out oil prospecting in the continental shelf of Nigerian shores at the payment of N1million each.

The Oil pipelines Ordinance of 1956 (Amended 1965) was enacted in anticipation of the success of Shell in its earlier prospecting activities. It was basically an ordinance for the establishment and maintenance of pipelines. According to this ordinance, each licence is issued in respect of and authorise the construction, maintenance and operation of one pipeline only. Among other things, the following rights were granted:

I. The holders of an oil prospecting licence or an oil lease who discovered mineral or natural gas in commercial quantities shall be entitled to the grant of a permit to survey the route for an oil pipeline for the transport of such oil or gas to a refinery in Nigeria or to any other point of destination to which such holder requires the product to be transported for purpose connected with oil trade or operations.

II. The holder of a permit to survey is entitled to enter with his officers, agents, workmen or other servants and with any equipment or vehicle into any land upon the route specified in the permit or reasonably close to such route for purposes of surveying and taking levels of land; digging and boring into the soil and subsoil; cut and remove such trees and other vegetation as may impede the purpose specified here; and doing all other acts necessary to ascertain the suitability of the land for the establishment of oil pipeline or ancillary installations. The holder, with such persons, equipment or vehicles, is entitled to pass through land adjacent to such route to the extent that such may be necessary or convenient for obtaining access to land upon the route specified.

III. Holders of such licence shall pay compensation to person(s) that suffer(s) losses due to the activities related to the operations of the licence that cannot be made good. The amount of such compensation must be acceptable to the person and the holder of the licence; otherwise it shall be fixed by a court at contestation.

The Petroleum Profits Tax Ordinance of 1959 (Amended in Decree 3 of 1979) specifies in clear terms the constituents of chargeable profits derived from sales of chargeable oil and gas, and deductions allowable as current expenditure for charge against income and expenditure items not allowable into the profit and loss account. The deductions allowed must be directly connected to the petroleum operations of such a company in Nigeria whether such expenditure is incurred within or outside the country. The deductions include rents on land (this is outside the land approved for petroleum activities which is usually freely acquired by law) and building incurred by the company and compensation paid for disturbance of the surface rights; interest paid on borrowed funds used for petroleum operations (provided the Board of Inland Revenue is satisfied); cost of repairs of premises, plants, machinery, etc; debts collectable that become bad and doubtful in the current accounting period (with the proviso of the satisfaction of the Board of Internal

Revenue); expenditure on drilling appraisal or development of well not covered under other expenses; contributions to pension and other approved funds in the current accounting period.

From these stipulated regulatory conditions, it is clear that certain disbursements and expenses can easily be exploited to cause reduction in the value of profits but are not necessarily connected to petroleum operations. Such entries include capital employed (as different from the cost of repairs and interests payable in the current period); value of expenditure recoverable under an insurance or contract of identity; amount incurred as income or profit tax; cost of depreciation, savings, royalty and interests payable on borrowed funds not directly connected to oil operations of the company. Nevertheless, all deductions allowed must not reduce the level of profit accruable to the Board of Internal Revenue (BIR) as tax revenue to less than 15 percent of the company's gross income (sales) in the current accounting period. The tax rate for the petroleum profit in the ordinance is 50 per cent of the company's chargeable profits.

The Hydrocarbon Oil Refinery Act (No 17) of 1965 specifies the requirements of the licensing and operation of hydrocarbon oil refineries by private persons. In its original state the requirements for licensing were simple but the Act had inbuilt disincentive to investment and instability, which could not allow for private sector commitment of funds to the hydrocarbon oil refining business. For instance, section 5 of the Act gives uncontrollable power to the government agent (The Board of Customs and Excise) to revoke the licence granted to any person upon its "satisfaction" to do so and that is done by simply writing to notify a licence holder of such revocation. In doing this, the investment interest of the investor is not considered and the investor is not given any chance of defence. Besides, the licence granted any person only lasts for a period of one year subject to renewal every year through re-application and reconsideration by the government board (section 6 of the Act). Being a long-term investment, this has disincentive effect on the investors since they are not certain of renewal given the possibility that long red tape of bureaucracy and corruption could undermine such a process.

These strict conditions in the Act for investment in petroleum oil and gas refineries could be the main reason for non participation of private investors in the refinery business in Nigeria. Private investors were perfectly risk averse when considering refinery business in Nigeria in the light of this discouraging regulatory provision. That has been the reason that only government-owned refineries operate in Nigeria for almost four decades since the Hydrocarbon Oil Refineries Act. The decision of government to forcefully acquire the shares of some oil companies in the 1970s under its policy of nationalisation/indigenisation further discouraged potential private investors in the business of refining oil and gas products. Such potential investors found it safer and more profitable to be contractors and technical partners to the government owned refineries.

The Nigerian National Petroleum Corporation (NNPC) was set up in 1977 through Decree No 33 of 1977 to usher in direct participation of the government of Nigeria in all petroleum activities; exploration, prospecting and production of oil and associated products. The NNPC is a key agent of the Federal government charged with the duty of exploring, prospecting, refining, processing and handling of petroleum for manufacture of petroleum products and its derivatives; providing and operating pipelines, tanker ships, etc. for transportation and distribution of crude oil, natural gas and their products; carrying out research in connection with petroleum for the purpose of enhancing the output of the petroleum industry; doing other things as may be directed by the federal government, or as may be in the overall interest of Nigeria.

Over the years, several other regulatory laws have been enacted to ensure adequate grip of the activities in the oil and gas industry by the government. These include The Mineral Oils (Safety) Regulations of 1963; Oil Pipelines Act of 1965; Petroleum Regulations of 1967; Oil Terminal Dues Decree of 1968; Oil in Navigable Waters Decree of 1968; Petroleum (Drilling and Production) Regulations of 1969; Petroleum Decree of 1969; Offshore Oil Revenues Decree of 1971; Petroleum (Amendment) Decree of 1973; Petroleum (Drilling and Production) Amendment of 1973; Petroleum (Refining) Decree of 1974; Petroleum (Amendment) Decree of 1977; Petroleum (Drilling and Production)

(Amendment) Regulation of 1979; Associated Gas Re-Injection Decree of 1979 and its 1984 Amendment; Crude Oil (Transportation and Shipment) Regulations 1984; Petroleum (Drilling and Production) (Amendment) Regulations of 1988.

To encourage the emergence of domestic technological capabilities for effective operations in the oil and gas industry that could drive economic growth, the Petroleum Technology Development Fund (PTDF) was established in1973 through Decree 25 of the Federal Republic of Nigeria. In 1990, the decree was amended as the PTDF Act. Since its formation the activities of the PTDF has been lull until it was reinvigorated in 2000. The cardinal objectives of the PTDF involve the initiation and implementation of strategies for developing domestic technological capabilities. A three-pronged approach has been adopted in pursuance of these objectives; providing opportunities for high level international training by qualified nationals in different fields that are relevant to the oil and gas industry; provision of essential infrastructural and technological facilities to training and research centres in the country to enhance their ability for training and research and coordinating the use of the available skilled indigenous manpower in the oil and gas industry. The long-term goal of the PTDF is to serve as a vessel for the development of indigenous manpower and technology in the petroleum sector of Nigeria The fund seeks to train Nigerian students, graduates, professionals, technicians and craftsmen in the fields of engineering, geology, science and management for the oil, gas and solid minerals industry in Nigeria and abroad.

In carrying out its mandate, the PTDF has been involved, among other things in the following:

- Awarding Scholarships and bursaries wholly or partly in Universities, Colleges, and Petroleum Institutes in Nigeria or elsewhere for students to undertake studies and research in oil and gas related disciplines.
- Sponsoring suitable endowments, providing books and equipments as well as other services for the enhancement of training in engineering and science faculties of Nigerian universities, colleges and other institutions.

- Coordinating and sponsoring visits to oilfields, refineries, petrochemical plants, and arrange necessary attachments of personnel to establishments connected with the development of the petroleum industry.
- Financing the participation of experts in seminars, conferences and workshops connected to the petroleum industry in Nigeria and abroad to enhance knowledge spillovers that can intensify domestic technological capabilities.

It can be observed that all the regulatory provisions tend to be emphatic on extraction, transportation and revenue accruable to the government. There appears to be little regulatory emphasis on the use of oil and gas resources within the domestic economy, which potentially weakens the synergy for inter-industry linkages. Downstream activities such as refining, which could have trigger a chain of inter-industry linkages, has been made exclusive to government operating with enormous monopolistic powers but without requisite technology for effective and efficient operations. This has the tendency of crippling the opportunities for inter-industry linkages that could form a basis for endogenous technological change that could give rise to spillover effects for a sustainable growth path for the Nigerian economy. The activities of the PTDF can be more effective in generating a process of technological acquisition and capabilities through the expansion of value adding activities in the oil and gas industry.

5.3: THE STRUCTURE AND OPERATIONS OF THE INDUSTRY

Nigeria has, at different stages of the development of its oil and gas industry, adopted and used all the three standard contracting methods. Even though a German Bitumen company was granted exclusive rights in 1908 to prospect for oil in the British protectorate of Lagos in what could have been regarded as the first Nigerian concession contract, Nigeria, as it is geographically constituted today, was established in 1914 by the amalgamation of Northern and Southern Protectorates that included Lagos. In 1937, the Shell D'Arcy Petroleum Company and the British Petroleum company (BP) both secured a concession agreement from the British colonial government that covers the onshore mainland areas of Nigeria (92500sqkm) and the entire offshore areas respectively. At the expiration of the first grant of thirty and forty years respectively, there could be an automatic renewal for another forty years. The terms of Shell (BP) concession of 1949 provided under paragraph 3(1b) (1) among others

> *"A royalty of four shillings a tone of 2,240lbs of all crude oil won and saved and casing head petroleum spirit recovered by the license from the said lands within such year ascertained in the manner provided by clause 6 (measurement of petroleum obtained from the said lands)".*

This arrangement was in consonance with the colonial economic policies of the time as such it was sustained until the eve of political independence in 1959 when the concession regime was reviewed to the duration of twenty (20) years. All the concessions were regulated by the Mineral ordinance of 1914, which defined concessions as the embodiment of exploratory rights and obligations and vested the power to grant a concession to search for oil in and under any land in Nigeria only to the Governor-General. At independence in 1960, the Federal Government of Nigeria assumed these powers. Legislations were promulgated (Petroleum Act, 1969 and the Petroleum Drilling and Production) Regulation of 1969) to reform the entire Nigerian Petroleum concession contract regime. These legislations vested the entire ownership of petroleum resources in the Federal Government. The 1969 ordinance in particular led to the termination of the uninterrupted thirty-two years era of traditional concession agreements and ushered in the era of modern concession regime in Nigeria. The second-generation concession agreements was a tremendous improvement in terms of structure, monitoring and regulatory mechanism. For instance, instead of one single exploratory permit under the traditional concession, the second-generation concessions requires three; Oil Exploration Licence (OEL); Oil Prospecting Licence (OPL) and Oil Mining Licence (OML). The Minister of Petroleum Resources has the authority of administering this three-in-one concession regime. The granting of any of the three licences is tied to a level of operation or work programme. The arrangement is such that every prospective investor begins by applying for OEL. If granted, the licence covers a grant area of about 12, 950sq km for the duration of one year. After one year of geological and geophysical search for hydrocarbon formation and in the event of a discovery or the prospect of finding oil, the licensee will apply for an OPL, the duration of which is to the discretion of the Minister, but on no account should it exceed five years and the area should not exceed 2,590 sq. km. The OPL entitles the beneficiary the exclusive right to search for and drill to extract samples, and to refine in Nigeria, as well as the right to export to the World market. The payment of the Petroleum Profit Tax is required upon the commencement of oil and gas production within the concession area. Discovery of oil in commercial quantity with an OPL qualifies an operator to apply for PML, which is purely a statutory mineral lease pursuant to the Petroleum Act of 1969 with robust terms of engagement that prescribes broad rights, duties and obligations. Paragraph 11 of schedule 1 of Petroleum Act 1969 confers an OML licence thus;

> *"The exclusive right within the leased area to conduct exploration and prospecting operations and to win, get, work, store, carry away, transport, export or otherwise treat the petroleum discovered in or under the leased area".*

Some contractual rights and obligations are embodied in OML. The rights include; licensed area operation; incidental right of usage within licensed area; right to be consulted and compensated in the event of change in decision while the obligations include; upholding to conduct efficient operations within the area of grants as well as to conserve petroleum and to control of land, water and air; continuous and vigorous operations in a "business like manner" and in accordance with "good oilfield practice".

Observed inadequacies in operations led to the adoption of the Joint Venture Contract (JVC) model by Nigeria. The United Nations Resolutions of 1962 on state sovereignty over natural resources and the policy resolve adopted by the Organisation of Petroleum Exporting Countries (OPEC) in 1968 further spurred the agitation for greater involvement in oil and gas industry operations by Nigeria, among other OPEC member countries. It is perceived that the JVC provides a basis for greater engagement in the areas of ownership and control over exploration and exploitation of oil and gas resources. Specifically, the Nigerian JVC arrangement recognises the government as an operator, in addition to being the owner of the hydrocarbon underground as well as the regulating authority in the contract relationship with the oil companies. In order to ensure effective regulation of the industry in terms of monitoring, setting standards of practice and the enforcement of compliance, the Nigerian National Petroleum Corporation was established to replace the defunct Nigerian National Oil Corporation (NNOC). The NNPC was statutorily empowered to among other things, acquire in-depth knowledge, techniques and general patterns of petroleum operation in order to enable it perform strategic role in the activities of the oil and gas industry in Nigeria. Basically, the NNPC was the brainchild of Nigeria's strategic plan arising from OPEC's motivation to all its members to strive to acquire greater say in the exploitation of their petroleum resources as enshrined in Resolution XVI, Article 90 of June 1968[41]. In corollary, Nigerian government's policies and programmes aimed at taking control of the petroleum industry was enunciated in the 1970-74 Development Plan with the overall strategy of asserting government's dominance either solely or as a principal partner in the exploitation of strategic natural resources with the objectives of:

(i) achieving maximum possible rate of economic development and industrialisation of the country;

[41] The resolution enjoined all member countries of OPEC to acquire participating interests in the operations of the oil companies according to a prescribed time-table by which each member country would achieve 51 per cent participation by 1982.

(ii) achieving greater familiarity with the oil business and hence better monitoring of oil operations and capital operating expenses and to achieve better tax administration in the sector;

(iii) expanding the opportunities for employing Nigerians in high level technical and management positions in the industry and hence promote the cause of oil technology acquisition;

(iv) speeding up indigenous development of petrochemical industries, and

(v) achieving even distribution of refined petroleum products and an equalisation of their prices nationally.

The regulatory framework of the NNPC determines the composition and extent of participation of the multinational oil companies in the industry. The NNPC is organised into six functional directorates: Corporate Services; Refining and Petrochemicals; Commercial and Investments; Finance and Accounts; Exploration and Production; and Engineering and Technical. The Exploration and Production directorate is vested with the direct management of the upstream activities of the industry and further divided into strategic units as follows:

- The National Petroleum Investment Management Services (NAPIMS).
- Crude Oil Sales Division (COSD).
- Nigerian Petroleum Development Company (NPDC).
- Integrated Data Services Limited (IDSL).
- Nigerian Gas Company (NGC).

Each of these units functions within the structure of the NNPC, with the exception of NAPIMS and COSD, which functions autonomously in their ascribed operational areas. COSD regulates and markets the crude oil and gas products from Federation investment in Joint venture contracts (JVC) as well as Production Sharing Contracts (PSC).

NAPIMS is ascribed greater and more strategic role both in the NNPC structure as well as in the oil and gas industry. The underlying objective of the functions of NAPIMS is to optimise the return on government investments in the upstream sector of the oil and gas industry. It projects, manages and protects the country's strategic interest in the upstream sector of the industry. Apart from earning a margin on investments in the sector, NAPIMS ensures the establishment and implementation of cost-deduction mechanism to maximise Petroleum Profit Tax (PPT) through the promotion of local content input by developing in-country technological capability to harness the utilisation of local supplies and materials. To ensure tractable performance and achievement, NAPIMS have set the following targets:

- Increasing the national reserve base from 24.1 billion barrels (with JVC and PSC contributing 22.5 billion barrels) as from January 1998 to 40 billion barrels by the year 2010, and also enhance daily production capacity from 2.5million barrels per day to 4.0 million barrels within the same period.
- Diversifying the revenue base in the hydrocarbon sector through commercialisation of the natural gas in order to ensure that the 2008 gas flare-out moratorium policy of the government is realised.
- Stimulating and encouraging the development of local entrepreneurs to compete with multinationals in areas of exploration and development of reserves in frontier areas.
- Ensuring that all activities are conducted within the framework of set environmental and safety standards in all the JVC and PSC upstream operations.
- Developing and managing the federation's hydrocarbon resources efficiently and effectively and also guaranteeing that various joint venture agreements function within the confines of operating arrangements (joint operating agreements, production sharing contracts and service contracts).

According to Ojo and Adebusuyi (1996), the on-shore existence of crude oil in Nigeria is between the depth 200-300 metres below the ground and 200 metres water depth in case of offshore, all of which often occurs either with associated and non-associated gas, condensates and tar sand with an estimated reserves of 21 billion barrels of oil and 31 billion barrels of oil equivalent in tar and sand. Extensive survey exploration activities indicates that petroleum exists in seven prospective basins (Niger Delta, Anambra Basin, Chad Basin, Dahomey Basin, Sokoto Basin and Benue Trough, while condensate deposits are in the South Eastern Shelf) but so far actual oil exploration and commercial activities have been concentrated in the Niger Delta Basin acreage and continental shelf with about 65 per cent of on-shore production. The crude oil production in Nigeria is characterised by relatively small fields and many wells, with each well producing between 500 and 5,000 barrels per day (bpd). Approximately, 65 per cent of the oil produced in Nigeria is light, sweet crude with an API specific gravity of 35 or higher. According to the NNPC[42], estimates of Nigeria's proven natural gas reserves are approximately 104 trillion cubic feet and Nigeria has the tenth largest reserves in the world, approximately 30% of African gas reserves. Much of this is associated gas, as many Nigerian oil fields are saturated, and have primary gas caps. There has been no dedicated exploration for gas. About 75% of the associated gas is currently flared off, as no domestic gas infrastructure or market exists, while fiscal terms remain unattractive.

The origin of the Nigerian nation state as a British colony and the nature of initial concessions agreements that were given to two major British oil companies, *Shell* and *BP*, in 1938 culminated into the dominance of the oil and gas industry activities by these companies. As at independence in 1960, incidentally the period that marked the beginning of significant shift of the Nigerian economic disposition from agricultural exports to oil mineral exports, *Shell* and *BP* had entrenched their dominance in the Nigerian oil and gas industry. In the early 1960s, other oil companies, some of which had started some form of activities in the industry in the 1950s sprang up and the number of operating companies in the Nigerian oil and gas industry increased. *Socony* Vacuum (later renamed *Mobil*) obtained its first oil exploration licence in 1955, *Tennessee* (also known as *Tenneco*) in 1961, Agip (an affiliate of the Italian government owned oil

[42] www.nigerianoil-gas.com

company, *ENI*) in 1962, *SAFRAP* (later *Elf*) in 1962, *Phillips* in 1965 and *Esso* (a subsidiary of the US oil company, *Exxon*) in 1965 (see Frynas, 2000, 11). By 1951, the exclusive concessions over all Nigerian oil resources, hitherto enjoyed by *Shell-BP*, was terminated with the reduction of its original exploration licence covering 357,000 sq miles to 58,000 sq miles and further reduced to 40,000 sq miles in the Niger Delta (Schaltz, 1969, Frynas, 2000, 11). Current operations in the Nigerian oil and gas industry is dominated by six major multinational oil companies; Shell, Mobil, Chevron, Elf, Agip and Texaco, which together accounted for about 97 per cent of total production in the industry between 1986 and 1992 while Shell alone accounted for 50 per cent of total production in the same period (Garba, 2000, 7). The NNPC had 60 per cent equity share in these companies before 1993 in line with joint venture agreements but this was reduced to 55 per cent in 1993. In 1970, the Federal government initiated both legislative and executive processes to be involved in practical implementation of its joint participation policy. As a matter of deliberate policy the action plan empowered government to acquire equity participation in the areas of Exploration and Mining in the upstream sector and Refining, Distribution and Marketing in the downstream sector of the oil and gas industry. A legislative provision of a participation ratio of about 35-51 per cent was initially given. As at 1973, the government had joint venture agreements with *Gulf*, *Mobil*, *Agip-Phillips*, *Texaco* and *Pan-Ocean* at the level of 35 per cent. By 1974, the participation increased to 55 per cent; by 1977, due to the promulgation of the Nigerian Enterprises Promotion Decree, the ratio increases to 60 per cent before the 1993 reduction to 55 per cent. It needs to be pointed out that joint venture participation of NNPC had hitherto being on non-equity basis. Equity joint venture contracts agreements, which enables the government as a co-venturer to have a dual contractual role as a shareholder and concurrently as a joint venture partner[43], gradually replaced the non-equity JVC as preferred choice of the government through the NNPC.

[43] In the case of non equity JVC, a company is usually formed between the NNPC and the Multinational oil company to handle the joint stock of the co-venturers.

Table 5.1: NIGERIA'S JOINT EQUITY PARTICIPATION IN TH OIL AND GAS INDUSTRY

Names of Companies	*Business Nature*	*Acquired Equity (%)*
Schlumberger Ltd	Well Survey	40
Forex Ltd	Drilling	36
Baroid Ltd	Mud Chemical Services	36
Dresser Ltd	Engineering Services	36
Solus Schalls Ltd	Driving Services	36
Baker Ltd	Equipment Marketing	35
NLNG Ltd	Gas Liquefaction and Sale	60
NETCO Ltd	Engineering Consultancy	60
Hyson Ltd	Refinery Services	60
Carlson Bermuda	Oil Marketing	51

Source: NNPC Head Office, Lagos, Nigeria, 2001, adopted from, Abdullahi (2002)

Under the Nigerian Enterprises Promotion Decree of 1977, the NNPC must hold 36 per cent shares in the Oil Service Companies while 14 per cent goes to the public. The Oil Services sub-sector, which provide various forms of engineering services to the entire industry (such as drilling, refining, surveying, data processing and general mechanical services), accounts for 56 per cent of the entire joint venture contracts regime in the Nigerian oil and gas industry. The NNPC have continued to establish several upstream joint ventures to expand the oil and gas reserves and increase production capability. Some of these include:

- The NNPC/Mobil Producing *Oso* Condensate joint venture worth $900 million in which NNPC and Mobil contributed $290 million while other international financial agencies provided the remaining; the World Bank ($218 million), IFC ($170 million), Export-Import Bank of USA ($95 million), Export-Import Bank of Japan ($47 million).
- $390 million worth Nigeria *Agip/Phillips/NNPC* joint venture.
- The Methyl-Tertiary-Butyl-ether (MTBE) project of the Standard Petrochemical (SPIL) Consortium worth $660 million.

- $450 million worth Methanol plant of *Pencol* Group.
- $450 million worth National Gas Project of NNPC/Chevron joint venture.
- *NNPC/Elf Qua Ib*oe River Condensate worth $300 million.

In all the JVC arrangements, in which the Federal government is represented by the NNPC, the average crude oil stream contribution to the annual production quota are; *Shell* (52%), *Mobil* (15%), *Chevron* (11%), *Agip* (18%), *Elf* (6%), *Texaco* (4%), *Ashland* (3%), *Pan Ocean* (0.03%), *Tenneco* (0.19%), and *Dubri* (0.01%). Tables 5.1 and 5.2 provide the details of the pattern of JVC acquisitions with various oil companies. It is important to point out the strategic significance of the *NNPC/Shell/Agip/Elf* joint venture contract to the Nigerian economy, among other joint venture contracts, basically because it nurtured the formation of the Nigerian Liquefied Natural Gas Ltd. The NNPC's equity share is 60 per cent; 20 per cent for Shell while Agip and Elf have 10 percent each. The strategic significance of this JVC lies in the fact that, it provides the requisite infrastructure for the utilisation of Nigeria's natural gas reserves, which has been flared all along in the process of crude oil production[44]. Growing pressure from environmentalists, led to increasing utilizations of the associated gas, and Shell has committed to ending all flaring of associated gas from their fields by the year 2008. This has been embodied in the National Gas Policy.

[44] In fact it has been estimated that Nigeria's gas reserves are far more than its oil reserves. The flaring of gas has continued despite this project, with the Federal Government persistently shifting its target dates for

Table 5.2: NIGERIA'S NON EQUITY PARTICIPATION IN THE OIL AND GAS INDUSTRY

Company	*Participation (%)*	*Date Acquired*	*No. of MOLs/OPLs*
Shell/BP	35	1.4.1973	58
	55	1.4.1974	58
	60	1.4.1979	58
	80	1.8.1979	58
	60	1.7.1990	58
Gulf Oil	35	1.4.1973	10
	55	1.4.1974	16
	60	1.7.1979	16
Texaco	55	1.5.1975	6
	60	1.7.1979	6
Mobil Oil	35	1.4.1973	4
	55	1.4.1974	4
	60	1.7.1979	4
Elf	35	1.4.1971	4
	55	1.4.1974	4
	60	1.7.1979	4
Agip & Phillips	3.3	1.4.1971	4
	55	1.4.1974	4
	60	1.4.1979	4
Pan-Ocean	55	1.1.1978	1
	55	1.7.1979	1

Source: NNPC Head Office, Lagos, Nigeria, 2001, adopted from, Abdullahi (2002)

The Liquefied Natural Gas project[45], currently the largest construction project in Nigeria, is an ambitious $3.8 billion facility being built at *Finima*, Rivers State. This first phase project is designed to process 5.9 million tonnes annually of LNG. The plant is expected

complete stoppage of gas flaring. Despite being a source of adverse environmental effects, gas flaring is also a waste of valuable resources and thus tends to undermine the process of economic growth.

[45] http://www.nlng.org

to process non-associated gas supplied from Shell Nigeria's Soku fields, as well as associated gas supplied from 2 Shell fields (Soku and Bomu), 2 Agip fields (Oshi and Idu), and 3 Elf fields (Ibewa, Obagi, and Ubeta). The shareholders of the project comprise NNPC (49%), Shell (25.6%), Elf (15%), and Agip (10.4%). The operating company is called the Nigerian Liquefied Natural Gas Company- (NLNG).

The project consists of a two train LNG liquefaction plant-(5.9million tonnes/year), 2 LNG Storage tanks (168,000 cubic metres), and a 200 km feed gas pipeline, jetty, office, housing, power generating facilities. Significantly, the output stream of the liquefied natural gas is sold out as the NLNG had negotiated a number of long term (22.5 years) purchase agreements for the gas before the project commenced: ENEL (Italy) agreed to take 2.5 million metric tonnes per year, ENAGAS (Spain) - 1.2 mmt/y, BOTAS (Turkey) - 0.8 mmt/y, GAZ de FRANCE- 0.4 mmt/y, with the balance going to TRANSGAS of Portugal. This implies that demand for the NLNG products is guaranteed, which should be a stimulus for production. The company has procured the seven LNG carriers required to transport the LNG. The company owns four carriers, while three have been chartered. Another two carriers have been ordered from Hyundai Construction to meet the demands of a third train extension of the project, basically as a response to existing demand.

The shareholders have signed an agreement for the front end engineering of a second phase development, planned to add a third train to the two currently under construction. TSKJ, the consortium comprising Technip, Snamprogetti, Kellogg, and JGC, have been re-appointed project managers for the second phase development. An agreement has also been signed by the partners for the development of 4th and 5th trains-a project known as NLNG PLUS. Financing has been arranged for the project, which is scheduled to come on stream in 2005.

The government entered into Production Sharing Contracts (PSCs) with the oil companies in the first half of 1993 for newly allocated oil blocks in 1990 and 1991. Under the PSCs, the operator (oil companies) is to shoulder all exploration and development costs while the government takes certain proportion of the produce (crude oil) and the remaining goes to the operator for recouping costs with a profit margin. Nigeria had previous PSC arrangements but was perceived overtime as being lopsided in favour of the oil companies. For instance the first Nigerian PSC signed on 25th March, 1973 between the Nigerian government through the NNPC and Ashland Oil Nigeria Ltd (an American oil company) under which the company was to provide risk finance and other technical facilities for the exploration activities until a commercial discovery was made to contain a clause such as:

> *"The contractor Ashland is given the right to sale, assigns, transfer, conveys, or otherwise disposes of any part of its rights and interests, subject to a pre-written consent of the NNPC of which the consent should not be unreasonably withheld".*

This and several other provisions of PSC arrangements by Nigeria are indications of NNPC (by extension, the Nigerian government) ceding its rights and interests to venture (risk) capital providers (oil companies). In the 1990s the Nigerian PSCs were reviewed in response to the perceived lopsidedness but focusing mainly in the ratio and pattern of financial obligations. For instance, "cost oil" recoverable by the company was reduced from 40 per cent to 30 per cent; "Tax oil" was reduced from 55 per cent to 40 per cent while the remaining 30 per cent, being "Profit oil" (which was just 5 per cent in the 1973 PSC) would be shared on the ratio of 35 per cent for NNPC (from 65 per cent in the 1973 model) and 65 per cent for the oil company (from 35 in the 1973 model).

In the downstream sector of the industry, where refining is the main activity, government has maintained a public sector monopoly policy for more than three decades. Nigeria has four refineries that are fully owned and operated by the Federal government through the NNPC:

- The first is the Port Harcourt I Refinery, which was commissioned in 1965 with an initial capacity of 35,000 bpd but later expanded to 55,000 bpd and further restructured to 60,000 bpd. It was initially jointly owned between Shell and British Petroleum (with majority shares) on one hand and the Government (with minority shares) on the other. It was then called Shell-BP refinery before the nationalisation policy of the government in the 70s changed the ownership structure.

- The Warri refinery was commissioned in 1978 with a capacity to process 100,000 bpd and later expanded to 125,000 bpd in1987.
- The Kaduna refinery was commissioned in 1980 with an installed capacity to process 100,000 bpd and upgraded to 110,000bpd in 1986.
- The new Port Harcourt (Port Harcourt II) refinery was commissioned in 1989 with 150,000 bpd refining capacity.

The total installed refining capacity of these four refineries is 445,000 bpd and they all produce the normal range of petroleum products such as liquefied petroleum gas (LPG), premium motor spirit, kerosene, fuel oil and automotive gas oil. In addition, the Kaduna refinery plant also produces lubricating oil, base stocks, bitumen and waxes from heavier crude blend which are not commonly found in Nigeria but usually imported from Venezuela and Saudi Arabia, involving a deal of importation of 56,000 bpd of crude oil. The other activities of the downstream sector such as marketing and distribution of (refined) petroleum products are government controlled with varied levels of participation by multinational oil companies and independent marketing businesses. Multinational oil companies such as Texaco, Shell, BP Nigeria Ltd, Unipetrol (formerly ESSO), Total Nigeria Ltd, Agip Nigeria Ltd, and Elf Marketing were dominant in marketing of petroleum products in Nigeria but the nationalisation policy of the 1970s gave substantial participation interest to the government. In 1975, the Federal Government acquired 60 per cent of Shell and renamed it National Oil and Chemical Company Limited (NOLCHEM); all the foreign interests in BP were acquired by the Federal Government in 1979 and renamed it African Petroleum (AP) and all the assets of Unipetrol were purchased by the Federal Government in 1976. The system of marketing petroleum products in Nigeria is dual with government playing a dominant role. This dualism comprises of eight major marketing companies and several (about 500) independent marketers. Of the eight major companies, five are Nigerian subsidiaries of multinational companies with 60 per cent ownership of their foreign parent with the same name (Mobil, Texaco, Agip, Total and Elf) while the other three (NOLCHEM, AP, and

Unipetrol) are substantially government-controlled. The "independent marketers" scheme was introduced in 1980 to encourage indigenous enterprise in marketing of petroleum products. The major marketing companies have 80 per cent of the share of the market and blend their own lubricants at formulation plants in the country while some do engage in the production of grease, plastic packaging, insecticides and petroleum jelly locally and even produce for exports.

The distribution of petroleum products is wholly controlled by the government through the NNPC. The Petroleum Products and Marketing Company (PPMC), a subsidiary of the NNPC ensures that refined petroleum products are distributed nationwide through pipeline network to its designated depots across different parts of the country. For this purpose, the PPMC maintains over 3,000 kilometres of pipelines nationwide which connect the coastal and storage depots for the distribution of refined petroleum. The pipeline distribution network is made up of three separate systems for the supply of petrol, kerosene and diesel that links the refineries with the depots. The Kaduna refinery is linked to the Escravos terminal via Warri by a crude oil pipeline. The pipelines system is being complemented by road, rail and coastal barges haulage from the refineries and depots to over 7,000 marketers' outlets nationwide. The Petroleum Act of 1969 requires that licences must be obtained for transportation to avoid contamination, adulteration, illegal distribution and for the guarantee of safety, fire, quality control and environmental pollution control of distribution activities. The Nigeria Railways Corporation is enlisted to provide necessary services for supply to industrial consumers near rail network nationwide while coastal shipments are done through barges and vessels registered with the Nigerian Ports Authority. Pricing of refined petroleum products for domestic use has been wholly controlled by the government especially since 1973 when the government began to assert its control over the operations in the oil and gas industry. The government determines the price for refined petroleum products at the pump, the price of crude sold to the refineries as well as the negotiated margin for distributors and marketers. The Uniform Pricing decree of 1973 was promulgated to ensure the prices of petroleum products across the country irrespective of location should be the same.

In recognition of the need to make more effective use of the oil and gas resources available, Nigeria conceived and established a Petrochemical Industry in 1978 for the purpose of making use of refinery by-products as feedstock (inputs) for the production of petrochemical products. This was sited at *Eleme* and thus referred to as the Eleme Petrochemical Complex Limited (EPCL)[46]. The inspiration and fundamental objective was to ensure profitable manufacturing of a range of Petrochemical Products that are Competitive both in the Local and International Markets by Processing Natural Gas and Refinery by-Products, providing rewarding careers for employees, and protecting the Environment. The main end-product was to be various types of Polymer Resins. The strategic and economic growth significance of the ECPL is among other things, providing basic petrochemical raw materials locally; effectively utilizing the abundant natural gas resources available in the country instead of flaring; providing job opportunities[47] as a means of improving the level of employment in the country thereby boosting macroeconomic performance; saving foreign exchange and enhancing the competitiveness of the economy through import substitution and direct importation; acting as catalyst to Nigeria's industrial expansion and diversification of the economy; enhancing the acquisition of modern technology for sustainable productive activities within the Nigerian economy through learning-by-doing.

The four refineries, liquefied natural gas project, and the petrochemical industry underscore the versatility of oil and gas resources that generate externalities for stimulating inter-industry linkages. Thus effective utilization of oil and gas resources has significant implication for inter-industry linkages and economic growth. It suffices to provide a prognosis for linkage and economic growth relevance of the oil and gas industry.

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[46] http://www.nnpc-nigeria.org.

5.4: LINKAGE AND ECONOMIC GROWTH RELEVANCE OF THE INDUSTRY

The intrinsically versatile uses of oil and gas resources confer tremendous linkage relevance to the industry in spearheading flourishing inter-industry linkages that could lead to effective contribution of the oil and gas industry to the growth of the economy. Abundant oil and gas resources present opportunities for varied economic activities that absorb different range of oil and gas (derived) products. The oil and gas industry in Nigeria has traversed through different adjustments at different stages of its development as a reflection of changing policy requirements towards enhancing the relevance of the industry to the growth of the economy. From the nature of the various forms of international contract agreements (ICAs) that occurred, it is evident that activities in the industry have been expanding over the years. Considering that interdependencies among different productive activities are the essential feature of modern production and that the direction and level of such inter-dependencies indicate each sector's potential capacity to stimulate other sectors (Cella, 1984), the expansion in oil and gas activities is expected to generate inter-industry linkage stimuli that could propel other sectors of the economy. Linkage effects emanating from the expansion of activities in the oil and gas industry can be further enhanced by inducement mechanisms for increasing use of resources from other sectors towards efficient and value-adding economic activities that can, through multiplier effects, lead to sustainable growth of the economy.

Absorption of oil and gas resources generates derived demands that are spurred basically by non-primary economic activities which induces supply of inputs needed by domestic production to generate *backward linkage effects*. Some of the activities which do not cater for final demands will induce attempts to utilise their outputs as inputs in some other activities to generate *forward linkage effects*. Increases in either primary or non-primary production activities tend to spiral wide ranging expansion in activities that re-enforces each other interdependently across different sectors of the economy. The upstream activities of the oil and gas industry are largely primary while the downstream

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[47] A United Nations Study indicates that in developing countries, one job in a Petrochemicals Complex of this type generates on the average, seven additional jobs outside), due to downstream activities (www.nnpc.org)

activities are secondary with manufacturing inclination. Each of these strand of activities in the oil and gas industry are linked to each other and also linked to other sectors of the economy in different forms. The upstream activities which involve pre-drilling (exploratory) surveys, drilling, field development and decommissioning require heavy financial capital and technology input. This creates a basis for linkage with the financial sector to provide the needed initial capital (venture capital) and for the capital goods industry to provide necessary machineries and equipments for the establishment of production platforms for extraction activities. As a less developed country, Nigeria lacks the appropriate technological wherewithal that can form a basis for effective linkage of domestic capital goods industry with upstream activities of the oil and gas industry. This constitutes a major constraint to the level of interdependence that can occur between the oil and gas upstream activities and domestic capital goods industry. Exogenous technology, through ICAs can give rise to opportunities for effective use of requisite technology and through the benefits of spin-off activities and "learning-by-doing", endogenous technological change can occur to enhance the linkage relevance of the capital goods industry and its interdependence not only with the oil and gas sector but other sectors of the economy as well, which will further stimulate the growth process of the economy. The intuition of endogenous technological change paradigm of endogenous growth analysis gives credence to this prognosis.

The downstream activities comprise of a chain of value-adding processes of transforming crude petroleum and associated gas into various final and intermediate petroleum products. These include refining of crude oil into final products such as gasoline, heating oil, lubricants and wax as well as such intermediate products as aviation fuel, industrial fuel, bitumen, asphalt and petrochemicals. The gas chain involves the processing of natural gas into cooking gas (a final product) and such intermediate products as liquefied natural gas and liquid gas. Each of these strand of downstream activities involve the use of various factor inputs that are sourced from different activity sectors in addition to the labour factor input from the household sector. This wide ranging production chain of the downstream sub-sector constitute the fountain for effective linkages with other sectors of the economy that can be consolidating and expanding with appropriate policy initiatives that creates favourable investment climate with a targeted supply response to existing markets and exploring new market opportunities. Inter-industry linkage benefits emanating from this conceptualisation will have far reaching positive impact on economic growth through bourgeoning value-adding industrial production activities that relates to numerous sectors of the economy. Persistent extraction of oil and gas resources with exogenous technological input without spin-off benefits to the economy is capable of stultifying the inter-industry linkage stimulus of the upstream sub-sector and concomitantly weakening the interdependence with the downstream sector and spilling over to other sectors of the economy, thereby hampering positive technological change and thus limiting the contribution of the sector to economic growth.

It can be inferred from the expositions under 5.2 and 5.3 that the linkage and economic growth potentials of the oil and gas industry has been recognised and considered in the regulatory and operational policies of government. Domestic technology input constraints gave rise to the use of ICAs. It is evident that all the different types of ICA (Traditional Concession; Joint Venture and Production Sharing) have been used at different stages of the development of the oil and gas industry. Notwithstanding the exogenous technology input associated with ICAs, tremendous opportunities for spin-off activities exist. Complementary low level technological equipments for the installation of production platforms, drilling rigs and barges and other related activities that are essential in the process of extraction can spring up to take advantage of existing opportunities to spiral inter-industry linkage stimulus. The essentialness of the output of the upstream sector as input into the downstream sector activities crystalises the inter-industry linkage relevance of the oil and gas industry.

The establishment of four refineries (Port Harcourt I and II, Warri and Kaduna), The *Eleme* Petrochemical Industry and the Nigerian Liquefied Natural Gas Project (NLNG) have the potential for generating inter-industry linkage benefits to the economy. The processes of production in each of these ventures are associated with high levels of externalities that can diffuse to other sectors of the economy. Spillover effects arising from surging need for responses to incentives generated by thriving industrial operations of these ventures could form the basis for self-perpetuation of value-adding activities in the various sectors of the economy. Effective operations in the oil and gas industry can prompt the springing up of such other activities as textile, plastics and bitumen production, which can expand the chain activities that are prompted by the oil and gas industry across sectors of the economy.

Thus, a high linkage sector ramification can emerge from the activities of the oil and gas industry to enable it emerge as a key sector for growth of the economy as prescribed by Hirschman's (1958) linkage hypothesis (see, for instance Yotopoulos and Nugent, 1973 and 1976; Laumas, 1975 and 1976; Jones, 1976 and Cella, 1984). However, high linkage performance of a sector is hinged more on the effectiveness and efficiency of its operations rather than the essentialness of products. Therefore efficacy of regulatory framework, the structure and operations in the oil and gas industry as well as the general macroeconomic disposition of the Nigerian economy are crucial determinants of the extent of linkage and economic growth relevance of the oil and gas industry to the Nigerian economy. Appropriate investment climate that creates favourable markets, cost-effectiveness and returns on investment are important factors for effective operations and efficiency of the activities of the sector. Thus the expansion in different aspects of upstream and downstream activities does not lead to automatic high linkage and economic growth contribution of the oil and gas industry. Rather the processes of mutation of endogenous stimulus are the key determinants of linkage effects and the impacts of the industry on the overall economy. Restrictive regulations, nationalisation, and exclusive government participation in downstream activities albeit weak domestic technological capability, key features of the Nigerian oil and gas industry, have implications for the extent of linkage and economic growth relevance of the oil and industry to the growth of the economy.

Methods of measuring inter-industry linkages are reviewed in chapter 6 and applied in chapter 7 to determine the inter-industry linkage outlook of the Nigerian economy and the impact of the oil and gas industry. This is followed by a performance evaluation of the oil and gas industry and its contribution to the growth of the Nigerian economy in chapter 8.

Chapter 6

INTER-INDUSTRY LINKAGES: METHOOLOGICAL REVIEW

6.1: BASIC LINKAGE COEFFICIENTS

Inter-industry linkage analysis has traversed different aspects of methodological constructions on the basis of varying need to capture the impact of the activities of sectors on the economy, thus providing a meaningful basis for initiating policies that could generate growth of the overall economy.

The simple computation of the technical input-output coefficients is based on the notion that the national economy comprises of $n+1$ sectors; n industries (producing sectors) and one (the $(n+1)^{th}$) final demand sector, usually categorised as the households sector. In mathematical terms, the output of sector i (i representing any hypothetical sector of the economy) is symbolised by x_i while x_{ij} represents the product of sector i absorbed by sector j as inputs to sector j. The quantity of the product of i delivered to the final demand sector x_{in+1} is usually identified as y_1. Given these, the input coefficients of product of sector i into sector j, that is the quantity of the output of sector i absorbed by sector j *per unit of its total output* is:

$$a_{ij} = \frac{x_{ij}}{x_j} \tag{6.1}$$

A complete set of the input coefficients of all sectors of an economy, arranged in the form of a rectangular table corresponding to the input-output table of the same economy, is the structural matrix of that economy. The basic input-output table, which provides information for the computation of input coefficients and the construction of the *structural matrix*, is the *flow matrix*.

The relationship between the total output and the combined inputs of the product of each sector can be described by the following set of n equations:

$$
\begin{aligned}
&(x_1 - x_{11}) \quad -x_{12} \quad -\cdots\cdots \quad -x_{1n} = y_1 \\
&\quad -x_{21} \quad +(x_2 - x_{22}) - \cdots\cdots - x_{2n} = y_2 \\
&\quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&\quad -x_{n1} \quad -x_{n2} - \cdots\cdots + (x_n - x_{nm}) = y_n
\end{aligned}
\tag{6.2}
$$

Substituting equation (6.1) into (6.2) leads to n general equilibrium relationships between the total outputs, $x_1, x_2, \cdots x_n$, by households, government, and other final users:

$$
\begin{aligned}
&(1 - a_{11})x_1 \quad -a_{12}x_2 \quad -\cdots\cdots \quad -a_{1n}x_n = y_1 \\
&\quad -a_{21}x_1 \quad +(1 - a_{22})x_2 - \cdots\cdots - a_{2n}x_n = y_2 \\
&\quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&\quad -a_{n1}x_1 \quad -a_{n2}x_2 - \cdots\cdots + (1 - a_{nm})x_n = y_n
\end{aligned}
\tag{6.3}
$$

where $y_1, y_2 \cdots y_n$ are final demands.

The general solution for the x's in terms of the given y's in equation (6.3) could be in the form:

$$
\begin{aligned}
x_1 &= A_{11}x_1 + A_{12}x_2 + \cdots\cdots + A_{1n}x_n + y_1 \\
x_2 &= A_{21}x_1 + A_{22}x_2 + \cdots\cdots + A_{2n}x_n + y_2 \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
x_n &= A_{n1}x_1 + A_{n2}x_2 + \cdots\cdots + A_{nn}x_n + y_n
\end{aligned}
\tag{6.4}
$$

The set of equations in (6.4) can be transformed into matrix form as:

$$
\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \cdots A_{1n} \\ A_{21} & A_{22} \cdots A_{2n} \\ \vdots & \vdots \quad\quad \vdots \\ A_{n1} & A_{n3} \cdots A_{nn} \end{bmatrix} + \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}
\tag{6.5}
$$

where the vector of x_s is the output of all sectors, the $(n \times n)$ matrix of A_s is the input-output coefficient matrix and the vector of y_s is final demand for goods and services of all sectors. The matrix formation in (6.5) can be expressed in standard equation form as:

$$X = AX + Y$$

This can be transformed into:

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

where I is a unit matrix. It is assumed that the inverse of $[I - A]$ exists, therefore:

$$[I-A]^{-1}[I-A]X=[I-A]^{-1}Y$$

resulting into:

$$X=[I-A]^{-1}Y \tag{6.6}$$

From (6.6), the vector of gross outputs can be solved given the values of the Y vector. The $[I-A]^{-1}$ matrix is referred to as the Leontief Inverse and its elements are expected to be non-negative because a negative value of any of the elements will imply that some final demands have negative impact on gross output, which have no economic sense. By the Hawkins-Simon restrictive conditions, the diagonal of the inverse matrix and all its principal minors should be positive. In economic terms, each element of the Leontief inverse denotes the quantity available from one sector for distribution to other sectors after satisfying its needs for its own output as an intermediate input. To understand why this should be positive, consider the oil and gas industry: a negative value of the element of the Leontief inverse implies for instance that the sector needs more than a barrel of crude oil to produce a barrel equivalent (or worth) of refined petroleum products. The second condition connotes that the net output of two sectors supplied to other sectors is more than their own needs. The elements of the Leontief Inverse matrix capture both the direct and indirect effects of any change in the exogenous vector Y (final demand). The column sum of the Leontief inverse gives the direct and indirect effects of a unit change in final demand for the particular sector on the economy. Similarly the row sum indicates the total effect of a sector on the economy when final demand increases by unity.

The $A_{ij's}$ are the technical coefficients indicating how much the output x_i of the i^{th} sector would increase if y_j, that is the quantity of good j absorbed by households (or any other final users), had been increased by one unit. If i=j then the increase would affect sector i both directly and indirectly but if $i \neq j$, it would affect the output x_i only indirectly. This is due to the fact that sector i has to provide additional inputs to all other sectors which in turn contribute to the increase in the delivery y_i made by sector j to the final users. The output of each sector depends on final demand for that sector and the output of all other sectors. Thus the magnitude of each coefficient A in the solution (6.4) depends on all the input coefficients a. The matrix:

$$\begin{bmatrix} A_{11} & A_{12} \cdots\cdots & A_{1n} \\ A_{21} & A_{22} \cdots\cdots & A_{2n} \\ \cdots\cdots\cdots & & \\ A_{n1} & A_{n2} \cdots\cdots & A_{nn} \end{bmatrix} \tag{6.7}$$

of constants appearing on the right-hand side of the solution (6.4) is identified as the inverse of the matrix:

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & \cdots\cdots & -a_{1n} \\ -a_{21} & (1-a_{22}) & \cdots & -a_{2n} \\ \cdots\cdots\cdots & & & \\ -a_{n1} & -a_{n2} & \cdots\cdots & (1-a_{mn}) \end{bmatrix} \tag{6.8}$$

of constants appearing on the left-hand side of (6.3). For there to exist a set of final deliveries, $y_1, y_2, \ldots\ldots, y_n$ with a combination of positive total outputs, $x_1, x_2, \ldots\ldots x_n$, all elements of the inverted matrix are nonnegative.

Several methodological approaches of in inter-industry linkage effects analysis have emerged over the years. Salimullah (1998) reviewed these approaches under two broad classifications; *Traditional* and *New Generation* approaches.

6.2: THE TRADITIONAL APPROACHES

These are based on the computation of backward and *forward linkage* coefficients by a formal production system of Leontief technology with competitive imports, using the balance condition between supply and demand of the total output described in matrix form as:

$$X + M = V + F + E \qquad (6.9)$$

where:

X= vector of sectoral output;

V= intermediate input demand vector consisting of domestic and imported intermediate commodities;

F=domestic final demand vector consisting of domestic output and imported final demand;

M= imports vector; and

E=exports vector exclusively consisting of domestic output.

Two fundamental assumptions of the elements of the Leontief Inverse matrix compromise of:

1. Constant input coefficients: V=AX, and

2. Constant import coefficients: $\mathrm{M} = \hat{\mu}(\mathrm{AX} + F)$

where:

A=flows coefficient matrix

$\hat{\mu}$= diagonal matrix of sectoral import ratios

Substituting the values of V and M into equation (6.9) and solving gives:

$$\mathrm{X} = \mathrm{AX} + F - \hat{\mu}(\mathrm{AX} + F) + \mathrm{E} = (\mathrm{I} - \hat{\mu})(\mathrm{AX} + F) + \mathrm{E}$$

$$= (\mathrm{I} - \hat{\mu})\mathrm{AX} + (\mathrm{I} - \hat{\mu})F + \mathrm{E} \qquad (6.10)$$

$$\therefore \left[\mathrm{I} - (\mathrm{I} - \hat{\mu})A\right]\mathrm{X} = (\mathrm{I} - \hat{\mu})F + \mathrm{E}$$

By assuming that the matrix $\left[\mathrm{I} - (\mathrm{I} - \hat{\mu})A\right]$ is non-singular and solving (6.10) yields:

$$X=\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right] \tag{6.11}$$

Substituting the value of *X* into equation (6.9) and solving gives:

$$M=\hat{\mu}A\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E+\hat{\mu}F\right] \tag{6.12}$$

Considering that the total output, represented by equation (6.11) comprises of domestic inputs, imported inputs and cost of labour and capital inputs, and since the *X's* and *M's* are measured in terms of monetary values (rather than physical quantities), equation (6.11) can be decomposed into three additive components thus:

$$X=\left[\left\{\left(I-\hat{\mu}\right)A+\hat{\mu}A(I-A)\right\}\right]\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]$$
$$=(I-\hat{\mu})A\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]+\hat{\mu}A\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]$$
$$+(I-A)\left[I-(I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]$$

= Cost of domestic inputs vector + Cost of imported inputs Vector +Cost of labour and capital inputs (i.e. value-added) vector

where:

Cost of domestic inputs vector $=(I-\hat{\mu})A\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]$;

Cost of imported inputs vector $=\hat{\mu}A\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]$; and

Cost of labour and capital inputs (i.e. value-added) vector

$$=\quad(I-A)\left[I-(I-\hat{\mu})A\right]^{-1}\left[(I-\hat{\mu})F+E\right]$$

The Leontief inverse matrix $\left\{I-(I-\hat{\mu})A\right\}^{-1}$, which is a component of equation (6.12) is a typical element of the Leontief System as a_{ij} in (6.1) and it can similarly be interpreted as the increase in the output in industry *i*, for per unit increase in the final demand for the product of industry *j*. Denoting R_{ij} as the element of the Leontief inverse, the power of dispersion, which means the backward linkage (Rasmussen, 1957) is defined as:

$$U_j = \frac{\frac{1}{n}\sum_i R_{ij}}{\frac{1}{n^2}\sum_i \sum_j R_{ij}} \qquad (6.13)$$

where $\sum_i R_{ij}$ is the sum of column elements and is to be interpreted as the total increase in the output (direct and indirect) from the whole system that is required to cope with an increase in the final demand for the product of industry *j* by one unit. Similarly, an index of forward linkage (Rasmussen's sensitivity of dispersion) is defined as:

$$U_i = \frac{\frac{1}{n}\sum_j R_{ij}}{\frac{1}{n^2}\sum_i \sum_j R_{ij}} \qquad (6.14)$$

where $\sum_j R_{ij}$ is the increase in output of industry *i*, needed to match a unit increase in the final demand of all industries. The overall averages are given by:

$$\frac{1}{n^2}\sum_i \sum_j R_{ij}$$

(i, j= 1, 2...n)

The average $\frac{1}{n}\sum_i R_{ij}$ illustrates the input requirement of a particular industry; say *j* so it follows that $U_j > 1$ indicates that the industry draws more heavily than average on the other industries and vice versa for $U_j < 1$. This analogy also holds for $U_i > 1$ and vice versa for $U_i < 1$.

To ensure that sensitivity to extreme values do not lead to misleading results, a measure of variability is measured by the coefficient of variation:

$$V_j = \frac{\sqrt{\frac{1}{(n-1)}\sum_i (R_{ij} - \frac{1}{n}\sum_i R_{ij})^2}}{\frac{1}{n}\sum_i R_{ij}} \qquad (6.15)$$

$$V_i = \frac{\sqrt{\frac{1}{(n-1)}\sum_j (R_{ij} - \frac{1}{n}\sum_j R_{ij})^2}}{\frac{1}{n}\sum_j R_{ij}} \qquad (6.16)$$

A high V_j means that a particular industry draws heavily from some specific industries/sectors of the system and a low V_j means that an industry draws evenly from other sectors. V_i is interpreted as an index showing to what extent the system of industries draws evenly on industry *i*; that is whether there is high concentration on few industries.

Thus instead of dwelling on matrix *R*, matrices *(R-I)* and $(R-\hat{R})$ should be given appropriate analytical significance, where *I* is an identity matrix and $\hat{R}$ is the diagonised matrix of *R*. The matrix *R* measures the power of dispersion (backward linkages), *(R-I)* measures the sensitivity of dispersion (forward linkages) while $(R-\hat{R})$ measures the coefficient of variation for the indices. Chenery and Watanabe (1958) measured backward linkage (U_j) by the ratio of purchased inputs to the value of total production and forward linkage (W_i) by the ratio of total supplies of intermediate inputs to total demand (i.e. total demand equals total production plus total competitive imports) excluding indirect effects as follows:

$$U_j = \frac{\sum_i X_{ij}}{X_j} \qquad (6.17)$$

$$W_i = \frac{\sum_j X_{ij}}{X_i + M_i} \qquad (6.18)$$

Jones (1976) identified three deficiencies of the Chenery and Watanabe indices; double counting of causal linkages; neglect of indirect impact; and failure to distinguish domestic effects from foreign economy effects. Yotopoulos and Nugent (1973 and 1976), in response to these deficiencies especially lack of indirect impact, developed the total linkage index to cover the higher order effects (ie both direct and indirect effects) that derive from the expansion of the activities which provide inputs to the non-primary activity that induces the backward linkage. The total linkage effects *(TLE)* is given by:

$$L_{Tj} = \sum a^*_{ij} \tag{6.19}$$

where $a^*_{ij} = (\mathrm{I} - a_{ij})^{-1}$, a_{ij} is the input-output coefficient matrix, I is the identity matrix and $(\mathrm{I} - a_{ij})^{-1}$ is the Leontief inverse matrix. The total linkage effects of Yotopoulos and Nugent is the same as the direct and indirect output multipliers used in the numerator of the Rasmussen backward linkage index in equation (6.13) and also the sectoral rankings provided by equation (6.13) and (6.19) are the same (Salimullah, 1998, 53). In essence the total linkage effects are similar to the backward linkage effects.

By the Hirschman-Compliance Index *(HCI)*, an effective strategy of generating economic growth should be based on identifying and emphasising on high linkage industries. This strategy will lead to the attainment of higher overall rate of economic growth. Studies and test hypothesis conducted by Yotopoulos and Nugent based on hypothesis testing of the Hirschman-Compliance Index revealed that there could be an optimum level of growth of an economy that corresponds to an optimal level of emphasis on high linkage industries, beyond which the economy would deviate from a balanced growth path. They proposed that a balanced overall rate of growth of an economy can be achieved based on:

$$V = \frac{1}{G}\sqrt{\sum_{i}^{n} W_i (g_i - G)^2} \tag{6.20}$$

where $G = \sum_{i}^{n} W_i g_i$ = average rate of growth of an economy over a given period

g_i = growth rate of sector i

W_i = the share of sector i

Nurkse (1953) advanced a variant of the notion of balanced growth that takes into account the income elasticity of demand. An increase in consumable output must progress along an expansion path determined by the income elasticity of demand for the products of the sectors of the economy. The index of variability that corresponds to the elasticity mode can be defined (Yotoupolos and Lau, 1970) by modifying (6.20) into:

$$V = \frac{1}{G}\sqrt{\sum_{i}^{n} W_i (g_i - \varepsilon_i G)^2} \qquad (6.21)$$

where ε_i is the total income elasticity of demand for sector i's output.

The optimum degree of imbalance reflecting on the sectoral linkage index give rise to different growth rates of sectors of the economy. The balanced growth version of the linkage hypothesis predicts that linkage-balanced countries should, over a long period, grow faster than linkage unbalanced countries.

The measure of sectoral imbalance was modified by Yotopoulos and Nugent as[48]

$$V_{Li} = \frac{1}{G_i}\sqrt{\frac{1}{n}\sum_{j=1}^{n} W_{ij} (g_{ij} - L_{Tj} G_i)^2} \qquad (6.22)$$

where n is the number of sectors, W_{ij} and g_{ij} are the relative importance (i.e. the sectoral value added over GDP) and sectoral growth rates of sector j in country 1 respectively, L_{Tj} is the total linkage of the sector j and G_i is the overall growth rate of the economy.

In order to account for differences in income elasticities of demand (ε_j) between sectors, further adjustments can be made to obtain:

$$V_{Li} = \frac{1}{G_i}\sqrt{\frac{1}{n}\sum_{j=1}^{n} W_{ij} (g_{ij} - \varepsilon_j L_{Tj} G_i)^2} \qquad (6.23)$$

[48] This modification used the measure employed by Yotopoulos and Lau in testing the von Neumann and Nurkse versions of the theory of balanced growth (Solow and Samuelson, 1953, Nurkse, 1953).

which also measure the extent to which a country departs from the balanced growth path based on the balanced growth version of the linkage hypothesis. A high V_{Li} index for a country indicates a deviation from the optimum linkage weighted growth proportions.

The Rasmussen matrix of technical coefficients (i.e. intermediate inputs as a share of total inputs including value added) has been perceived as having conceptual drawbacks (Jones, 1976, Bulmer-Thomas, 1982), as such an output approach based on the use of output coefficients (i.e. intermediate sales as a share of total sales including final demand) was developed. Based on the pioneering work of Augustinovics (1970) involving the use of a method of structural analysis that is symmetrical to the input approach, the output approach emerged as an alternative method of measuring linkage effects. Consider the following:

Z= intermediate input flow matrix $(n \times n)$

X= total output flow vector $(n \times 1)$

$\hat{X}$ =diagonised matrix $(n \times n)$ whose diagonal elements are those of the X matrix

I= identity matrix

i= unity column vector

$B = \hat{X}^{-1} Z$ (output coefficient matrix)

$B^* = (I - B)^{-1}$ (output inverse)

$X' = i'Z + V' = X'B + V'$

Hence $X' = V'(I - B)^{-1} = V'B^*$ can be written in full as:

$$X_1 = v_1 b^*_{11} + v_2 b^*_{21} + \ldots\ldots + v_n b^*_{n1}$$
$$X_2 = v_1 b^*_{12} + v_2 b^*_{22} + \ldots\ldots. + v_n b^*_{n2}$$
$$X_n = v_1 b^*_{1n} + v_2 b^*_{2n} + \ldots\ldots. + v_n b^*_{nn}$$

An increase in the value-added of the i^{th} sector, say by unity, will induce a chain of (forward) linkages throughout the economy as the using sectors respond to the stimulus, given the assumption of fixed output proportion. The total increase in output for the entire economic system is given by $\sum_j b^*_{ij}$, i.e. the row sum of B^* matrix. This can be normalised as a measure of the forward linkage effect for sector i and the index becomes:

$$U_i^* = \frac{\frac{1}{n}\sum_j b_{ij}^*}{\left(\frac{1}{n}\right)^2 \sum_i \sum_j b_{ij}^*} \tag{6.24}$$

and the coefficient of variation becomes:

$$V_i^* = \frac{\sqrt{\frac{1}{(n-1)}\sum\left(b_{ij}^* - \frac{1}{n}\sum b_{ij}^* \right)^2}}{\frac{1}{n}\sum_j b_{ij}^*} \tag{6.25}$$

The measurement index U_i^* differs from the Rasmussen index, U_i. U_i^* measures the forward linkage effect as the increase in output of all using industries rather than as the increase in output of the (one) supplying industry, which is more consistent with the original conception of forward linkages as espoused by Hirschman (1958). Furthermore the U_i^* index tends to unravel the process of causality through cummulative impact of forward iteration $(1 + B + B^3 + ...)$, showing that output expands first in sector i to meet the unit increase in the value added product for sector i; the expansion of output is distributed to using sectors $\left(\sum_j^n b_{ij}\right)$; the increase in output of these sectors are then made available to other sectors $\left(B^2\right)$, and so on and so on.

6.3: SECOND GENERATION APPROACHES

6.3.1: The Hypothetical Extraction Method

It is derived from Schultz (1977) definition of total linkage, which is consistent with Strassert (1968). This approach aims at identifying key sectors without evaluating backward and forward linkages. To measure the significance of different industries, Schultz uses improved quantitative magnitudes that included the sectoral deliveries to final demand. This method comprise of suppressing the column and the row of an identified j^{th} industry from the input-output coefficient matrix to obtain a reduced matrix of order *n-1*. The actual production levels of the reduced matrix are then evaluated to establish a hypothetical level of linkage effects and output performance using the Leontief inverse. The difference between the full and reduced matrix (which is expected to be non-negative) is then used as a measure of the total effects of industry *j* on the rest of the economy. The Schultz index can be mathematically illustrated as follows:

$$S_c = \frac{\sum_{i=1, \neq j} (X_i - X_j^*)}{X_j - F_j} \tag{6.26}$$

where:

$X_j^* = C_j^* F_j^*$

X_i = Gross production of sector *i*;

C_j^* = Inverse of the reduced matrix after elimination of the extracted sector *j*;

F_j^* = Final demand vector as shortened by omission of the extracted sector *j*;

X_j = Gross production of the extracted sector;

F_j = Final demand of the extracted sector.

The S_c indicator (6.26) is defined by the ratio of net effects on other sectors, $\sum_{i=1, \neq j} (X_i - X_j^*)$ and the intermediate deliveries of the extracted sector, $X_j - F_j$.

If the S_c indicator is less than one ($S_c < 1$) it means the extracted sector is dependent on impulses of the other sectors, and the extracted sector is stimulating if the S_c is greater than one ($S_c > 1$). Thus key sectors are expected to have large S_c indicator.

Employment linkages can be identified and used as a basis for determining key sectors instead of production linkages (Meller and Marfa'a, 1981). Identifying key sectors for employment generation could be useful in providing insights into the investment incentives that are needed to stimulate high employment linkage sectors, given the level of technical and economic efficiency. The usually low-labour absorption problem associated with developing countries can be appropriately diagnosed using the instrument of linkage index. An output sector, say *j*, is removed and replaced by imports so that the sector would not have any backward and forward linkages with other sectors. This will lead to a diminishing effect of the remaining due to reduced level of domestic input being bought and sold as a result of the removal of sector *j*, which will also affect employments that are related to the activities of sector *j*. The multiplier effects of the economy will also reduce. The total reduction in employment due to removal of a sector provides the total backward and foward linkage of the removed sector *j* and the forward employment linkage are then calculated as the difference between the total employment and backward employment linkage.

Consider $TL_j = L'(I-A)^{-1}i - L_j*'(I-A_j*)^{-1}i$

where:

A = technological matrix of $(n \times n)$;

A_j* = Technological matrix of $((n-1)\times(n-1))$ obtained by removing from matrix A the row and column of a given sector *j*;

$L =$ direct labour coefficient vector $(n \times n)$;

L_j* = direct labour coefficient vector $((n-1)\times 1)$ obtained by extracting the j^{th} element of vector *L*;

i = sum vector formed by ones.

TL_j can be interpreted as the sum of backward and forward linkages of the j^{th} sector.

$$TL_j = BL_j + FL_j$$

where BL_j corresponds to the j^{th} element of the vector given by $L'(I-A)^{-1}$, and FL_j is the difference between TL_j and BL_j.

A zero forward linkage for a particular sector indicates that the sector does not deliver any output to intermediate demand while a small backward linkage imply that the sector does not relatively draw output from other sectors. Backward linkage coefficients are obtained by scaling down simple average of all industries backward linkage effects and computing the relative value of each sector. To enhance the distinctive essence of backward and forward linkages and to appropriately capture the extent of total linkage effects, Cella (1984) provided an alternative approach that does not require suppressing the sector of interest. This method is based on the difference between the existing output X, and the adjusted output, $\bar{X}$ calculated by assuming no intermediate transaction of the extracted sector with other sectors of the economy. Using the technique of matrix partitioning, the sector of interest is partitioned into backward and forward linkage components.

Denote 1 as the focused sector of interest (or group of sectors) and 2 as the remaining sectors of the economy, then the structural form of equations for a standard (closed economy) Leontief model is:

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \times \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \qquad (6.27)$$

where A is the Leontief technology matrix, X is the vector of output and F is the vector of exogenous (final) demand. Equation (6.27) can be solved to obtain:

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} I-A_{11} & -A_{12} \\ -A_{21} & I-A_{22} \end{bmatrix}^{-1} \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \qquad (6.28)$$

Substituting $\begin{bmatrix} I-A_{11} & -A_{12} \\ -A_{21} & I-A_{22} \end{bmatrix}^{-1} = \begin{bmatrix} P & Q \\ R & S \end{bmatrix}$ into (6.28) will yield:

$$\begin{bmatrix} X_1 \\ \\ X_2 \end{bmatrix} = \begin{bmatrix} P & Q \\ \\ R & S \end{bmatrix} \begin{bmatrix} F_1 \\ \\ F_2 \end{bmatrix}$$

Since $AA^{-1} = I$, then

$$\begin{bmatrix} I - A_{11} & -A_{12} \\ \\ -A_{21} & I - A_{22} \end{bmatrix} \times \begin{bmatrix} P & Q \\ \\ R & S \end{bmatrix} = \begin{bmatrix} I & 0 \\ \\ 0 & I \end{bmatrix} \qquad (6.29)$$

Four equations are obtained from the partitioned product of (6.29) as follows:

$$(I - A_{11})P - A_{12}R = I \qquad (6.30a)$$

$$(I - A_{11})Q - A_{12}S = 0 \qquad (6.30b)$$

$$-A_{21}P + (I - A_{22})R = 0 \qquad (6.30c)$$

$$-A_{21}Q + (I - A_{22})S = I \qquad (6.30d)$$

From (6.30c), $R = (I - A_{22})^{-1} A_{21} P$ (6.31)

and from (6.30a), $(I - A_{11})P = I + A_{12}R$ (6.32)

Substitute the value of R in (6.31) into (6.32) to get:

$$(I - A_{11})P = I + A_{12}(I - A_{22})^{-1} A_{21} P$$

or

$$(I - A_{11})P - A_{12}(I - A_{22})^{-1} A_{21} P = I$$

or

$$P = \left\{ I - A_{11} - A_{12}(I - A_{22})^{-1} A_{21} \right\}^{-1} \qquad (6.33)$$

Substitute P from (6.33) into (6.31) to obtain:

$$R = (I - A_{22})^{-1} A_{21} \left\{ I - A_{11} - A_{12}(I - A_{22})^{-1} A_{21} \right\}^{-1} \qquad (6.34)$$

From (6.30c), $S = (I - A_{22})^{-1} + (I - A_{22})^{-1} A_{21} Q$ (6.35)

and from (6.30b) $(I - A_{11})Q = A_{12}S$ (6.36)

Substitute (6.28) into (6.36) to get:

$$(I - A_{11})Q = A_{12} \left\{ (I - A_{22})^{-1} + (I - A_{22})^{-1} A_{21} Q \right\}$$

$$= A_{12}(I - A_{12}(I - A_{22})^{-1} + A_{12}(I - A_{22})^{-1} A_{21} Q$$

or

$$\left\{I - A_{11} - A_{12}(I - A_{22})^{-1}A_{21}\right\}Q = A_{12}(I - A_{22})^{-1}$$

or

$$Q = \left\{I - A_{11} - A_{12}(I - A_{22})^{-1}A_{21}\right\}^{-1} A_{12}(I - A_{22})^{-1} \tag{6.37}$$

Substitute (6.30a) into (6.35) to obtain:

$$\begin{aligned} S &= (I - A_{22})^{-1} + (I - A_{22})^{-1}A_{21}\left\{I - A_{11} - A_{12}(I - A_{22})^{-1}A_{21}\right\}^{-1} A_{12}(I - A_{22})^{-1} \\ &= (I - A_{22})^{-1}\left[I + A_{21}\left\{I - A_{11} - A_{12}(I - A_{22})^{-1}A_{12}(I - A_{22})^{-1}\right\}\right] \end{aligned} \tag{6.38}$$

Substituting the values of P, Q, R and S as obtained above leads to:

$$\begin{bmatrix} I - A_{11} & -A_{12} \\ -A_{21} & I - A_{22} \end{bmatrix}^{-1} = \begin{bmatrix} H & HA_{12}B_{22} \\ B_{22}A_{21}H & B_{22}(I + A_{21}HA_{12}B_{22}) \end{bmatrix} \tag{6.39}$$

where: $H = \left\{I - A_{11} - A_{12}(I - A_{22})^{-1}A_{21}\right\}^{-1}$; and $B_{22} = (I - A_{22})^{-1}$

Substitute (6.39) into (6.28) to get:

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} H & HA_{12}B_{22} \\ B_{22}A_{21}H & B_{22}(I + A_{21}HA_{12}B_{22} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \tag{6.40}$$

To measure the linkage capacity (by suppressing the sales to and purchases from other sectors of the economy, substituting $A_{12} = A_{21} = 0$ and equation (6.40) reduces to:

$$\begin{bmatrix} \hat{X}_1 \\ \hat{X}_2 \end{bmatrix} = \begin{bmatrix} (I - A_{11})^{-1} & 0 \\ 0 & (I - A_{22})^{-1} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \tag{6.41}$$

where the $\wedge$s on the output terms indicate that they have been computed on the assumption that the subject sector's inter-sectoral transactions have been suppressed. It is expected that:

$$\begin{bmatrix} X_1 \\ \\ X_2 \end{bmatrix} > \begin{bmatrix} \hat{X}_1 \\ \\ \hat{X}_2 \end{bmatrix}$$

If A_{12} and $A_{21} > 0$, Cella's measure of the total linkage for the subject sector 1 is:

$$TL_1 = i' \begin{bmatrix} X_1 - \hat{X}_1 \\ \\ X_2 - X_2 \end{bmatrix} \tag{6.42}$$

where i' is unit summation vector. Substitute equations (6.40) and (6.41) into (6.42) to obtain Cella's decomposition[49] of TL_1 into backward and forward components as:

$$\begin{aligned} TL_1 &= i'[H - B_{11} + B_{22}A_{21}H]F_1 \\ &+ i'[HA_{12}B_{22} + B_{22}A_{21}HA_{12}B_{22}]F_2 = BL + FL \end{aligned} \tag{6.43}$$

where; $B_{11} = (I - A_{11})^{-1}$ and for i =1, 2

Equation (6.42) is a definition of TL_1 in the form of its two decomposed components that are dependent on the technical coefficients in the full matrix A as well as on the vector of final demand of outputs F. Since H and B are non-singular matrices, then for non-zero F_1 and F_2, *BL=0*, if and only if $A_{21} = 0$ (meaning that there is no intermediate purchase by sector 1) and *FL=0*, if and only if, $A_{12} = 0$ (meaning no intermediate supply by sector 1).

Thus the hypothetical extraction method generates two components of backward linkage index; $i'(H + B_{22}A_{21}H)F_1$ which represents the total direct and indirect inputs required to support the final output F_1 of the sector; and $i'B_{11}F_1$, which is a subtraction from the first component and includes both final production F_1 and that share of sector 1 outputs that are purely due to internal transactions of the sector, meaning that they are independent of the purchases of sector 1 and cannot thus be regarded as having linkage

[49] See Cella (1984) for the details of this decomposition.

with sector 2. Also the forward linkage index of the hypothetical extraction method is decomposed into two components; $i'HA_{12}B_{22}F_2$ which is the gross output of sector 1 required to support the final output of sector 2; and $i'B_{22}A_{21}HA_{12}B_{22}F_2$ is the feedback of this gross output onto sector 2.

Cella's method of hypothetical extraction is not without limitations. Harrigan and McGilvary (1988) identified three weaknesses of Cella's method as; inability to measure the forward linkage in terms of the output of all industries; omission of internal linkage from the measure of total linkage and confusion arising from the division of total linkage into indices of backward and forward linkages in terms of their relation with direct effects of backward and forward linkages. Cella's approach was hinged on the assumption that total linkage depends only on the sources of stimulus to demand, which implies that the demand for the subject sector's output propagate the backward linkage and the demand for the remaining sector's output is the source of the forward linkage.

6.3.2: Hypothetical Addition Method

This was advanced by Harrigan and McGilvary in order to capture the effects of the internal linkage and the closed-loop linkage along with the backward and forward linkage of a focused sector. The method decomposes total linkage into four additive components; internal linkage; the backward linkage; the forward linkage; and the closed-loop linkage. The extended taxonomy of linkages is derived from Stone (1978), Pyatt and Round (1979) and Defourney and Thorbecke (1987). By adding, rather than extracting flows, a decomposition can be obtained in which internal feedback, backward and forward linkages are identified in a natural way. This method enables for the evaluation of the effects on the whole economy in terms of output, income employment etc. of activating the transactions of sector 1 rather than suppressing it. Deriving the linkage indices of the hypothetical addition method starts from the root system as follows:

$$\begin{bmatrix} 0 & 0 \\ 0 & A_{22} \end{bmatrix} \times \begin{bmatrix} 0 \\ \hat{X}_2 \end{bmatrix} + \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} F_1 \\ \hat{X}_2 \end{bmatrix}$$

Solving for the vector $\begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$ yields:

$$\begin{bmatrix} F_1 \\ \hat{X}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & (I-A_{22})^{-1} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 \\ 0 & (I-A_{22})^{-1} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 \\ 0 & (I-A_{22})^{-1} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} + \begin{bmatrix} F_1 \\ 0 \end{bmatrix}$$

Subtracting the vector $\begin{bmatrix} F_1 \\ 0 \end{bmatrix}$ from both sides and solving yields:

$$\begin{bmatrix} 0 \\ \hat{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & (I-A_{22})^{-1} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \tag{6.44}$$

Subtract (6.44) from (6.40) to get:

$$TL_1{*} = i' \begin{bmatrix} X_1 \\ X_2 - \hat{X}_2 \end{bmatrix}$$

$$= i' \begin{bmatrix} H & HA_{12}B_{22} \\ B_{22}A_{21}H & B_{22}A_{21}HA_{12}B_{22} \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} \tag{6.45}$$

The feedback mechanism is captured by the matrix: $\begin{bmatrix} H & HA_{12}B_{22} \\ B_{22}A_{21}H & B_{22}A_{21}HA_{12}B_{22} \end{bmatrix}$

This can be netted out by decomposing each element into internal-loop, open-loop and closed-loop elements as follows:

Given that $H = B_{11}(1 - A_{12}B_{22}A_{21}B_{11})^{-1}$

$$= B_{11}\left[1 + A_{12}B_{22}A_{21}B_{11}(1 - A_{12}B_{22}A_{21}B_{11})^{-1}\right]$$

$$= B_{11} + B_{11}A_{12}B_{22}A_{21}H \qquad (6.46)$$

where:

$B_{11} = (1 - A_{11})^{-1}$ = internal-loop matrix; and

$B_{11}A_{12}B_{22}A_{21}H$ = closed-loop matrix

Substituting $B_{11} = (1 - A_{11})^{-1} = 1 + A_{11}(1 - A_{11})^{-1} = 1 + A_{11}B_{11}$ into (6.46) yields:

$$H = 1 + A_{11}B_{11} + B_{11}A_{12}B_{22}A_{21}H \qquad (6.47)$$

which indicates that the internal-loop matrix is divided into initial injection and first and higher order effects of initial injection accounted by $A_{11}B_{11}$.

Decomposing the first element, H and rearranging (6.46) and (6.47) leads to the following equations:

$$\left.\begin{array}{l} H - B_{11} = B_{11}A_{12}B_{22}A_{21}H \\ H - 1 = A_{11}B_{11} + B_{11}A_{12}B_{22}A_{21}H \end{array}\right\} \qquad (6.48)$$

Partitioning the first element of the matrix produces the internal-loop and the close-loop/feedback effect as:

$$H = B_{11} + B_{11}A_{12}B_{22}A_{21}H$$

$$= B_{11} + (H - B_{11}) \qquad (6.49)$$

where

B_{11} = internal or transfer-loop multiplier component of internal linkage;

$H - B_{11}$ = a component of closed-loop linkage representing feedback effect.

After series of substitutions and manipulations[50], the final equation of the hypothetical addition method is:

$$TL_1{*} = \left[i'\{H + B_{22}A_{21}H\}F_1 + i'\{HA_{12}B_{22} + B_{22}A_{21}HA_{21}HA_{12}B_{22}\}F_2\right]$$

---

[50] Details of this derivation can be found in Salimullah (1998)

$$= [i' B_{11} F_1] + [i' B_{22} A_{21} F_1] + i' [A_{12} B_{22}] F_2$$
$$+ \left[i' \{ H - B_{11} + B_{22} A_{21} (H - I) \} F_1 + i' \{ (H - I) A_{12} B_{22} + B_{22} A_{21} H A_{12} B_{22} \} F_2 \right]$$

$$= IL_1 + BL_1 + FL_1 + CL_1 \qquad (6.50)$$

where:

$IL_1 = i' B_{11} F_1$ = internal linkage

$BL_1 = i' B_{22} A_{21} F_1$ = backward linkage

$FL_1 = i' A_{12} B_{22} F_2$ = forward linkage

$CL_1 = i' \{ H - B_{11} + B_{22} A_{21} (H - I) \} F_1 + i \{ (H - I) A_{12} B_{22} + B_{22} A_{21} H A_{12} B_{22} \} F_2$ =closed loop linkage

The hypothetical addition method generates backward linkage index that measures the direct and indirect increase in the output of sector 2 that results from the direct and indirect input demands required by sector 1 to provide a given level of final demand F_1. The forward linkage index measures the increase in output of sector 1 induced by the direct and indirect demand placed by sector 2 for a given level of final demand.

The internal and transfer linkage index measures the output of sector 1 generated by its demands for own output, having suppressed all feedback effects from sector 2. The closed loop linkage index is by construction, equal to the value of the addition to the output of the economy due to other activities of sector 1 not accounted for by backward, forward and internal linkages.

The closed-loop linkage index captures the following feedback mechanisms:

1. The feedback of sector 1's demands for sector 2 on the output of sector 2 generated by the final demand for sector 1, $Y_1 = B_{22} A_{21} (H - I)$.
2. The feedback of sector 1's demand on sector 1's own output generated by the final demand for sector 2, $Y_2 = (H - I) A_{12} B_{22}$.

3. The feedback of sector 1's demands on sector 2 on the output of sector 1 generated by the final demand for sector 1, $Y_1 : H - B_{11}$.
4. The feedback of sector 2's demands on sector 1 on the output of sector 2 generated by the final demand for sector 2, $Y_2 : B_{22}A_{21}HA_{12}B_{22}$.

Total flow coefficients matrix provides only the potential linkage indices but actual linkages which are computed from domestic flow coefficients (i.e. intermediate inputs net of imported intermediates), are more relevant for policy decisions.

6.4: TYPES 1 AND 2 MULTIPLIERS

The impact of inter-sectoral linkage effect is in the form of multiplicative-chain. The multiplier coefficient that determines the extent of the chain effects is categorized into two: *Type 1* and *Type 2.*

A *Type 1* multiplier is derived from direct and indirect changes in exogenous final demand when households are part of final demand while the *Type 2* multiplier is derived from indirect and induced changes in exogenous final demand when the household sector is part of the endogenous system of inter-dependence and final demand consisting of government spending, investment expenditure and foreign purchases (Bradly and Gander, 1969, Salimullah, 1988, 72).

The *Type 1* multiplier which represents the total requirements per unit of final demand is an indicator of the degree of structural interdependence between each sector and the rest of the economy. The *Type 2* multiplier takes into account the repurcussionary effect of secondary rounds of consumer spending in addition to the direct and indirect inter-industry effects.

An input-output model can be closed (with respect to households) by moving the household's row (i.e. income from employment) and column (i.e. household consumption or private consumption) into the transaction matrix to be regarded as another industrial sector. The induced effects of increased household spending generated as a result of the direct increase in output can then be calculated from the inverse of the $(I - A^*)$ matrix, where A^* is the A matrix enlarged by one sector, the households. The sum of the columns of the $(I - A^*)^{-1}$ matrix up to first n rows gives the total effect on output (i.e. direct and induced) of one unit increases in volume of sales by sector j to final demand.

In matrix notation

$$(I - A^*) = \begin{bmatrix} I - A & -K \\ & \\ -H & 1 - g \end{bmatrix} \qquad (6.51)$$

where:

A=input-output coefficient matrix of order *(n x n)*;

K= column vector of household consumption coefficients of order $(n \times 1)$;

H=row vector of household income coefficients of order *(1 x n)*;

and

G= intrahousehold consumption coefficient

Consider $(I - A^*)$ as partitioned in equation (6.29) and let

$$(I - A^*)^{-1} = \begin{bmatrix} P & Q \\ R & S \end{bmatrix} \qquad (6.52)$$

where P is an *(n x n)* matrix, R is a *(1x n)* row vector, Q is *(n x1)* column vector and S is a single element, then:

$$(I - A^*)(I - A^*)^{-1} = \begin{bmatrix} 1-A & -K \\ -H & 1-g \end{bmatrix} \times \begin{bmatrix} P & Q \\ R & S \end{bmatrix} = \begin{bmatrix} I & 0 \\ 0 & I \end{bmatrix} \qquad (6.53)$$

From the partitioned products four equations are obtained as:

$$(I - A)P - KR = I \qquad (6.54a)$$

$$-HP + (1-g)R = 0 \qquad (6.54b)$$

$$(I - A)Q - KS = 0 \qquad (6.54c)$$

$$-HQ + (1+g)S = I \qquad (6.54d)$$

Solving (6.54a) and (6.54b) yields:

$$P = (I - A)^{-1} + (I - A)^{-1} K \{1 - g - H(I - A)^{-1} K\}^{-1} H(I - A)^{-1}$$

and

$$R = \{1 - g - H(I - A)^{-1} K\}^{-1} H(I - A)^{-1}$$

Similarly, (6.54c) and (6.54d) can be solved to get:

$$Q = (I - A)^{-1} K \{1 - g - H(I - A)^{-1} K\}^{-1}$$

and

$$S = \{1 - g - H(I - A)^{-1} K\}^{-1}$$

Substitute the values of P, Q, R and S into (6.51) to obtain:

$$(I-A^*)^{-1} = \begin{bmatrix} (I-A)^{-1} + (I-A)^{-1}K\theta H(I-A)^{-1} & (I-A)^{-1}K\theta \\ \theta H(I-A)^{-1} & \theta \end{bmatrix} \tag{6.55}$$

where $\theta = \left\{1 - g - H(I-A)^{-1}K\right\}^{-1}$ = scalar constant showing economy-wide rounds effect on income generation for a unit change in consumption. Equation (6.55) indicates that if the Leontief inverse matrix, $(I-A)^{-1}$ is known then by using the partitioned matrix, the inverse of the enlarged matrix can be augmented by the household sector. Given these structural matrix forms, *Type 1* and *Type 2* output multipliers are:

Type 1 output multiplier *(T1OM)* $= i'(I-A)^{-1}$

Type 2 output multipliers *(T2OM)* $= i'\left[(I-A)^{-1} + (I-A)^{-1}K\theta H(I-A)^{-1}\right]$

$$= T1OM + i'(I-A)^{-1}K\theta H(I-A)^{-1}$$

$$= T1OM + \varphi\theta H(I-A)^{-1} \tag{6.56}$$

where i'=row vector of ones of order *(1 x n)*, $\varphi = i'(I-A)^{-1}K$ = a scalar constant showing economy-wide output generated for a unit change in consumption.

Type 2 output multiplier exceeds *Type 1* output multiplier by an amount $\varphi\theta H(I-A)^{-1}$. While the *Type 1* output multiplier is influenced by the value of direct intersectoral transaction coefficient matrix A, the *Type 2* output multiplier is determined by the direct and indirect payments to labour inputs purchased from household sector over *Type 1* output multiplier. Equation (6.56) indicates that the greater the payments to labour services, the higher the *Type 2* multiplier effect.

Type 1 income multipliers *(T1IM)* $= H(I-A)^{-1}\hat{H}^{-1}$

Where $\hat{H}^{-1}$ = diagonal matrix whose diagonal elements are the reciprocals of the elements of *H*.

Type 2 income multipliers *(T2IM)* $= \theta H(I-A)^{-1}\hat{H}^{-1} = \theta T1IM$

It shows that the *Type 2* income multiplier is a fixed multiple of the *Type1* income multiplier and both *Type 1* and *Type 2* multipliers are a direct function of payments to labour services (purchased) from the household sector. The smaller the value of direct payment, the greater the multiplier and vice versa.

Type 1 employment multipliers *(T1EM)* $= L(I-A)^{-1}\hat{L}^{-1}$

Where: L= row vector of employment output coefficients of order $(1\times n)$; and

$\hat{L}^{-1}$ = diagonal matrix with diagonal elements reciprocal of the elements of L

Type 2 employment multipliers *(T2EM)* $= LP\hat{L}^{-1}$

$$= L'(I-A)^{-1}\hat{L}^{-1} + L(I-A)^{-1}K\theta H(I-A)^{-1}\hat{L}^{-1}$$

$$= T1EM + \varphi\theta H(I-A)^{-1}\hat{L}^{-1} \qquad (6.57)$$

where $\varphi = L(I-A)^{-1}K$ is a scalar constant showing the direct and indirect effect on employment for a unit change in the basket of household consumption.

(6.57) indicates that the smaller the employment output ratio the bigger the *Type 2* multiplier and vice versa. The difference between *Type 2* and *Type 1* employment multipliers is equal to a constant multiple of *Type 1* income multiplier and wage rate which means that the impact of increased household spending on employment is influenced directly by *Type 1* income multiplier and wage rate.

If the Leontief inverse matrix $(I-A)^{-1}$, row vector of income coefficients H, column vector of household consumption coefficients K, and intrahousehold consumption coefficient g are given, then the *Type 1* and *Type 2* multipliers can be calculated. Analytical inspection reveals that:

- The *Type 2* multiplier is greater than the *Type 1* multiplier
- The difference between the numerator of *Type 2* and *Type 1* multipliers is a constant multiple of the numerator of the *Type 2* income multiplier.
- *Type 2* output multiplier respond positively to a high value of direct income output ratio while both the *Type 2* income and output multiplier respond negatively to high value of direct income output and employment-output ratios respectively.

Copeland and Henry (1975) consider the *Type 2* multiplier not as a multiplier *per se* but a coefficient of fully worked-out effects of an exogenous change to the direct effects on the sector where the change occurred. The significance of the *Type 1* output multiplier lies in the fact that it is used to determine sectoral linkages of output under various approaches. Also, by replacing unit row vector by income and employment row vectors, income and employment linkages can be derived from the *Type 1* output multiplier.

The use of the *Type 2* multipliers requires caution basically due to the fact that the household sector, the principal determinant of the *Type 2* multiplier, could be a source of leakages to the economic system. The household sector is a component of final demand and does not supply any of its output to final demand except in cases of intrahousehold consumption. The consumption expenditure of household purchases accounts for a major share of sectoral deliveries to final demand. As a unique supplier of labour services to different sectors of the economy it draws income from the other which constitutes industrial value added. There are additional sources of money for the household sector apart from direct income such as unemployment benefit, social securities, basket of consumer necessities at subsidised prices, charity and remittances from abroad. All these additional monies contribute to household spending but are not captured by the input-output framework. Furthermore, it is not all the total income received from selling of labour services and other sources that are used to buy domestically produced goods and services. There are leakages in the form of income-tax, payments to charities, investment and purchasing of directly imported goods. *The Type 2* output multiplier is useful in tracking the impact of increased household spending on output, which can be netted out by the direct and indirect income generated per unit of final demand delivery.

6.5: TRACKING THE GROWTH CONTRIBUTION OF A SECTOR

The structural transformation of sectors occurs in the process of industrial growth which reflects in the growth of the economy. Changes in industrial structure are regarded as deviations from the proportional growth (Chenery, 1960, Chenery, Shishido and Watanabe, 1962 and Cenery and Syrquin, 1977). The methodology developed, among others, by Kubo and Robinson (1984), Blair and Wyckoff (1989), as well as Albala-Bertrand (1996) can be used to track the relative contribution of a sector to the growth of the economy. While the methods of Kubo/Robinson and Albala-Bertrand are based on the decomposition of the total change in output between two periods, the Blair/Wyckoff's are based on the division of structural change in output into changes in the sectoral contribution to final demand and production recipe.

Kubo and Robinson (1984) illustrate the use of the static input-output model as a tool for disentangling the relative contribution of sectors to growth and structural change of different components of changes in final demand and intermediate structure. Sectoral output can be decomposed into four components thus:

- domestic demand growth;
- export expansion;
- import substitution; and
- change in input-output coefficients

This decomposition illuminates the basic characteristics of the process of industrialisation in relation to promotion of new industries, changes in industrial structure and economic performance. The balance condition between supply and demand of total output is described in vector form as:

$$X = AX - M + F + E$$

where

X= vector of domestic production;

$M = \hat{\mu}(AX + F)$ = vector of imports;

$\mu_i = \frac{M_i}{V_i + F_i}$ = import ratio of sector ***i;***

$\hat{\mu}$ = diagonal matrix of import ratios;

$V = AX$ = vector of intermediate deliveries (composite of domestic and imported inputs);

F= vector of domestic final demand;

E=vector of exports

The balance equation can be written in matrix form as:

$$X = \left[I - (I - \hat{\mu})A\right]^{-1}\left[(I - \hat{\mu})F + E\right] \qquad (6.58)$$

where $\hat{\mu}$ is a diagonal matrix of μ_i ratios, A is the matrix of technical input-output coefficients. The matrix $(I - \hat{\mu})A$ is the input-output coefficients matrix of domestically produced goods.

The matrix equation for domestic output, (6.58) can be partitioned into three additive components:

$$X = \left[I - (I - \hat{\mu})A\right]^{-1}\left[(I - \hat{\mu})F + E\right]$$

$$= \left[(I - \hat{\mu})A + \hat{\mu}A + (I - A)\right]\left[I - (I - \hat{\mu})A\right]^{-1}\left[(I - \hat{\mu})F + E\right]$$

$$= \left[(I - \hat{\mu})A\right]\left[I - (I - \hat{\mu})A\right]^{-1}\left[(I - \hat{\mu})F + E\right] + \hat{\mu}A\left[I - (I - \hat{\mu})A\right]^{-1} \qquad (6.59)$$

= cost of intermediate inputs from domestic output + cost of imported inputs + cost of labour and capital inputs (i.e. value added).

The three components of (6.59) can be estimated separately to determine and compare the per unit requirement of each component in two different years to track the changes in domestic and imported input per unit of output at constant prices. This provides indications for adaptation to improved technology in the production sectors of the economy. The level of technological change that has been brought to bear on the productive sectors of the economy is expected to reflect on the change in value added. A positive change in value added per unit of labour between two different years indicates a positive change in technology.

Define changes in variable by $\Delta(\Delta X = X_2 - X_1)$, change in total domestic demand is

$$\Delta X = X_2 - X_1$$

(6.60)

Substitute $X_2 = \left[I - (I - \hat{\mu}_2)A_2\right]^{-1}\left[(I - \hat{\mu}_2)F_2 + E_2\right]$ into (6.60) to get:

$$\Delta X = \left[I - (I - \hat{\mu}_2)A_2\right]^{-1}\left[(I - \hat{\mu}_2)F_2 + E_2\right] - X_1 \tag{6.61}$$

Therefore: $(I - \hat{\mu}_2)F_2 + E_2 = (I - \hat{\mu}_2)F_2 - (I - \hat{\mu}_2)F_1 + (E_2 - E_1) + (I - \hat{\mu}_2)F_1 + E_1$

$$= (I - \hat{\mu}_2)(F_2 - F_1) + (E_2 - E_1) + (I - \hat{\mu}_2)F_1 \\ -(I - \hat{\mu}_1)F_1 + (I - \hat{\mu}_1)F_1 + E_1 \tag{6.62}$$

Substitute $(F_2 - F_1) = \Delta F$ and $(E_2 - E_1) = \Delta E$ into (6.62) to get:

$$(I - \hat{\mu}_2)F_2 + E_2 = (I - \hat{\mu}_2)\Delta F + \Delta E + \left\{(I - \hat{\mu}_2) - (I - \hat{\mu}_1)\right\}F_1 + \left\{(I - \hat{\mu}_1)F_1 + E_1\right\}$$

$$= (I - \hat{\mu}_2)\Delta F + \Delta E + \left\{(I - \hat{\mu}_2) - (I - \hat{\mu}_1)\right\}F_1$$

$$+\left[I - (-\hat{\mu}_1)A_1\right]\left[I - (I - \hat{\mu}_1)A_1\right]^{-1}\left\{(I - \hat{\mu}_1)F_1 + E_1\right\}$$

$$= (I - \hat{\mu}_2)\Delta F + \Delta E + \left\{(I - \hat{\mu}_2) - (I - \hat{\mu}_1)\right\}F_1 + \left[I - (I - \hat{\mu}_1)A_1\right]X_1$$

$$= (I - \hat{\mu}_2)\Delta F + \Delta E + \left\{(I - \hat{\mu}_2) - (I - \hat{\mu}_1)\right\}F_1$$

$$+\left[(I - \hat{\mu}_2)A_1 - (I - \hat{\mu}_1)A_1 + 1 - (I - \hat{\mu}_2)A_1\right]X_1$$

$$= (I - \hat{\mu}_2)\Delta F + \Delta E + \left\{(I - \hat{\mu}_2) - (I - \hat{\mu}_1)\right\}F_1$$

$$+\left\{(I - \hat{\mu}_2) - (I - \hat{\mu}_1)\right\}A_1X_1 + \left\{1 - (I - \hat{\mu}_2)A_1\right\}X_1$$

$$=(I-\hat{\mu}_2)\Delta F+\Delta E+\left\{(I-\hat{\mu}_2)-(I-\hat{\mu}_1)\right\}(F_1+A_1X_1)+\left\{(I-\hat{\mu}_2)A_1\right\}X_1$$

$$=(I-\hat{\mu}_2)\Delta F+\Delta E+\left\{(I-\hat{\mu}_2)-(I-\hat{\mu}_1)\right\}(F_1+A_1X_1)$$

$$+\left\{1-(I-\hat{\mu}_2)A_1+(I-\hat{\mu}_2)A_2-(I-\hat{\mu}_2)A_2\right\}X_1$$

$$=(I-\hat{\mu}_2)\Delta F+\Delta E+\left\{(I-\hat{\mu}_2)-(I-\hat{\mu}_1)\right\}(F_1+A_1X_1)$$

$$+\left[(I-\hat{\mu})(A_2-A_1)+\left\{I-(I-\hat{\mu}_2)A_2\right\}\right]X_1 \tag{6.63}$$

Substitute $(A_2-A_1)=\Delta A$ and $A_1X_1=V_1$ in (6.63) to get:

$$(I-\hat{\mu}_2)F_2+E_2=(I-\hat{\mu}_2)\Delta F+\Delta E$$

$$+\left\{(I-\hat{\mu}_2)-(I-\hat{\mu}_1)\right\}(F_1+V_1) \tag{6.64}$$

$$+\left[(I-\hat{\mu})\Delta A+\left\{I-(I-\hat{\mu}_2)A_2\right\}\right]X_1$$

Multiply both sides of equation (6.64) to get:

$$\left[I-(I-\hat{\mu}_2)A_2\right]^{-1}\left[(I-\hat{\mu}_2)F_2+E_2\right]$$

$$=\left[I-(I-\hat{\mu}_2)A_2\right]^{-1}\left[(I-\hat{\mu})\Delta F+\Delta E\right]$$

$$+\left[I-(I-\hat{\mu}_2)A_2\right]^{-1}\left\{(I-\hat{\mu}_2)-(I-\hat{\mu}_1)\right\}(F_1+V_1)$$

$$+\left[I-(I-\hat{\mu}_2)A_2\right]^{-1}\left[(I-\hat{\mu}_2)\Delta AX_1\right]$$

$$+\left[I-(I-\hat{\mu}_2)A_2\right]^{-1}\left[\left\{I-(I-\hat{\mu}_2)A_2\right\}\right]X_1$$

$$=R_2(I-\hat{\mu}_2)\Delta F+R_2\Delta E+R_2\left\{(I-\hat{\mu}_2)-(I-\hat{\mu}_1)\right\}(F_1+V_1)$$

$$+R_2\left[(I-\hat{\mu}_2)\Delta AX_1+X_1\right]$$

where $R_2 = \left[I - (I - \hat{\mu}_2)A_2 \right]^{-1}$. It follows that:

$$\left[I - (I - \hat{\mu}_2)A_2 \right]^{-1} \left[(I - \hat{\mu}_2)F_2 + E_2 \right] - X_1$$
$$= R_2(I - \hat{\mu}_2)\Delta F + R_2\Delta E + R_2\left\{ (I - \hat{\mu}_2) - (I - \hat{\mu}_1) \right\}(F_1 + V_1) \quad (6.65)$$
$$+ R_2(I - \hat{\mu}_2)\Delta A X_1 + X_1$$

Substitute the value of $\left[I - (I - \hat{\mu}_2)A_2 \right]^{-1} \left[(I - \hat{\mu}_2)F_2 + E_2 \right] - X_1$ as obtained in equation (6.61) to get:

$$\Delta X = R_2(I - \hat{\mu}_2)\Delta F + R_2\Delta E$$
$$+ R_2\left\{ (I - \hat{\mu}_2) - (I - \hat{\mu}_1) \right\}(F_1 + V_1) + R_2(I - \hat{\mu}_2)\Delta A X_1 \quad (6.66)$$

where: $R_2(I - \hat{\mu}_2)\Delta F$ = domestic demand expansion

$R_2\Delta E$ = export expansion

$R_2(I - \hat{\mu}_2)\Delta A X_1$ = change in input coefficients;

$V_1 = A_1 X_1$

(6.66) is based on terminal year structural coefficients and the initial year volume weights but can also be derived using initial year structural coefficients and terminal year volume weight:

$$\Delta X = X_2 - X_1$$
$$= R_1\left[(I - \hat{\mu}_1)\Delta F + \Delta E + \left\{ (I - \hat{\mu}_2) - (I - \hat{\mu}_1) \right\}\{F_2 + V_2\} + (I - \hat{\mu}_1)\Delta A X_2 \right]^1 \quad (6.67)$$

where $R_1 = \left[I - (I - \hat{\mu}_1)A_1 \right]^{-1}$

The following deductions can be made from the above decomposition:

- Changes in the ratio of imports to total demand give rise to import substitution. This implies that imports may not be perfect substitutes for domestic goods (because the source of supply constitutes an integral part of economic structure), which differs from the conception (Chenery *et al*, 1962) that considers imports as perfect substitutes for domestic goods and lumped together without distinction in final and intermediate demand and hence the input-output material balance equation.

- The effect of changes in input-output coefficients includes changes in the total coefficients and does not separately distinguish between imported and domestically produced goods.

- Each term in the decomposition is multiplied by elements of the Leontief domestic inverse, which captures both the direct and indirect impact of each causal factor on gross output, taking into account the linkages through induced intermediate demand.

- There is an index number problem implicit in the decomposition equation because the decomposition equation is defined either using terminal year structural coefficients and the initial year volume weights or using the initial year structural coefficients and the terminal year volume weights. The two versions are analogous to Paasche and Laspeyres price indices respectively.

Industrial growth can be tracked by another approach based on a "factor decomposition model" (Torri and Fukasaku, 1984) by decomposing changes in industrial output rather than deviations from the proportional growth as in the Chenery approach. Total change is decomposed into effect of changes in domestic final demand ***(FDE)***; effect of changes in export **(E-effect)**; effect of changes in import coefficient of intermediate demand ***(IDE)*** and effect of changes in input coefficients **(A-effects)**.

The basic consideration would be the final demand effect ***(FDE)*** and the intermediate demand effect ***(IDE)***. ***FDE*** is estimated as the difference in output required (direct and indirect) to produce the actual final expenditure between two different years given constant structures and technology (or input coefficients). The ***IDE*** is estimated as the difference in output required (direct and indirect) to produce the final expenditure/output) of a given year with a changing structure and technology (or the input coefficients) between two different years.

Total Change = $X_t - X_{t-1}$

$$
\begin{aligned}
&= \left[I - (I - \hat{\mu}_t) A_t \right]^{-1} \left[(I - \hat{\mu}_t) F_t + E_t \right] - \left[I - (I - \hat{\mu}_{t-1}) \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_{t-1} + E_{t-1} \right] \\
&= \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right] \left[(I - \hat{\mu}_t) F_t + E_t \right] - \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_{t-1} + E_{t-1} \right] \\
&+ \left[I - (I - \hat{\mu}_t) A_t \right]^{-1} \left[(I - \hat{\mu}_t) F_t + E_t \right] \\
&- \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right]^{-1} \left[(I - \hat{\mu}) F_t + E_t \right] = FDE + IDE
\end{aligned}
\tag{6.68}
$$

where :

$$
FDE = \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right]^{-1} \left[(I - \hat{\mu}_t) F_t + E_t \right] - \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_t + E_t \right]
$$

Equation (6.68) can be written by changing structural coefficients for ***FDE*** from the initial year to the terminal year and volume weights for IDE from the terminal year to the initial year as follows:

$$
FDE = \left[I - (I - \hat{\mu}_t) A_t \right]^{-1} \left[(I - \hat{\mu}_t) F_t + E_t \right] \quad IDE = \left[I - (I - \hat{\mu}_t) A_t \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_{t-1} + E_{t-1} \right]
$$

$$
- \left[I - (I - \hat{\mu}_t) A_t \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_{t-1} + E_{t-1} \right] \quad - \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_{t-1} + E_{t-1} \right]
$$

To avoid index number problem, the Kubo and Robinson procedure can be used to obtain the averages of ***FDE*** and ***IDE*** as follows:

$$
FDE = \frac{X_1 + X_{01}}{2} - \frac{X_{10} + X_0}{2}
$$

$$IDE = \frac{X_1 + X_{10}}{2} - \frac{X_{01} + X_0}{2}$$

where: $X_{01} = \left[I - (I - \hat{\mu}_{t-1}) A_{t-1} \right]^{-1} \left[(I - \hat{\mu}_t) F_t + E_t \right]$;

$$X_{10} = \left[I - (I - \hat{\mu}_t) A_t \right]^{-1} \left[(I - \hat{\mu}_{t-1}) F_{t-1} + E_{t-1;} \right]$$

$X_1 = X_t$; and $X_0 = X_{t-1}$

Following Albala-Bertrand (1996), the final demand effect can be further decomposed into domestic demand expansion, import substitution of final goods and export demand effects, and intermediate demand effect into import substitution of intermediate goods and input-output coefficient effects, which makes the composition of total change into five additive components thus:

$$\text{Total Change} = B_t \Delta U F_{t-1} + B_t U_t \Delta F + B_t \Delta E + B_t \Delta U A_{t-1} X_{t-1} + B_t U_t \Delta A X_{t-1} \qquad (6.69)$$

where:

$B_t = \left[I - (I - \hat{\mu}_t) A_t \right]^{-1}$; $U_t = (I - \hat{\mu}_t)$; $U_{t-1} = (I - \hat{\mu}_{t-1})$; $\Delta F = F_t - F_{t-1}$;

$\Delta E = E_t - E_{t-1}$; $\Delta U = U_t - U_{t-1}$; *and* $\Delta A = A_t - A_{t-1}$

It is possible to track and compute the sources of growth in value added, imports and employment by extending the growth decomposition model. Import growth is obtained directly by taking the first difference of import equation, $M = \hat{\mu}(AX + F)$, and substituting the output formula appropriately such that:

$$\Delta M = M_2 - M_1 = \hat{\mu}_2 (A_2 X_2 + F_2) - \hat{\mu}_1 (A_1 X_1 + F_1)$$

$$= \hat{\mu}_2 A_2 (X_2 - X_1) + (\hat{\mu}_2 A_2 - \hat{\mu} A_1) X_1 + \hat{\mu}_2 (F_2 - F_1) + (\hat{\mu}_2 - \hat{\mu}_1) F_1$$

$$= \hat{\mu}_2 A_2 \Delta X + \left\{ \hat{\mu}_2 (A_2 - A_1) + (\hat{\mu}_2 - \mu_1) A_1 \right\} X_1 + \hat{\mu}_2 \Delta F + \Delta \hat{\mu} F_1$$

$$\Delta M = \hat{\mu}_2 A_2 \Delta X + (\hat{\mu}_2 \Delta A + \Delta \hat{\mu} A_1) X_1 + \hat{\mu}_2 \Delta F + \Delta \hat{\mu} F_1 \qquad (6.70)$$

or

$$\Delta M = \hat{\mu}_1 A_1 \Delta X + (\hat{\mu}_1 \Delta A + \Delta \hat{\mu} A_2) X_2 + \hat{\mu}_1 \Delta F + \Delta \hat{\mu} F_2 \qquad (6.71)$$

The average of the two equations, (6.70) and (6.71) gives the estimated value of ΔM as follows:

$$\Delta M = (\hat{\mu}_2 A_2 + \hat{\mu}_1 A_1)\Delta X \div 2 + (\hat{\mu}_2 \Delta A X_1 + \hat{\mu}_1 \Delta A X_2) \div 2$$
$$+ \Delta \hat{\mu}(A_1 X_1 + A_2 X_2) \div 2 + (\hat{\mu}_2 + \hat{\mu}_1)\Delta F \div 2 + \Delta \hat{\mu}(F_2 + F_1) \div 2 \qquad (6.72)$$

Substituting the value of the Laspeyres and Paasche indices of ΔX into (6.72) and solving gives the estimate of ΔM .

Following the same procedure and defining the sectoral value added output ratio, v_i, and the sectoral labour-input ratio, l_i leads to value added and employment equations thus:

$$\Delta V = \hat{V}_2 X_2 - \hat{v}_1 X_1 = \hat{v}_2 (X_2 - X_1) + (\hat{v}_2 - \hat{v}_1) X_1 \qquad (6.73)$$
$$= \hat{v}_2 \Delta X + \Delta \hat{v} X_1$$

where $\Delta \hat{V} = \hat{V}_2 - \hat{V}_1$

Hypothetically, $\Delta V = \hat{v}_1 \Delta X + \Delta \hat{v} X_2$ (6.74)

and the average of (6.73) and (6.74) is

$$\Delta V = 0.5 \times (\hat{v}_2 + \hat{v}_1)\Delta X + 0.5 \times \Delta \hat{v}(X_2 + X_1) \qquad (6.75)$$

Changes in labour will be given by:

$$\Delta L = 0.5 \times (\hat{l}_2 + \hat{l}_1)\Delta X + 0.5 \times \Delta \hat{l}(X_2 + X_1) \qquad (6.76)$$

where $\Delta \hat{l} = \hat{l}_2 - \hat{l}_1$

For the fact that ΔX is decomposable into five effects, the changes in value added (equation 6.75) and employment (equation 6.76) can both be decomposed into six causal factors: final demand expansion; export expansion; import substitution of final demand; import substitution of intermediate demand; technical changes in the intermediate input-output coefficients; and changes in value-added to production ratio, or changes in labour-output ratio.

The effect of change in labour productivity on employment is measured by the last term of equation (6.76), $\Delta\hat{l}(X_2+X_1)$, which is expected to be negative because labour coefficients decline during industrialisation. As Chenery, Robinson and Syrquin (1986) pointed out; the change in labour coefficients reflects an aspect of technological change in a different but related strand of the technological change captured by input-output coefficients.

The structural change in output, which is the variations in the patterns of output of an economy, can be affected by either final demand or production function (Blair and Wyckoff, 1989). Equation (6.68) provides a basis for determining the patterns and factors affecting the structural change in output while the relative shares of output can be analysed using the deviation model of Kubo and Robinson (1984).

Define $\delta X = X_2 - \lambda X_1$ where $\lambda = \frac{i'X_2}{i'X_1} = 1+g =$ ratio of total output of the comparative year to base year; and $i' =$ a row vector of ones.

δX measures the deviation between the comparative year production and balanced growth production and $i'\delta X = 0$.

Balanced growth production is defined as:

$$X_{BG} = \lambda X_1 = \left[I-(I-\hat{\mu}_1)A_1\right]^{-1}\left[(I-\hat{\mu}_1)\lambda F_1 + \lambda E_1\right] \tag{6.77}$$

The relationship described by equation (6.77) is that given the inbuilt linearity of the input-output model with constant structural coefficients, if all the elements of domestic final demand and export grow at the same rate, gross output would also increase at the same rate in every sector, which leads to changes in the composition of output.

Similar to the decomposition of equation (6.66), the deviation from balanced growth in output can be decomposed into:

$$\delta X = R_2(I-\hat{\mu}_2)\delta F + R_2\left\{(I-\hat{\mu}_1)\right\}(F_1+V_1) + R_2(I-\hat{\mu}_2)\Delta A X_1 \quad (6.78)$$

where $\delta F = F_2 - \lambda F_1$ and $\delta E = E_2 - \lambda E_1$[51]

This allows for the removal of the effects of general expansion of the economy, so as to focus only on differential growth which underscores the emphasis on change in structure of an economy, rather than growth rate *per se*, as the basic consideration of the deviation model.

The change in the output share of industry $i, \Delta S_i$, can be expressed as:

$$\Delta S_i = \frac{X_{i2}}{i'X_2} - \frac{X_{j1}}{i'X_1} = \left(\frac{X_{i2}}{i'X_2} - \lambda\frac{X_{i1}}{iX_2}\right) + \left(\lambda\frac{X_{i1}}{i'X_2} - \frac{X_{i1}}{i'X_1}\right) \quad (6.79)$$

where $iX_2 = \sum X_{i2}$; and $i'X_1 = \sum X_{i1}$

Substituting the value of $\lambda\left(i.e.\ \lambda = \frac{i'X_2}{i'X_1}\right)$ into equation (6.79) yields:

$$\Delta S_i = \frac{X_{i2}}{X_2} - \lambda\frac{X_{i1}}{X_2} = \frac{\delta X_i}{X_2} \quad (6.80)$$

where $\delta X_i = (X_{i2} - X_{i1})$

Substituting deviation formula given by equation (6.79) into equation (6.80) yields relative change measure of structural change.

The different methodological perspectives exhibit common properties that are encapsulated in the multipliers. The multiplier is an all encompassing measure as such the values of the multipliers for different periods (years) could form the basis for tracking changes in productive structures by the different sectors of the economy. The tracked changes can be useful in explaining the inter-industry processes and by extension, the structure of the Nigerian economy. This can generate insights into the relevance of various sectors of the economy in the growth performance of the economy. Furthermore,

[51] Albala-Bertrand replaced λ by 1+g where g is the average growth rate of the economy.

either of the second generation approaches (precisely, the hypothetical extraction or hypothetical addition method) can be useful in analysing the impact of the oil and gas industry on the inter-industry linkage and growth process of the Nigerian economy.

An empirical discussion of inter-industry linkages in the Nigerian economy and the impact of the oil and gas industry are carried out in chapter 7 that follows. Traditional linkage measures such as the output (types 1 and 2), income, employment, and value-added multipliers as well as forward linkages for sectors of the Nigerian economy are computed to illustrate the levels of inter-industry linkages within the Nigerian economy for five years (1997-2001) for which data availability permitted. Changes in the multipliers, as well as changes in output, income, value-added and total final demand were tracked and used to estimate the impact of such changes by the different sectors on the economy. The Hypothetical Extraction method is used as the second generation approach for determining the impact of the oil and gas industry on other sectors of the economy. The choice of only one second generation method, the hypothetical extraction is because the results are proven to be the same with the hypothetical addition method. The empirical analysis is preceded by a review of previous inter-industry linkage analysis of the Nigerian economy using backward and forward linkages (Ajakaiye, 1990) and factor decomposition analysis to track the effects of changes in industrial outputs of the Nigerian economy (Falokun, 1998), employing the method factor decompositions as espoused by Torri and Fukasaku (1984).

Chapter 7

EMPIRICAL DISCUSSION OF INTER-INDUSTRY LINKAGES AND THE IMPACT OF THE OIL AND GAS INDUSTRY

7.1: PREVIOUS INTER-INDUSTRY LINKAGES IN THE NIGERIAN ECONOMY

In the past, construction of input-output tables was not given priority consideration by the statistical and economic agencies in Nigeria such as the Federal office of Statistics (FOS) and the Central Bank of Nigeria (CBN). This resulted into difficulties in obtaining constructed input-output tables for the Nigerian economy. However, owing to the work of a special taskforce in 1973, an improved system of national accounts system for Nigeria provided the basis for determining the value-added performance of the various sectors of the Nigerian economy. This paved the way for independent sectoral estimates of basic macroeconomic aggregates such as gross output; domestically produced intermediate input requirements; imported intermediate input requirements; value added and its components; intermediate input demands; and final demand and its components. It also led to the construction of a Nigerian economy input-output table for 1973. This initial endeavour was not sustained. Subsequent national accounts estimates especially between 1974 and 1977 did not contain sectoral intermediate demands and there were no sectoral breakdown of total final demand and its components. This tended to diminish the usefulness of national account statistics as a basis for proper diagnosis national economic problems and articulating effective policies and programmes to deal with the situation.

A model for estimating sectoral intermediate input demands in an economy with import dependent production structure was developed (Ajakaiye, 1989) that could form the basis for obtaining data on sectoral gross output, intermediate input requirements and value-added by components. Due to data constraints, this model considered only eighteen sectors of the Nigerian economy between 1974 and 1977. These are: Agriculture(1); Livestock(2); Forestry(3); Fishing(4); Crude Petroleum(5); Other Mining(6); Large Scale Manufacturing(7); Small Scale Manufacturing(8); Utilities(9); Building and Constructions(10); Transport(11); Communications(12); Wholesale and Retail Trade(13); Finance and Insurance(14); Producers of Government Services(15); Hotels and Restaurant(16); Real Estate and Business(17); and Housing(18). The key findings of the study, which examined the structure of intermediate input demands by the various sectors, was that, there were no significant gains in terms of integrating the primary sectors such as agriculture and crude oil into the domestic production structure. The focus of public policy during the period of the study was to use increasing oil revenue to develop basic industrial, social and physical infrastructure that engender sustainable economic growth without any conscious strategy for ensuring significant linkage effects in achieving high economic growth performance. The analysis of inter-industry linkages from Ajakaiye (ibid) was considered to be cursory without in-depth determination of the technology coefficients for a more detailed discussion of inter-industry linkages in Nigeria, which motivated the construction of input-output table for Nigeria for the period 1974-1977, and thus provided the basis for analysing inter-industry linkages of the Nigerian economy.

In recent years, the Federal Office of Statistics (FOS) is providing structured data on intermediate consumption by different sectors/industries of the Nigerian economy. This structured data is classified in the format of input-output tables, containing a section of columns for intermediate consumption by all industries as well as a column of output for all the industries. The FOS tables, contain thirty-three sectors of the Nigerian economy comprising: Crop Production(1); Livestock(2); Forestry(3); Fishing(4); Coal Mining(5); Crude Petroleum and Natural Gas(6); Metal Ores(7); Quarrying and other Mining(8); Oil refining(9); Cement(10); Other Manufacturing(11); Electricity(12); Water(13); Building and construction(14); Wholesale and Retail Trade(15); Hotel and Restaurants(16); Road Transport(17); Rail Transport and Pipelines(18); Water Transport(19); Air Transport(20); Other Services(21); Telecommunications(22); Post(23); Financial Institutions(24); Insurance(25); Real Estates(26); Business Services(27); Public Administration(28); Education(28); Health(30); Private Non-Profit Organisations(31); Other Services(32) and Broadcasting(33).

The backward and forward linkage coefficients that emerged from the works of Ajakaiye (1990) are reproduced in Tables 7.1 and 7.2 respectively. In determining the coefficients of linkage effects, Ajakaiye gave due considerations to direct and indirect increase in total input requirements for a unit increase in every element of the final demand vector and that its row sums define the full increase in total output necessary to meet a unit increase in every element of the final demand vector as espoused by Rasmussen (1957). The Hirschman indicator of sectoral backward linkages is synonymous with Rasmussen's indicator of 'power of dispersion'. If this coefficient for any sector of the economy exceeds unity, it means that the sector will stimulate production of a relatively large increase in inputs from other sectors in order to be able to cope with a unit increase in final demand sector. Similarly, Hirschman's indicator of forward linkages is Rasmussen's indicator of 'sensitivity of dispersion'.

In recognition of the possibility of coefficients of sectors exceeding one simply because of very intense linkage with few sectors of the economy without any significant linkages with others, based on which normalised averages of coefficients could be misleading, Rasmussen emphasised the need to supplement the backward and forward linkage coefficients with the coefficients of variation for each of the simple average linkage indicator. It follows that the lower the coefficients of variation of the indicators, the more evenly are the spread effects of backward or forward linkages as the case may be.

Table7.1: Backward Linkage Indicators and Coefficients of Variations (1973-1977)

	1973		1974		1975		1976		1977	
SECTORS	V_j	S_j	V_j	S_j	V_j	S_j	V_j	S_j	V_j	S_j
Agriculture	0.81	4.11	0.875	4.17	0.882	4.02	0.867	4.17	0.873	4.19
Livestock	0.78	4.16	0.840	4.19	0.846	4.31	0.828	4.21	0.838	4.21
Forestry	0.76	4.18	0.838	4.21	0.849	4.19	0.833	4.18	0.846	4.18
Fishing	0.87	3.95	0.872	4.03	0.867	4.11	0.851	4.09	0.858	4.11
Crude Petroleum	0.86	4.03	0.844	4.19	0.856	4.17	0.839	4.17	0.847	4.18
Other Mining	1.10	2.95	1.075	3.29	1.035	3.44	1.081	3.24	1.090	3.25
Large Scale Manufacturing	1.27	3.02	1.220	2.82	1.236	3.17	1.240	3.13	1.226	2.92
Small Scale Manufacturing	1.29	2.71	1.169	3.02	1.174	3.03	1.175	2.97	1.160	3.04
Utilities	1.17	2.94	1.149	3.07	1.139	3.13	1.133	3.09	1.111	3.18
Building and Construction	1.16	2.71	1.110	3.14	1.082	3.27	1.093	3.16	1.102	3.17
Transport	1.02	3.16	1.103	3.24	1.061	3.40	1.056	3.34	1.030	3.47
Communications	1.11	2.91	0.048	3.38	1.107	3.23	1.141	3.00	1.136	3.11
Wholesale and Retail Trade	0.91	3.61	0.926	3.83	0.926	3.87	0.919	3.82	0.910	3.85
Finance and Insurance	0.90	3.48	0.950	3.72	0.952	3.76	0.959	3.65	0.945	3.70
Government Services	0.74	4.25	0.830	4.18	0.841	4.18	0.823	4.24	0.837	4.24
Hotels and Restaurants	1.14	2.85	1.122	3.10	1.117	3.15	1.112	3.09	1.111	3.10
Real Estate and Business Services	1.12	3.02	1.083	3.29	1.076	3.35	1.092	3.23	1.081	3.25
Housing	0.91	3.56	0.941	3.74	0.967	3.68	0.956	3.64	0.935	3.72

V_j=backward linkage coefficients for sector j and Sj=coefficient of variation for sector j

Source: Reproduced from Ajakaiye (1990).

From table 7.1, it is evident that the same set of industries had backward linkage coefficients exceeding one throughout the period 1973 to 1977. These are Other Mining; Large Scale Manufacturing; Small Scale Manufacturing; Utilities; Building and Construction; Transport; Communications; Hotels and Restaurants and Real Estate and Professional Business Services. It can also be observed that seven sectors; Agriculture, Livestock, Forestry, Fishing, Crude Petroleum, Producers of Government Services and Housing, had higher indicators than their 1973 figures. Two sectors, namely Wholesale and Retail and Finance and Insurance had almost no change in their backward linkage indicators. There were sectors with significantly lower backward linkage indicators than their 1973 figures throughout the period. These were Other Mining; Large Scale Manufacturing; Small Scale Manufacturing; Building and Construction; Hotels and Restaurants and Real Estate and Professional Business Services. The table also shows that whereas the backward linkage indicators for Utilities and Transport sectors were higher than their 1973 figures in 1974, these figures continued to decline in subsequent years such that by 1977, the figures have fallen below those of 1973. The reverse is the case for the Communications sector whose backward linkage indicators continued to increase from 1975 onwards.

Table 7.2: Forward Linkage Indicators and Coefficients of Variations (1973-1977)

SECTORS	1973		1974		1975		1976		1977	
	V_i	S_i	V_i	S_i	V_i	S_i	V_i	S_i	V_i	S_i
Agriculture(1)	1.160	2.97	1.140	3.19	1.157	3.17	1.159	3.11	1.161	3.13
Livestock(2)	0.821	3.99	0.877	4.03	0.891	3.99	0.875	3.97	0.883	3.99
Forestry(3)	0.869	3.76	0.906	3.88	0.897	3.96	0.877	3.96	0.880	4.01
Fishing(4)	0.789	4.16	0.847	4.16	0.858	4.15	0.840	4.15	0.852	4.14
Crude Petroleum(5)	1.026	3.18	1.238	2.85	1.147	3.10	1.164	2.99	1.149	3.68
Other Mining(6)	0.941	3.49	0.953	3.69	0.969	3.67	0.946	3.67	0.949	3.71
Large Scale Manufacturing(7)	1.559	2.46	1.336	2.91	1.303	3.00	1.532	2.86	1.315	2.95
Small Scale Manufacturing(8)	0.789	4.18	0.841	4.21	0.849	4.21	0.832	4.20	0.842	4.21
Utilities(9)	0.868	3.80	0.897	3.94	0.898	3.97	0.890	3.92	0.898	3.94
Building and Construction(10)	0.921	3.56	0.944	3.73	0.974	3.66	0.959	3.63	0.949	3.72
Transport(11)	1.476	2.28	1.283	2.77	1.284	2.78	1.366	2.56	1.394	2.55
Communications(12)	0.864	3.86	0.900	3.95	0.892	4.04	0.876	4.12	0.880	4.05
Wholesale and Retail Trade(13)	1.275	2.56	1.214	2.88	1.213	2.91	1.239	2.79	1.232	2.84
Finance and Insurance(14)	0.959	3.45	0.956	1.71	0.959	3.73	0.944	3.71	0.945	3.75
Government Services(15)	0.774	4.25	0.830	4.18	0.841	4.18	0.823	4.24	0.837	4.24
Hotels and Restaurants(16)	0.793	4.14	0.843	4.18	0.855	4.17	0.840	4.15	0.849	4.16
Real Estate and Business Services(17)	1.231	2.75	1.097	3.26	1.115	3.25	1.118	3.18	1.092	3.29
Housing(18)	0.897	3.63	0.907	3.87	0.909	3.91	0.899	3.86	0.904	3.90

V_i =forward linkage coefficient for sector i and Si =coefficient of variation for sector i

Source: Reproduced from Ajakaiye (1990)

The coefficients of variation figures indicates that the general backward linkage effects of the sectors had become more concentrated by 1977 than they were in 1973, except in the case of Large Scale Manufacturing, which appeared to have widened the spread of its backward linkage effects significantly in 1974 and less so by 1977. Sectors such as Other Mining, Small Scale Manufacturing, Building and Construction, Communications, Hotels and Restaurants and Real Estate and Professional Business Services have their coefficients of variation higher than their 1973 figures by approximately 10 per cent and above. These are among the sectors with relatively large backward linkage indicators. This implies that not only were the backward linkage effects getting weaker between 1973 and 1977 but they were also reducing in scope during this period. Thus as the backward linkage effects were weakening in these sectors, they continued to relate to fewer sectors within the domestic economy.

A proper scrutiny of the sectors whose backward linkage indicators exceeded one throughout the period reveals that only the Other Mining, Large Scale Manufacturing and Small Scale Manufacturing sectors can be considered to be in direct productive activities. Utilities, Transport and Communications sectors belong to the infrastructural services while the remaining two sectors belong to the service sectors. The complete absence of the Agriculture, Livestock, Forestry, Fishing and Crude Petroleum sectors from this list indicates that the chemical, steel fabrication and engineering sub sectors capable of supplying the spare parts requirements of these sectors were yet to be operating effectively within the Nigerian economy by 1977. Wholesale and Retail, Finance and Insurance and Housing sectors appears to have relatively low backward linkage indicators while it suggests that the engineering sub sectors were still at their infancy if they existed at all by 1977 which has hindered the sourcing of the critical inputs of these sectors within the Nigerian economy.

Table 7.2, which shows the forward linkage indicators for the period 1973 to 1977, reveals that except for Agriculture, Transport, Wholesale and Retail, Finance and Insurance, Real Estate and Professional Business Services sectors, forward linkage indicators for all other sectors were not lower than they were in 1973. It is also evident that there were no significant increases in these indicators. In the case of Crude Petroleum and Large Scale Manufacturing sectors however, the indicators were higher than they were in 1973 by over 10 per cent while the percentage increases in all others were so small that they can be regarded as having remained roughly the same throughout the period. Significantly, three sectors whose forward linkage indicators were well below their 1973 figures were also among those whose indicators exceeded one throughout the period. Also two sectors whose indicators were significantly higher than their 1973 figures also had their indicators exceeding one throughout the period. Evidently, there was a diminishing forward linkage effects of the service sectors of the economy between 1973 and 1977, especially Transport, Wholesale and Retail, Finance and Insurance, Real Estate and Professional Business Services, while those of goods producing sectors increased substantially. The coefficients of variation indicate that the increasing forward linkage effects during the period did not spread to several sectors of the economy. The forward linkage effects tended to have been derived from fewer sectors by 1977 compared to the situation in 1973. The forward linkage indicators for six sectors, namely, Agriculture, Crude Petroleum, Large Scale Manufacturing, Transport, Wholesale and Retail Trade, Real Estate and Business Services, exceeded one throughout the period. However, only the Agriculture and Transport sectors delivered larger proportions of their outputs to intermediate demands in 1977 compared to 1973. The table shows that, deliveries to intermediate inputs by the remaining four sectors as proportions of their total outputs decreased continuously throughout the period. This implies that the potential forward linkage effects of these sectors were not realised within the economy during the period. The case of the crude petroleum sector is a reflection of the large proportion of crude oil exports with very little for domestic processing and utilisation within the economy due to cost-ineffectiveness of refining and other downstream investments arising from the lack of appropriate investment climate and the inefficiencies of public sector monopoly of refining and other downstream activities. The Large Scale Manufacturing sector delivered intermediate inputs decreasingly throughout the period, which indicates that the sector was largely involved in final goods production. It is either that intermediate input production activities in the manufacturing sector were at infancy or did not exist during the period. The intermediate input deliveries from the output of wholesale and retail sector decreased continuously throughout the period. This is contingent upon the profile of the manufacturing output. Given that the bulk of output of the manufacturing sector is delivered to final demand, it should be expected that the bulk of services in the Wholesale and Retail sector will be dominated by distribution of final goods.

It is deducible that the nature of inter-industry linkage that existed in the economy between 1973 and 1977 was not inspiring enough to generate high level of value-adding activities. As illustrated by the tables of backward and forward linkage coefficients, the same set of sectors were found to have relatively higher backward linkage effects throughout the period and the same set of sectors had relatively higher forward linkage effects throughout the period. This implies that the structure of the economy did not change significantly during the period. Only three sectors had backward and forward linkage effects exceeding one throughout the period. These are Large Scale Manufacturing, Transport, Real Estate and Professional Business Services. However, these sectors were found to be delivering smaller proportions of their outputs to intermediate input demands while also absorbing increasingly lower share of domestically produced intermediate input requirements. This means that these sectors were highly characterised by increasing dependence on foreign inputs. In addition, the backward linkage indicators of these sectors were generally below what they were in 1973 for the subsequent years. In terms of the forward linkage indicators, only large scale manufacturing among these three had its forward linkage indicators for subsequent years exceeding that of 1973. Furthermore the coefficients of variation for the backward and forward linkage indicators of these sectors show that the linkage effects did not cover several sectors of the economy. This implies that the absorptive capacity of the economy was low which can lead to constraints in diversifying the production structures of the economy.

Falokun (1998) used the methods of factor decomposition as espoused by Torii and Fukasaku (1984) to determine the sources of industrial growth in the Nigerian economy based on the effects of changes in the import coefficients of domestic final demand (M_f-

effect); effects of changes in domestic final demand (F_d-effect); effects of changes in export (E-effect) and effects of changes in input coefficients (A-effects). His findings indicate that the Crude Petroleum sector has consistently for the period 1973-1990, been induced by E-effects while other sectors have been at different periods within the whole period of the study been induced mainly by F_d-effect and M_f-effects. It revealed that the direct impact of the Crude Petroleum sector, as well as other Mining and Quarrying sector on output expansion (mainly induced by export expansion) was very insignificant.

From the findings and analysis of the forward and backward linkages of the Nigerian economy between 1973 and 1977, as well as the factor decomposition patterns of industrial growth, the Nigerian economy witnessed a weak inter-industry relation from the initial year of observation, 1973. This deteriorated further by the year 1977. There was an increasing dependence between imported inputs and sectoral outputs of "key" industries and most of the sectors produced only to satisfy final demand with insignificant contribution to intermediate needs of other sectors of the economy. Over 75 per cent of gross output was accounted for by value-added between 1973 and 1977; while the proportion of intermediate input requirement sourced from the domestic economy declined from over 80 per cent in 1973 to less than 60 per cent by 1977; whereas gross output and value-added each grew at an average annual growth rate of 29.8 per cent and 29.9 per cent respectively during the same period. This means that processing activities such as manufacturing constituted over 75 per cent of gross output during the period and that the supply of raw materials and other production inputs by sectors of the economy to other sectors of the economy reduced from 80 per cent in 1973 to less than 60 per cent in 1977. The pattern and sources of industrial growth between 1973 and 1990 also reveals export-driven output expansion of the Crude Petroleum sector except during the period 1980-85 when oil glut at the international level led to decrease demand and prices of crude oil in the international market.

Given that the economy was characterised by weakening inter-industry linkages with associated low level of absorptive capacity, the potential growth dividends to be derived from bourgeoning oil and gas sector activities would not benefit the economy, except if revenues from oil exports are expended on growth yielding projects such as physical infrastructures, education and health to create a basis for future investments that could enhance inter-industry linkages and increased absorptive capacity of the economy. The large part of the multiplier effects of oil and gas sector led growth of the 1970s was transmitted to trade partner economies with requisite technological wherewithal and other ingredients of absorptive capacity, especially the economies of Europe and America, which has been the source of large components of Nigeria's imports and also main source of markets for Nigeria's export of primary commodities. This trend has continued through to the 1980s up to 1990 as the factor decomposition analysis have shown, which explains the vulnerability of the economy during the period of glut in the international oil market.

Inter-industry linkage analysis of Ajakaiye (1990) was entirely based on Rasmussen's method of backward and forward linkages without using other linkage measures and Falokun's (1998) analysis of sources of industrial growth using the factor decomposition method of Torii and Fakasaku (1984) was not broad enough to adequately explain inter-industry linkage and economic process in the Nigerian economy. Besides, Ajakaiye's study was between 1973 and 1977 while Falokun's study covered the period 1973 and 1990. There is therefore the twin need to provide inter-industry linkage analysis covering more recent periods and also use new additional linkage measures. The computational derivation of multipliers and other linkage measures of the various sectors of the economy can elucidate the extent and implication of inter-industry linkages of the economy. With these approaches, it is possible to establish the direct and indirect impacts, as well as induced effects of different sectors of the economy in different dimension. In addition the multiplier conceptually encapsulates the backward linkage effects of sectors of the economy. In essence, the dynamic properties of inter-industry linkages can be more coherently analysed with the use of output multipliers and such other linkage measures as employment and income effects. The *Hypothetical Extraction* method is also useful in determining the extent to which a particular sector generates stimuli that provide opportunities for other sectors of the economy to enhance their productive activities through inter-industry linkages and thus illuminate the contribution of the sector to the process of economic growth.

7.2: LINKAGE MEASURES OF THE NIGERIAN ECONOMY

7.2.1: Description and Review of the Data

The *National Accounts of Nigeria (1981-2002)* published by the Federal Office of Statistics contain Supply and Use Tables (SUTs) for thirty-three sectors of the Nigerian economy for 1997, 1998, 1999, 2000 and 2001. It has series of datasets for different years in which the current price estimates have been raised to agree with the higher levels of economic activity identified in the Supply and Use Table (SUT). The SUT is internationally recognised as the best way of estimating GDP. The tables contain thirty-three sectors of the Nigerian economy as follows; *Crop Production(1); Livestock(2); Forestry(3); Fishing(4); Coal Mining(5); Crude Petroleum and Natural Gas(6); Metal Ores(7); Quarrying and other Mining(8); Oil refining(9); Cement(10); Other Manufacturing(11); Electricity(12); Water(13); Building and Construction(14); Wholesale and Retail Trade(15); Hotel and Restaurants(16); Road Transport(17); Rail Transport and Pipelines(18); Water Transport(19); Air Transport(20); Other Services(21); Telecommunications(22); Post(23); Financial Institutions(24); Insurance(25); Real Estates(26); Business Services(27); Public Administration(28); Education(29); Health(30); Private Non-Profit Organisations(31); Other Services(32) and Broadcasting(33).*There are three sections, each comprising of a different structure of a semi-table but related to the information on the other sections. Manufacturing activities are disaggregated into three classified activity sectors; Oil Refining, Cement and Other Manufacturing.

The first section has the 33 sectors presented as vertical rows while the horizontal columns comprises: *Output; Imports; Imports taxes; Transport margins; Trade margins; Exports taxes; Other taxes on Products; Subsidies on Products; Non deductible VAT; Total Supply.*

The second section, caption *"INTERMEDIATE CONSUMPTION"* is structured to reflect all the classified sectors at the horizontal columns and at the vertical rows of the table. The range of values across the columns and rows represent the values of goods and services delivered by sectors to other sectors and absorbed from other sectors of the economy. After the 33 rows for the 33 sectors, there are six additional rows with the following descriptions; *output; value-added; compensation of employees; taxes; subsidies and operating surplus.* At the vertical bottom of the second section (after all the rows), six additional rows with similar description as the one in the first type (output; value-added; compensation of employees; taxes; subsidies and operating surplus) are added.

The third section comprise of additional columns representing *Total Intermediate Consumption; Final Consumption (FC) Household Own Account.; FC Households Marketed; FC Government; FC Net Private Investment (NPI); Gross Fixed Capital Formation (GFCF); Changes in Inventories; Exports; Total Final Use; and Total Use.* It continued with another form with the following columns: *VAT Theory; Discrepancy; Compensation of Employees (COE); Taxes (COE and taxes grouped under transposed elements); and Subsidies.*

The format of presentation of the Supply and Use Table (SUT) by the Federal Office of Statistics (FOS) was found to be in conformity with the updated International Standard as published by the United Nations (Studies in Methods: Handbook of National Accounting, *Series F, No. 74, 1999*).

The Nigerian SUTs are constructed input-output tables that seek to describe how the production process of the economy is split by industry and product classifications. Each table demonstrates the components of imports, net taxes and trade margins for each product to domestic output and total supply for a given year. It also illustrates how each product is used for intermediate consumption, household or government final consumption, investments and exports. In addition, the table shows how each industry/sector uses each product for intermediate consumption, as well as the value-added for each industry and its composition. In essence, the SUT encapsulates all the three measures of GDP; production, income and expenditure.

Construction of input-output table involves a process that is arduous and complex demanding heavy investment in human and material resources as well as requiring strong logistic support. These serious requirements tend to discourage countries from undertaking the construction of input-output tables and for those that do, various limitations are often accommodated. In recognition of the difficulties associated with constructing input-output tables, international procedures and instruments have been conceived under the auspices of the United Nations in order to minimise inaccuracies that may arise and also ensure uniform standard of constructing input-output tables. However, the extent of circumventing the numerous complexities of constructing input-output table is limited by the nature and vagaries of the economy for which input-output table is constructed. As a result therefore, input-output tables are often treated with commensurate degree of caveats.

It implies that the nature and vagaries of the Nigerian economy will influence the quality and accuracy of the Nigerian input-output tables. As such it is pertinent to review the sources and processes used in constructing the input-output tables of the Nigerian economy so as to properly contextualise the results obtained and the conclusions that are drawn there from. According to the Nigerian Federal Office of Statistics (National Accounts of Nigeria, 2003), the Nigerian input-output table was constructed from the following main data sources:

- Production, intermediate consumption and the breakdown of value added by industry from the existing National Accounts,
- Trade data from the EUROTRACE files of FOS' trade section
- Household consumption from the National Consumer survey.
- Employment from the National Integrated Survey of Households.

In addition, certain items were taken from the balance of payment and government accounts as in the annual reports published by the Central Bank of Nigeria (CBN).

Each of the data sources comprise data for purposes other than input-output tables, but were transformed to fit the classifications of input-output framework. Assumptions and adjustments were imposed on the process of data transformation. For instance, the original estimate of manufacturing data was disaggregated into Cement Production, Oil Refining and Other Manufacturing. Cement Production and intermediate consumption were estimated using returns from economic censuses and surveys and benchmarked to the estimated total output. Oil Refining output and intermediate consumption were estimated from the 1990 input-output table and adjusted them in line with CBN's index of refinery output and FOS' oil and gas deflator. Output and intermediate consumption of "Other Manufacturing" were calculated as residuals. Compensation of Employees is calculated in proportion to value-added and indirect taxes and subsidies in proportion to output. Basic data on service sectors such as Health and Education are not readily available so estimates were obtained by disaggregating total government services into Public Administration, Health and Education in proportion to their recurrent allocation as reported in CBN annual report. Household Consumption and Employment estimates were derived from National Survey of household expenditures while data on trade and taxes were obtained from EUROTRACE system. Data on imports, exports, excise duty and other such related data were obtained and/derived from CBN reports.

As in any input-output analysis, the processes and assumptions adopted in the construction of the Nigerian input-output tables, as well as the vagaries of the economy and the associated socio-political issues, have implications for the quality and accuracy of the input-output table. Some pertinent weaknesses can be pointed out such as:

- The assumptions and adjustments adopted in transforming data are open to misinterpretation of the original data. Although the FOS stressed that transformations were carried out in consultation with users of the data (see National Accounts, 2003, 20), the purpose of generating the original data, which is not for input-output table, could have significant influence on the nature and pattern of the data and this can hardly be completely neutralised by consultation with users. Besides, users of data are usually different from their producers as such the reliability of users in removing any transformation difficulties cannot be very strong.

- ❖ Surveys were used to obtain data on Household consumption and Employments. Considering that the Nigerian economy is not well advanced and institutions for data generation are not sufficiently established, coupled with the obvious difficulties of conducting a survey in an environment that is deficient in basic infrastructure and other social and economic amenities, the success of surveys in generating accurate data is circumspect. Therefore, the quality and accuracy of the data used in constructing the input out tables cannot be regarded as absolute.

Apart from these inherent weaknesses of the data generation process, certain limitations bordering on the format and contents of the input-out tables are identified as follows;

- ➢ Data on imports are not disaggregated into intermediate consumption and final demand. As a result, the derivation of import coefficients of sectors for use will tend to include final demands of imports. It will also be difficult to determine the impact of change in final demands from imports.

- ➢ The input-output tables do not contain information on non-wage income, which makes it difficult to use total income to determine consumption coefficients, especially for Type 2 linkage measures.

- ➢ The columns and rows of the Transport Service sector has zero entries all through, suggesting that it is an inactive sector; that is not absorbing from, nor delivering to any sector of the economy. This is a puzzle since, by logic, a sector is considered to exist if it is involved in one form of activity or the other.

By international standard, input-output tables, even from the most advanced economies, are treated with commensurate degree of caveats, owing to the arduous and complex process of their construction. In the Nigerian case, it is obvious from the weaknesses of the data generation and transformation process, as well as the specific limitations that the Nigerian input-output tables can hardly measure up to international standard. However, it is considered that with the involvement of international agencies such as the UNDP and the EU, providing logistic and financial support, some of the inherent inadequacies of the data generation process could have been mitigated and as such, the degree of unreliability of data and the input-output tables may have been substantially minimised. In any case, the standard of the data is a reflection of the tendencies of the economy, therefore using such input-output data to analyse inter-industry linkages of the economy is considered to be reasonably commensurate to the disposition of the economy. Besides, the use of the input-output data for research and analysis could generate insights into aspects that require improvement and thus spur the process of quality enhancement of the data generation process and the construction of input-output tables. The tables are therefore used as published for computation of linkage measures while identifying results that defy basic expectation and attempting to track the influence of data limitation and/or other factors.

7.2.2: Description of Linkage Measures

The traditional linkage measures for unraveling the derived pattern of interdependence of sectors of an economy are the backward and forward linkages. Traditional linkage measures are of two sub-categories (Song et al 2005); one is direct backward and forward linkages rooted in the input-output coefficient matrixes while the other is backward and forward linkage measures derived from the Leontief or Gosh inverse matrixes. Backward linkage effects are related to derived demand, i.e. provision of input for a given sector and Forward linkage effects are related to output utilization, i.e. the outputs from a given sector used as inputs by other sectors of the economy.

Rasmussen's measures of the "index of dispersion" and "sensitivity of dispersion" have gained prominence in inter-industry linkage analysis. The index of dispersion describes the relative extent to which an increase in final demand for the products of a given sector is dispersed throughout (other sectors of the) economy. It can be interpreted as the total increase in output from the entire economy needed to cope with an increase in the final demand for the products of a given sector of the economy by one unit. The sensitivity of dispersion index, describes the extent to which the entire economic system draws upon a given sector of the economy. Thus the sensitivity of dispersion measures the increase in the production of a given sector driven by a unit increase in the final demand for all sectors of the economy. If a sector have high power of dispersion and relatively small value of sensitivity of dispersion, it indicates that it draws evenly on the total system of the economy and could be regarded as a "key sector", since it gives relatively large share of the increase in final demand for its products to the economy in general. Thus Hirschman indicator of sectoral backward linkages is synonymous with Rasmussen's indicator of "power of dispersion" and similarly, Hirschman's indicator of forward linkages is Rasmussen's indicator of "sensitivity of dispersion".

Hirschman (1958) described Rasmussen's index of "power of dispersion" as a measure of backward linkages based on a mental experiment, assuming for every industry in turn that the country's development started with just that industry, so that all the industry's sales to and purchases from other domestic industries are imagined to have developed as a sequel to the foundation of the industry in question. The existing industries provide the incentives and driving forces for the development/expansion of the system through their activities, or rather through the input demands as well as output production stemming from these activities. It implies therefore that, economies with high level of interrelatedness and strong causal linkage effects are more dynamic than economies with few causal linkages due to few incentive-driving activities in the existing industries. By the same intuition, Rasmussen's index of sensitivity of dispersion is regarded as the forward linkage indicator. The multipliers, such as *Type 1* and *Type 2*, employment and income multipliers are supplementary linkage measures that capture the direct and indirect, as well as induced (if Type 2 is used) of inter-industry linkages. Others include employment, income and value-added effects. These linkage measures reflect the nature and processes of economic activities imbued in inter-dependency of different activity sectors of the economy and signify the extent to which a sector can be a source of growth to the economy through inter-industry linkages.

The economy revolves around four basic economic activities that are intertwined in a regeneration process that forms the bedrock of self-perpetuating growth. These four activities are: Production (of goods and services by industry and commodity sectors); Consumption (purchases of goods and services by industries, individuals and various government agencies for direct use); Accumulation (savings, capital transactions such as fixed investment expenditure and stock change) and Trade (imports from and exports to other economies). Consumption and trade constitute the source of demand for goods and services, and thus propels the other two in the chain of economic activities. An increase in the demand for goods and services for a particular sector leads to increase in the output for goods and services as producers react to meet the increase in demand. This is the direct impact. The increase in output by producers will lead to an increase in demand for inputs which implies an increase in demand for goods and services of sectors of the economy that supply to the sector with an initial increase in output. This process continues in the supply and demand chain; this is the indirect impact. The direct and indirect impacts create more employments through efficient utilisation of resources. The level of income earned by households will increase throughout the economy as a result of increase in employment opportunities arising from increase in economic activities by sectors of the economy. A proportion of the increased income of households will be re-spent on final goods and services (consumption). This is the induced effect which further enhances the chain of direct and indirect impacts. A combination of these three linkage effects (direct, indirect and induced) impacts on the economy through the inter-industry linkage cycle is the critical tonic for a healthy and sustainable growth path for the economy.

The quantification of multipliers and other linkage measures allows for the analysis of impacts of potential and actual inter-industry linkages to be carried out for the economy. Multipliers are classified into *Type 1* and *Type 2*. The *Type 1* multiplier considers only the goods and services activity sectors while the *Type 2* multiplier incorporates the household as a sector in addition to other sectors of the economy. The variable effects (employment, income and value-added), which measures the immediate impact of change in demand on the variable are important levers of understanding inter-industry linkage processes. All these linkage measures are useful instruments for the relevance of inter-industry linkages and the impacts of changes in output of the sectors on the overall economy.

By definition, the Output Multiplier for a sector of the economy is the ratio of direct and indirect (and induced if *Type 2* multiplier is used) output changes to the direct output change due to an increase in final demand so that multiplying a change in final demand (direct impact) for an industry's output by that industry's *Type 1* multiplier will generate an estimate of direct and indirect impacts upon output throughout the economy. Thus the output multiplier of an industry measures the total impacts on gross outputs when final demand for the industry changes by unity. The Employment Multiplier is the ratio of direct plus indirect (plus induced if *Type 2* multipliers are used) employment changes to the direct employment change. Employment Effect describes the ratio of direct plus indirect (plus induced if *Type 2* multipliers are used) employment change to the direct output change due to a unit increase in final demand. Income multipliers measure the change in income (compensation of employees) which occurs throughout the economy as a result of a change in final demand; that is the ratio of direct plus indirect (plus induced if *Type 2* multipliers are used) income changes to the direct income change. Income effects show the ratio of direct plus indirect (plus induced if *Type* 2 multipliers are used) income change to the direct output change due to a unit increase in final demand. Value-added multipliers measure the change in value-added (activities) which occur throughout the economy as a result of change in final demand. Value-added effect is the ratio of change in value-added to a direct change in final demand.

It needs to be pointed out that the value of the multiplier for a sector is not a reflection of the volume of activities in the sector but rather a measure of the extent to which the activities of the sector are linked to other sectors of the economy. The output, employment, income and value-added effects and multipliers are additional linkage measures for evaluating the impacts of the activities of sectors of the economy on the overall economy, beyond conventional cost-benefit analysis that tends to disregard indirect linkages and externalities arising from the chain of inter-industry linkages. Production activities in the oil and gas industry requires the absorption of factor inputs from other sectors (backward linkages); the sectors that supply the oil and gas industry also absorbs inputs from some other sectors. This chain of inter-dependent input requirements in successive rounds are captured by the multiplier effect. In essence, the multiplier of any sector encapsulates the direct backward linkages of that sector as well as the cumulative effects of successive rounds of the chain of linkages. Large multipliers for a particular sector does not solely connote a large multiplier impacts of the sector on the economy but requires the complement of large activities to generate high magnitude of exogenous stimulus by which the multiplier is multiplied to determine the impact of the sector. Multiplier effects are based on the assumption of the existence of unutilized (underutilized) human and material resources that can accommodate the effects. In a full employment economy therefore, multiplier effects will tend to ignore negative displacement effects that could give rise to hidden opportunity costs and substitution effects.

7.2.3: Model Specification and Computation Procedures

A number of computer software and programmes such as *SPSS*, *LOTUS*, *C-MAP* and *EXCEL* lend themselves to matrix computations that could be used for computing the linkage measures (multipliers and other linkage indicators). Some of these software/programmes tend to accommodate large size of data sets comprising large number sectors (columns and rows of the matrix). For instance, if the number of sectors is above 40 (40 x 40 matrix), *Lotus* is considered to be more useful but if the number is more than 80 (80 x 80 matrix), then *C-Map* will be more appropriate. Excel is considered to be adequate for this computation considering that 33 (33x33) sectors are involved. It is also more appealing because of its flexibility.

The available data on the Nigerian input-output tables as described under 7.2.1 fits into the format of balanced total flows with imports. It is therefore appropriate to apply the balanced equation system of the form;

$$X + M = IX + D \Rightarrow X = IX + D - M \qquad (7.1)$$

where:

X= vector of industry outputs

M= vector of commodity imports

IX= matrix of intermediate sales of domestic plus imported commodities

D= final demands (including exports) for domestic plus imported commodities.

The intermediate technical coefficients are determined to form the A matrix as:

$$A = \frac{IX}{X} \text{ (i.e. } a_{ij} = \frac{x_{ij}}{X_j}\text{)} \tag{7.2}$$

and import coefficients are determined as;

$$m = \frac{M}{X} \text{ (i.e. } m_i = \frac{M_i}{X_i}\text{)} \tag{7.3}$$

By substituting equations (7.2) and (7.3) into (7.1), the balanced equation becomes;

$$X = AX + D - MX$$

This is transformed into;

$$X(I - A + \hat{M}) = D \tag{7.4}$$

where: I=identity diagonal matrix.

The result of equation (7.4) is inverted so that:

$$X = (I - A + \hat{M})^{-1} D \tag{7.5}$$

where $\hat{M}$ is a diagonal (33 x 33) matrix of import coefficients based on equation (7.3). The inverted matrix $(I - A + \hat{M})^{-1}$ is used to determine linkage measures of the Nigerian economy.

The direct backward linkage is given by the column sum of the elements of the "A" matrix, i.e. $\sum a_{ij}$ (Chenery and Watanabe, 1958, Song *et al*, 2005).

The Rasmussen's power of dispersion (backward linkages) is given by:

$$U_j = \frac{\frac{1}{n}\sum_i a_{ij}}{\frac{1}{n^2}\sum_i \sum_j a_{ij}} \tag{7.6}$$

and Rasmussen's power of sensitivity is given by:

$$U_i = \frac{\frac{1}{n}\sum_j a_{ij}}{\frac{1}{n^2}\sum_i \sum_j a_{ij}} \qquad (7.7)$$

Type 1 output multiplier for each sector is obtained as the column sum of the elements (b_{ij}) of the inverted matrix, $(I - A + \hat{M})^{-1}$, i.e. $\sum b_{ij}$ and the forward linkage is the row sum of its elements (b_{ji}), i.e. $\sum b_{ij}$.

To determine the *Type 2* multipliers, additional column and row of coefficients representing the activities of the Household (sector) are added to extend the "A" matrix to 34x34. The household consumption coefficient vector is the additional column while the additional role is the income coefficient. The column of consumption coefficient is obtained by dividing each element of household final consumption vector by total household consumption (as total income), that is (C_i/C). The use of this approach of total expenditure follows Yan (1969, 71) and was further necessitated by difficulties in obtaining total income from the Nigerian National Accounts data. The logic of this approach is that total consumption expenditure by household is the same as total household income that was spent for consumption purposes. It also ensures that the Hawkins-Simon condition is met[52]. The row of income coefficients is obtained by dividing sectoral wage income (compensation of employees) by each sectoral output; that is (W_i/X_i). The resultant 34x34 matrix is used to obtain a new $(I - A + \hat{M})^{-1}$ of 34x34 matrix, the column and row sums of which gives *Type* 2 multipliers and forward linkages respectively.

[52] The Hawkins-Simon condition requires that the sum total of the coefficients must not exceed one.

Income, Employment, and Value-Added effects and multipliers are computed using each variable/output coefficient. Thus, income/output (Y/X), employment/output (E/X) and value-added/output (V/A) coefficient column vectors;

$y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_{33} \end{bmatrix}$ = income coefficient vector, $e = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_{33} \end{bmatrix}$ =employment coefficient vector, and

$v = \begin{bmatrix} v_1 \\ v_2 \\ \vdots \\ v_{33} \end{bmatrix}$ = value-added coefficient vector.

Multiplying and adding the elements of the vector of coefficients by row elements of the Leontief inverse gives the variable effect of the corresponding sector. For instance, the income effect of sector 1 is given by: $y_1 b_{1,1} + y_2 b_{2,1} + y_3 b_{3,1} \cdots\cdots + y_{33} b_{33,1} = \sum_{i=1}^{33} y_i b_{i1}$

where y_1 is the income-output coefficient; and $b_{1,1}, b_{2,1} \cdots, b_{33,1}$ represent the row elements of the Leontief inverse.

Following the same pattern, employment effect is $\sum_{i=1}^{33} e_i b_{i1}$ and value-added effect is $\sum_{i=1}^{33} v_i b_{i1}$. From the variable effects, the variable multipliers are obtained as follows;

$$\text{Income Multiplier } (M_y) = \frac{\sum_{i=1}^{33} y_i b_{i1}}{y_i} \quad (7.8)$$

$$\text{Employment Multiplier } (M_e) = \frac{\sum_{i=1}^{33} e_i b_{i1}}{e_i} \quad (7.9)$$

and

$$\text{Value-Added Multiplier}(M_v) = \frac{\sum_{i=1}^{33} v_i b_{i1}}{v_i} \qquad (7.10)$$

The *Hypothetical Extraction method* is applied to determine the linkage relevance and impact of the oil and gas industry on other sectors and by extension, the economy as a whole. Of the 33 sectors of the Nigerian input-output tables, two (Crude petroleum and Oil refining) sectors belong to the oil and gas industry so their rows and columns were extracted to form an adjusted matrix of 31x31. The procedures of equations (7.2) through to (7.5) are applied to obtain $X = (I - A + \hat{M})^{-1} D^*$ for the adjusted (31x31) matrix and $(I - A + \hat{M})^{-1} *$ is used to obtain the linkage measures of the remaining 31 sectors of the economy. The differences in the linkage measures as well as the output differences which are negative if the values of the 33 sector are subtracted from the 31 sectors and positive if the values of the 31 sector are subtracted from the 33 sector are used to analyse the inter-industry linkage influence of the oil and gas industry on the economy.

To further underline the potential linkage significance of downstream activities of the oil and gas industry, import substitution policy simulation of downstream activities is carried out by moderately varying the columns and rows of the Oil refining sector by 25 per cent, reducing the exports of crude and the imports of Oil Refining by the same margin and computing the linkage measures using similar procedures. Evaluations are carried out based on the comparison of the simulated results with the non simulated values.

The non-desegregation of data on imports (into final demand and intermediate consumption)-one of the limitations of the Nigerian input-output tables-impose constraints in carrying out the decomposition analysis based on the methodology reviewed under 6.5. However, the main focus of the research is to determine the levels of inter-industry linkages and the stimulating effects of the oil and gas industry in the inter-industry linkage process of the Nigerian economy. For this, the use of traditional linkage measures, the hypothetical extraction and policy simulation of import substitution are considered to be adequate for analysing the inter-industry linkage essence of the sectors of the economy and the impact of the oil and gas industry, in tandem with the purpose of the research. Decomposition analysis could have provided additional insights in terms of the impacts of final demand emanating from different sources (imports, export or domestic factors) but do not necessarily significantly reflect on the inter-industry linkage processes and performance. Therefore the inability to carry out the decomposition analysis does not inflict any shortcomings on the inter-industry linkage analysis and the stimulating effects of the oil and gas industry, which is the main purpose of the research. The robustness of inter-industry linkage process is regarded as a key determinant of the value-adding functions of factors of production, which is the requisite precondition for generating economic growth.

7.2.4: Presentation and Analysis of Results

The analysis seeks to unravel the structural pattern of inter-industry linkages using the results obtained for the various linkage measures. The main linkage measures considered are the direct backward and forward linkage indicators as well as the Rasmussen measures of power dispersion and sensitivity of dispersion. Other linkage measures such as *Types 1 and 2* output multipliers, employment, income and value-added effects and multipliers are used to supplement the basic linkages. The changing values of these measures reflect the dynamic characteristics of inter-industry relationships spanning the period covered and juxtaposing with the conclusions of previous inter-industry linkage analysis of the Nigerian economy further illuminate the trend of inter-industry linkages over a longer period of time. Sectors of interest are identified by the coefficient of their linkage measures and rankings among all the sectors. While there is appropriate focus on high linkage sectors and emphasis on the oil and gas sectors, those with results that defy theoretical and empirical intuition are also identified. Furthermore, sectors with results that reveal economic growth challenges are given appropriate analytical consideration.

Backward linkage indicators provide a basis for measuring the extent to which sectors absorb goods and services produced by other sectors of the economy. *Type 1* backward linkage (using input-output coefficients) indicators are presented in Table 7.3. The backward linkage indicators of sectors of the economy are generally very low, mostly below one except for Air Transport with (1.34, R1) in 2000 and (3.39, R1) in 2001; Water Transport: (1.12, R2) in 2000 and (2.82, R2) in 2001; Road Transport: (2.40, R3) in 2001; Electricity (2.04, R4) in 2001 and Fishing (1.36, R5) in 2001. The backward linkage significance of the oil and gas sectors is not strong, though Oil Refining has high rankings with: (0.76, R4) in 1997, (0.81, R1) in 1998, (0.94, R1) in 1999, (0.69, R6) in 2000 and (0.030, R17) in 2001. The backward linkage indicators of the Crude Petroleum sectors are (0.09, R28), in 1997, (0.015, R24) in 1998, (0.11, R26) in 1999, (0.07, R30) in 2000, (0.12, R27) in 2001. The dismal backward linkage relevance of the oil and gas sectors and by extension, of all sectors of the economy is a reflection of general low level of interdependence of sectors of the economy in their activities.

The *Type 2* backward linkage indicators are presented in Table 7.4 and it shows that the Household sector has significant influence on the backward linkage relevance of the Rail Transport and Pipelines sector resulting into very high *Type 2* backward linkage indicators as 6.13 in 1997, 9.95 in 1998, 9.36 in 1999, 13.02 in 2000 and 12.37 in 2001 with rank of 1 throughout the period. The Household sector itself has backward linkage indicator of unity throughout the period mainly due to the equi-proportionate relationship between household consumption expenditure and total income of household in line with the Hawkins-Simon condition, more so that data limitation (lack of information on non-wage income) necessitated the use of total consumption expenditure as proxy for total income. The sequences of Type 2 backward linkage relevance of other sectors are mixed in the years. The Electricity sector has (0.80, R3) in 1997, (0.68, R11) in 1998, (0.76, R9) in 1999, (1.17, R7) in 2000 and (2.34, R6) in 2001; Air Transport: (0.79, R4) in 1997, (0.64, R13) in 1998, (0.74, R10) in 1999, (1.36, R5) in 2000 and (3.41, R2) in 2001; Hotel and Restaurants: (0.78, R5) in 1997, (0.76, R9) in 1998, (0.68, R12) in 1999, (0.66, R16) in 2000 and (0.78, R15) in 2001. Apart from the Rail Transport and Pipelines sector and the unitary values of the Household sector, with the exception of few other sectors for some of the years, all the other sectors have Type 2 backward linkage indicators of less than one. The few sectors are Health: (1.21, R2) in 1998 and (3.25, R2) in 1999, (3.20, R2) in 2000 and (3.35, R3); Education: (1.94, R3) in 1999, (1.84, R3) in 2000 and

(1.86, R7) in 2001; Air Transport: (1.36, R5) in 2000 and (3.41, R2) in 2001; Public Administration: (1.57, R4) in 1999, (1.45, R4) in 2000 and (1.43, R8); Water Transport: (1.19, R6) in 2000 and (2.89, R4) in 2001; Post: (1.03, R3) in 1998, (1.03, R5) in 1999 and (1.09, R8) in 2000; Road Transport: (2.40, R5) in 2001; Electricity: (1.17, R7) in 2000 and (2.34, R6) in 2001; Broadcasting: (1.07, R9) in 2000 and Fishing: (1.40, R9) in 2001. The high levels of Type 2 backward linkage indicators for the Health and Education sectors in particular, and other service-oriented sectors in general underlie the human resource intensity of the activities of the service sectors. It appears that the Type 2 backward linkage performance of the economy is improving over the years with some sectors such as Air Transport, Water Transport and Road Transport emerging with high indicators. The general low levels of backward linkages of the economy means that sectors of the economy use relatively little of outputs of other sectors of their productive activities. This have adverse implications for domestic production activities in that the economy will be lacking demand stimulus that could have been derived from a stronger backward linkages of sectors of the economy.

Forward linkage indicators are useful in measuring the delivery capabilities of sectors of the economy thus illuminating further inter-industry linkage opportunities that exists within the various sectors. *Type 1* Forward linkage indicators of the sectors of the economy are presented in Table 7.5, which shows that the two oil and gas sectors are the most forward linkage significant sectors. The Oil Refining sector has (2.98, R1) in 1997, (2.24, R4) in 1998, (2.50, R2) in 1999, (4.86, R1) in 2000 and (14.14, R1) in 2001 while the Crude Petroleum sector exhibits (2.58, R2) in 1997, (2.11, R5) in 1998, (2.71, R1) in 1999, (3.76, R2) in 2000 and (3.58, R2) in 2001. The high forward linkage relevance of these two oil and gas sectors can be perceived within the context of the nature of the oil and gas resources, that is, versatile uses and indispensability of petroleum products in virtually all aspects of economic activities. Crop Production follows with (2.58, R3) in 1997, (2.56, R1) in 1998, (2.22, R4) in 1999, (2.28, R3) in 2000 and (2.52, R4) in 2001. Crop Production is mainly about food production activities that produce the essential consumption needs of the economy. The Other Manufacturing sector, considered a strategic final demand sector with potential for value-adding activities, exhibit high forward linkage significance with (2.49, R4) in 1997, (2.37, R2) in 1998, (2.09, R5) in 1999, (1.87, R5) in 2000 and (1.58, R5) in 2001. The high forward linkage indicators suggests that the sector delivers significant amount of intermediate goods to other sectors implying that the sector is saddled with large intermediate goods production activities as against the expected final goods production activities. Other forward linkage significant sectors are; Livestock: (1.50, R6) in 1997, (1.50, R6) in 1998, (1.42, R7) in 1999, (1.36, R7) in 2000 and (2.52, R4) in 2001; Road Transport: (1.96, R5) in 1997, (2.30, R3) in 1998, (2.33, R3) in 1999, (2.24, R4) in 2000 and (2.93, R3) in 2001 and Real Estate: (1.21, R7) in 1997, (1.33, R8) in 1998, (1.42, R6) in 1999, (1.49, R6) in 2000 and (1.42, R6) in 2001. The forward linkage indicators of sectors of the economy over the period ranges from; (0.01, R33) for Coal Mining to (2.98, R1) for the Oil Refining in 1997; (0.04, R33) for Telecommunications to (2.56, R1) in 1998; (0.04, R33) for Telecommunications to (2.71, R1) for Crude Petroleum in 1999; (0.04, R33) for Telecommunications to (4.86, R1) for Oil Refining in 2000 and from (0.05, R33) for Telecommunications to (14.14, R1) in 2001. Apart from 1997 when Coal Mining exhibits the least forward linkage relevance, the Telecommunication sector has consistently been the least forward linkage relevance of all the sectors. Crucial service sectors (Education and Health) have very low forward linkage indicators and ranking. This implies that the use of ideas embodied in human resources as the Education sector represents, is very low and the services of the Health sector, which is useful in ensuring a robust labourforce, does not have significant service delivery linkages with other sectors of the economy. The forward linkage indicators and ranks of the Education sector are; (0.86, R23) in 1997, (0.88, R24) in 1998, (0.89, R24) in 1999, (0.93, R24) in 2000 and (0.94, R24) in 2001 and for the Health sector; (0.63, R26) in 1997, (0.73, R27) in 1998, (0.74, 26) in 1999, (0.79, R26) in 2000 and (0.81, R26) in 2001.

Type 2 forward linkage indicators are presented in Table 7.6. It shows that, the Household sector is the most significant forward linkage sector with forward linkage indicators and ranks at: (10.72, R1) in 1997, (16.79, R1) in 1998, (20.19, R1) in 1999, (25.04, R1) in 2000 and (24.01, R2) in 2001. Considering the pivotal role of the household sector in inter-industry linkage process, the main source of final demand and the veritable source of factor inputs, the high forward linkage indicators of the sector are expected. Adherently, the mainly final consumption activity sectors follow in the order of the *Type 2* forward linkage indicators. The Other Manufacturing sector exhibits; (10.68, R2) in 1997, (12.79, R2) in 1998, (14.24, R2) in 1999, (17.79, R2) in 2000 and (14.42, R4) in 2001; Crop Production: (8.92, R3) in 1997, (11.63, R3) in 1998, (13.07, R3) in 1999, (14.34, R3) in 2000 and (16.29, R3) in 2001; Oil Refining: (5.50, R4) in 1997, (4.36, R4) in 1998, (5.17, R4) in 1999, (11.76, R4) in 2000 and (33.68, R1) in 2001; Crude Petroleum: (3.91, R5) in 1997, (3.16, R6) in 1998, (4.53, R6) in 1999, (7.68, R5) in 2000 and (7.16, R5) in 2001; Road Transport: (3.38, R6) in 1997, (4.26, R5) in 1998, (4.59, R5) in 1999, (4.72, R6) in 2000 and (5.35, R6) in 2001 and Livestock: (2.51, R7) in 1997, (2.81, R8) in 1998, (2.89, R8) in 1999, (3.17, R9) in 2000 and (3.45, R8) in 2001. The high *Type 2* forward linkage indicators suggest high levels of deliveries to other sectors by the promptings of household activities. Deliveries by these sectors are used either for transformation into final use or for direct final use. Again, the inclusion of the two oil and gas sectors, as well as the transport sectors, underscores the essential requirement of transportation in economic activities and the dependency of transportation on petroleum products.

Results of Rasmussen's power of dispersion indices (backward linkages) are presented in Table 7.7. It shows that for all the years, all the sectors have Rasmussen's backward linkage of less than one implying that the sectors do not significantly stimulate large increase in inputs from other sectors as a result of increase in demand. The Air Transport sector has index of 0.68 in 1997, 0.64 in 1998, 0.67 in 1999, 0.76 in 2000 and 0.86 in 2002 and ranking 1 throughout. It is followed by Water Transport with 0.66, 0.63, 0.66, 0.74 and 0.85 ranking 2, the Electricity with 0.63, 0.60, 0.62, 0.69, and 0.80. The fact that the two transport sectors have the highest ranks is a reflection of the essential role of transportation in economic activities of networking different segments and aspects of economic activities. This is even more pronounced for an economy such as the Nigerian economy that relies on consumption goods with low levels of domestic value-adding production. With relatively more domestic production, the frequency of transportation, which will involve mainly capital goods will not be as high as when the transportation of consumer goods are involved, which are needed within much shorter time period. Rasmussen indicators of power of dispersion for the two oil and gas sectors are very low reflecting a very low level of interrelatedness with the other sectors of the economy. It is 0.31, 0.36, 0.30, 0.23 and 0.27 for the Crude Petroleum sector and 0.39, 0.46, 0.46, 0.27 and 0.10 for the Oil refining sector. The gradual decline in the values for the oil refining is a reflection of the declining levels of capacity utilization of the refineries, which further worsened already inadequate refining activities, giving rise to importation of refined petroleum products. Crude Petroleum activities are heavily technology intensive and considering the lack of domestic technological wherewithal, domestic inputs into the crude petroleum activities is expected to be low, which reflects the very low values of the sector.

Rasmussen's indices of sensitivity (forward linkages) are presented in Table 7.8. Also, the indices for all the sectors are less than one. The Crude Petroleum sector has the highest level of delivery to other sectors with (0.69, R1) in 1997, (0.64, R3) in 1998, (0.70, R1) in 1999, (0.77, R1) in 2000 and (0.73, R2) in 2001. This points to the fact that despite the general low level of inter-sectoral delivery of output by sectors to other sectors to be used as inputs for their production, the crude petroleum sector remain the most significant product that other sectors of the economy are using as inputs for their production. This stems from the intrinsic versatility of crude oil as a commodity that can be used in different aspects of economic activities and for the production of various types of commodities. Crop Production follows with (0.69, R2) in 1997, (0.69, R1) in 1998, 0.67, R2) in 1999, (0.66, R3) in 2000 and (0.68, R3) in 2001. This relative high level of delivery significance of the Crop Production sector may have arisen from the fact that it revolves around food, which is a basic requirement without which no other activity can take place. Every aspect of economic activity requires human capital either as entrepreneur or labour and food is critical for any human to be able to function. It therefore follows that the most highly needed commodities are food, which is why the Crop Production sector, even though may be operating abysmally below its potential, have such a relative significance in sensitivity of dispersion. Other Manufacturing has

(0.69, R3) in 1997, (0.67, R2) in 1998, (0.65, R3) in 1999, (0.63, R4) in 2000 and (0.55, R5) in 2001. Other manufacturing is about secondary production of goods and services that are for either intermediate or direct consumption. This makes it a very important sector in terms of delivery to other sectors of the economy. Therefore its relatively high ranking, which is an indication of its delivery significance, is consistent with its expected role in the economy. The Oil Refining sector, which is another form of manufacturing has (0.61, R4) in1997, (0.54, R9) in 1998, (0.54, R7) in 1999, (073, R2) in 2000, (0.90, R1) in 2001. While the relative high ranking reflects the essentiality of petroleum products in modern economic activities, it does not necessarily illuminate the effectiveness of the sector in delivering the needed products especially since it could have delivered imported petroleum products instead of domestically refined petroleum products. This is even more likely if compared with the very poor ranking in of the index of dispersion of this sector, which indicates that it does not use inputs from other sectors of the economy. Sectors with very low sensitivity index include Air Transport, Water Transport and Electricity, implying that they have little or no direct delivery link with other sectors of the economy. Though the values of the coefficients are different from the direct backward linkages, the patterns of the linkage significance of the sectors are similar.

To supplement the inter-industry linkage analysis, the multipliers and measures of effects are considered. The (output) multiplier of a sector of the Nigerian economy is the number of times the direct change in output of the sector (as measured by the change in final demand) will be multiplied to obtain the total output change in the economy. In table 7.9, the *Type 1* output multipliers of sectors of the economy for the years 1997-2001 are presented. It shows that the Road Transport sector has the highest multiplier of 1.93 (Rank 1) in 1997 but declined to 1.55 (R6) in 1998, rose to 1.68 (R3) in 1999, 2.48 (R1) in 2000 and 4.75 (R1) in 2001. The Oil Refining sector has 1.89 (R2) in 1997, 1.90 (R1) in 1998, 2.09 (R1) in 1999, 1.84 (R3) in 2000 and 1.63 (R9). The Electricity sector has 1.81 (R3) in 1997, 1.60 (R4) in 1998, 1.75 (R2) in 1999, 2.35 (R2 in 2000 and 4.31 (R2) in 2001. Building and Construction has 1.71 (R4) in 1997, 1.76 (R2) in 1998, 1.46 (6) in 1999, 1.67 (R5) in 2000 and 1.94 (R6) in 2001. Hotel and Restaurants has 1.66 (R5) in 1997, 1.67 (R3) in 1998, 1.60 (R4) in 1999, 1.66 (R6) in 2000 and 1.99 (R4) in 2001.

Public Administration has 1.62 (R6) in 1997, 1.57 (R5) in 1998, 1.53 (R5) in 1999, 1.45 (10) in 2000 and 1.49 (R14) in 2001. The high ranking of these six sectors illustrate the possibility of high multiplier impact of their activities on the economy. Even though the rankings of these six sectors experienced some changes over the period, they remained high in rankings ranging from 1 to 6 except the ranking of 10 for the Public Administration sector in 2000. The nature of the activities of these sectors with high multiplier values reveals the core activities within the Nigerian economy. All the Agricultural sectors (Crop Production, Livestock, Forestry and Fishing) have low multiplier values and rankings over the period with only the Fishing sector improving remarkably from 1.33 (R10) in 1997, 1.24 (R12) in 1998, 1.34 (R10) in 1999 to 1.77 (R4) in 2000 and 2.79 (R3) 2001 in comparison with the other agriculture related sectors such as Crop Production Livestock and Forestry.

Ten sectors have multiplier values less than one in 1997. These are Coal Mining (0.03, R32), Quarrying and Other Mining (0.99, R24), Water Transport (0.29, R28), Air Transport (0.38, R27), Telecommunications (0.09, R30), Financial Institutions (0.52, R26), Insurance (0.09, R30), Business Services (0.14, R29) and Health (0.78, R25). It means that these sectors are not well integrated into the process of domestic production activities. Examination of the basic input-output data reveals that with the exception of two sectors (Health and Quarrying and Mining), are highly import-intensive. In the subsequent years, two sectors; Metal Ore and Quarrying and Other Mining improved their level of integration as their multiplier exceeded one in 1998; (1.72, R15) and (1.10, R20); 1999(1.21, R13) and (1.10, R20); 2000; (1.31, R13) and (1.32, R12); 2001(1.60, R10) and (1.65, R8) respectively. Others remained consistently less than one throughout the period except Water Transport with 1.01 and rank of 26 in 2001. In 1999 and 2001, the Cement sector joined the group of less than one multipliers with 0.62 (R26) in 1999 and 0.87 (R 26) in 2000 with marginal improvement in 2001 (1.06, R24). The fact that the Financial Institutions sector is among the sectors with less than one multipliers consistently implies than financial intermediation, a potent source of investment financing has very little relevance to the economy. This can create difficulties of capital sourcing by investors, which could in turn weaken productive activities of the economy.

While the less than one multiplier values of some of the sectors may indicate high levels of import intensity, the non disaggregaton of imports into output and intermediate consumption may have further contributed to the results of less than one. Considering the seeming low levels of interdependence between sectors of the economy, high import intensities of the affected sectors is plausible.

Focusing on the two oil and gas sectors is relevant to the analysis. The trend of multipliers of the Oil Refining sector has been illustrated among the six top ranked sectors, which is: (1.89, R2) in 1997, (1.90, R1) in 1998, (2.09, R1) in 1999, (1.84, R3) in 2000 and (1.63, R9) in 2001. For the Crude Petroleum sector, it is as follows: (1.14, R19) in 1997, (1.20, R14) in 1998, (1.16, R15) in 1999, (1.34, R19) in 2000 and (1.30, R19) in 20001. This indicates that the Oil Refining sector, which is the hallmark of downstream activities of the oil and gas industry, is not only more integrated than the Crude Petroleum sector but also has high level of integration along with other sectors of the economy. This arises from the imperativeness of petroleum products both for direct use and as input to numerous essential economic activities with very tremendous influence on transportation. Also, oil refining activities is manufacturing related and manufacturing activities tend to generate high levels of endogenous stimulus for other sectors of the economy. Perhaps, the crucial role of transportation in economic activities and the expected high level of dependency of transportation activities on products of oil refining is the reason why the Road Transport sector exhibits high multipliers and rankings consistently over the period, ranging from (1.55, R6) to (4.75, R1). The persistent low multiplier of the Crude Petroleum sector is indication that it has insignificant direct and indirect impact on the economy. It implies that upstream activities such as drilling and extraction have little linkage effect with other sectors of the economy, most probably because of lack of domestic technological capabilities and the inability of the intermediate goods industry sub sector to take advantage of oil and gas activities to develop the ability to supply basic components of machineries and equipments for extraction platforms and other spin-off activities.

Six sectors have multipliers at 1.5 and above in 1997, five in 1998 and 1999, seven in 2000 and thirteen in 2001. This means that the remaining sectors (27 in 1997, 28 in 1998 and 1999, 26 in 2000 and 20 in 2001) have less than fifty per cent direct and indirect impact on the economy of any change in output (demand) from the particular sectors. There is no sector with multiplier of 2 and above in 1997 and 1998, only one (Oil Refining) in 1999, two (Electricity and Road Transport) in 2000 and three (Fishing, Electricity and Road Transport) in 2001. Road Transport and Electricity sectors have very high multipliers of 4 and above in 2001; (4.75, R1) and (4.31, R2) respectively. The high number of sectors with less than 1.5 multipliers across the years, coupled with the fairly high number of sectors multipliers at less than one indicates a structural weakness and low levels of interdependence of the sectors of the economy. This further attests to the results of the backward and forward linkages. Thus the extent to which expansion in consumption (demand) for goods and services within the economy can impact positively on the domestic economy is very little. The Other Manufacturing sector, considered to be the most useful source of positive externalities that can stimulate endogenous value-adding activities, have very low multipliers and rankings throughout the period as follows; (1.14, R18) in 1997, (1.17, R16) in 1998, (1.11, R18) in 1999, (1.11, R21) in 2000 and (1.32, R18) in 2001. Apart from illustrating a very insignificant direct and indirect impact of expansion in demand for goods and services of this sector, it also reflects the weaknesses of the domestic economy to respond to the basic goods and services requirements of the economy since the main household consumption needs of contemporary economies are manufacturing based. Furthermore, the manufacturing sector remains the most viable source of employment and more effective in absorbing and utilizing resources. Therefore, a lack of flourishing manufacturing sector tends to cripple the value-adding capabilities of factors of production thereby stultifying the chances of generating endogenous technological progress and by extension, economic growth. The Transport Services sector is indolent without any form of activity; it does not absorb from nor deliver to any sector of the economy reflecting in multiplier of one throughout the period, and thus ranking higher than some active sectors (with less than one multipliers) that have very high import intensity (delivering more than they absorb from other sectors of the economy). This higher ranking of the indolent Transport Services sector, which suggests non direct and indirect impact, can be misleading as tracking checks reveal that the indolence of the sector has adverse effect on the gross output of the economy due to "pull-effects" of the indolent sector on other sectors of the economy. The high multipliers for the Public Administration sector, especially between 1997 and 1999 reflect the public sector dominance of economic activities in the Nigerian economy.

Introducing the Household sector enables for determining the induced influence of household activities (consumption and labour services) which results into *Type 2* multipliers. *Type 2* multipliers for the thirty-four (including the household) sectors of the economy are presented in Table 7.10. As can be observed from the Table, the order of linkage relevance of the sectors changed significantly with the introduction of the Household sector. It is striking that some sectors with insignificant direct and indirect impact on the economy as their *Type 1* multipliers suggest have very high *Type 2* multipliers suggesting that such sectors have very high induced effect influence on the inter-linkage process of the economy. Rail Transport and Pipelines, which has *Type 1* multipliers ranging between 1.26 and 1.96 and rankings ranging between 5 and 12 has very high *Type 2* multipliers and ranking of 1 for all the years at 17.03 in 1997, 27.94 in 1998, 26.80 in 1999, 39.22 in 2000 and 39.89 in 2001. Even though the extreme values appear to be outliers, the high ranking of the sector could be as a result of the fact that the Rail Transport activities have been dysfunctional for years but with very large personnel hangover with entitlements to various income claims such as outstanding salaries and pensions. It therefore means that earnings are received without matching economic activities in the sector. Additional possible reason is the merger of the sector with Pipelines which is linked to the activities of the oil and gas industry as such has the potential for combined direct, indirect and induced impact on the economy as the *Type 2* multipliers imply. The Health sector has *Type 2* multiplier and ranking of (2.84, R2) in 1997, (4.13, R2) in 1998, (9.85, R2) in 1999, (10.34, R2) in 2000 and (11.63, R2) in 2001. For a sector with very low *Type 1* multipliers ranging from 0.77 to 0.96 and rankings ranging from 25 to 28, it shows a very high influence of household activities on the sector. Probably, the essential service delivery status of the sector with large number of trained professionals earning reasonably high income that has significant inducive effect on the economy explains the high *Type* 2 Multipliers of the sector. This reasoning extends to the Education sector though with relatively less level of induced effect influence compared with the Health sector. The *Type* 2 multipliers and rankings of the Education sector are; (2.60, R8) in 1997, (3.16, R5) in 1998, (6.01, R3) in 1999, (6.17, R3) in 2000 and (6.83, R4) in 2001.

The Household sector itself has *Type* 2 multipliers and rankings for the period thus; (2.82, R3) in 1997, (2.74, R7) in 1998, (2.78, R7) in 1999, (2.96, R10) in 2000 and (3.19, R12) in 2001. With reasonably high values especially in 1997, it indicates that the Household sector has significant induced effect on the inter-industry linkage process. A critical role of the Household sector in the inter-industry linkage process is expected. By and large the inter-industry linkage process is driven by consumption of households as the source of effective demand that provides the impetus for production and also the source of crucial factor input requirements for production. Consequently, the Household sector is expected to show a much higher level of induced effect significance but more curiously, the declining levels of significance after 1997 indicates a weakening induced effect linkage influence the Household sector. Public sector rationalisation policies, coupled with the difficult operational terrain that crippled vulnerable investment ventures as a result of various reform policies implemented which culminated into labour lay-offs and shrinking labour demand can be attributed to the decrease in household economic activities. It can be further observed that non-direct productive sectors of the economy have significant induced linkage effect on the economy than direct productive sectors such as Crop Production. Apart from those already mentioned (Rail Transport and Pipelines, Health, Education), other non-direct productive sectors with high *Type* 2 multipliers and ranking are; Broadcasting: (2.65, R5) in 1997, (3.26, R4) in 1998, (3.14, R6) in 1999, (3.90, R5) in 2000 and (3.97, R9) in 2001; Air Transport: (2.63, R6) in 1997, (2.29, R9) in 1998, (2.55, R9) in 1999, (3.70, R7) in 2000 and (7.27,R3) in 2001; Post: (2.61, R7) in 1997, (3.45, R3) in 1998, (3.40, R5) in 1999, (3.80, R6) in 2000 and (3.76, R10) in 2001; Public Administration: (2.53, R9) in 1997, (2.89, R6) in 1998, (4.90, R4) in 1999, (4.97, R4) in 2000 and (5.45, R7) in 2001 and Electricity: (2.78, R4) in 1997, (2.49, R8) in 1998, (2.67, R8) in 1999, (3.61, R8) in 2000 and (5.75, R6) in 2001. The two oil and gas sectors have insignificant induce effect on the economy as they both exhibit low *Type 2* multipliers and rankings throughout the period. The Oil Refining sector has Type two multipliers and ranking of (2.12, R16) in 1997, (2.21, R12) in 1998, (2.34, R10) in 1999, (1.98, R19) in 2000 and (1.76, R26) in 2001. For the Crude Petroleum sector, the *Type 2* multipliers and ranking are; (1.20, R32) in 1997, (1.29, R31) in 1998, (1.23, R31) in 1999, (1.18, R31) in 2000 and (1.37, R29) in 2001. It implies that despite the enormous activities of the oil and gas industry, it has very little linkage with activities of the household, which comprises mainly of consumption and labour services. The income earned by households in exchange for their services forms the basis for consumption of goods and services that can enhance the inter-industry linkage process, thus highlighting the relevance of employment generation abilities of the sectors of the economy. It is therefore pertinent to consider the employment effects and multipliers of the sectors.

Employment effect is the ratio of change in employment as a result of change in final demand (output) of sectors while employment multiplier is a measure of the extent of change in employment in the economy due to change in output of sectors of the economy. Table 7.11 presents the employment effects of the sectors of the economy. It shows that the Private and Non Profit Organisations sector has the highest employment effects, ranking 1 throughout the period with 0.278 in 1997, 0.240 in 1998, 0.208 in 1999, 0.174 in 2000 and 0.143 in 2001. This indicates that the sector has the most labour absorption capability among other sectors of the economy probably because of the limited absorptive capacity of the public sector which is the dominant employer of labour and lack of thriving real productive sectors that can create labour employment opportunities. The Rail Transport and Pipelines follows in order of employment effects measures ranking second throughout the period with 0.188 in 1997, 0.169 in 1998, 0.152 in 1999, 0.137 in 2000 and 0.124 in 2001. The Other Services sector ranked 3 for all the years with 0.043 in 1997, 0.032 in 1998, 0.022 in 1999, 0.018 in 2000 and 0.014 in 2001. None of the two oil and gas sectors has any significant employment effects. Both the Crude Petroleum and Oil Refining sectors have almost zero employment effects with the Crude Petroleum sector ranking between 27 and 31 while the Oil Refining sector ranked between 21 and 28. This implies that changes in demand (or expansion in output) in the oil and gas sector will not lead to significant change in the labour absorption. Considering that activities in the oil and gas sectors, especially the upstream subsector are capital intensive using sophisticated technological equipments with relatively small labour input requirements, the very low levels of employment effects of these sectors is perceivable. In general the labour absorption capacity of the sectors of the economy is very low as the employment effects range between 0.000 and 0.278 across the sectors througout the five year period of consideration.

Employment multipliers of the sectors, which measures the extent to which a change in output of a sector can generate labour absorption capability within the whole economy through chain impacts on activities of other sectors of the economy, has different order of sectoral relevance. As Table 7.12 shows, the Hotel and Restaurants, Crude Petroleum and Oil Refining have significant employment impact on the economy than all other sectors of the economy. The employment multipliers of 69.95 in 1997, 65.47 in 1998, 62.51 in 1999, 66.04 in 2000 and 67.45 in 2001 for the Hotels and Restaurants sector; 34.18 in 1997, 33.44 in 1998, 29.78 in 1999, 32.63 in 2000 and 38.43 in 2001 for the Crude Petroleum sector and 28.62 in 1997, 24.03 in 1998, 23.87 in 1999, 23.27 in 2000 and 59.38 in 2001 for the Oil Refining sector appear to be outliers. However, the nature of the Nigerian economy is such that revenue earning (rather than regenerating) aspects of oil and gas operation dominate any other economic activities and revenues earned are used to facilitate various consumption activities. Public sector projects such as constructions and the financing of public service activities without matching productive sector activities constitutes the nucleaus around which other economic activities revolve. This creates incentives for businesses that are based on consumption of goods and services that do not necessarily have linkage with productive sectors of the economy. By its nature, Hotels and Restaurant business thrives on flourishing businesses irrespective of their productive nature and tends to absorb increasing amount of goods and services from other sectors of the economy thereby stimulating chain of employments across sectors of the economy. In the case of the two oil and gas sectors, since it is the revenues derived from these sectors that determine the levels of expenditures that facilitate the process of chain activities, it is logical for these sectors to exhibit high employment multipliers. The activities of these sectors are lopsided, which may have given rise to the extreme values of the multipliers. For instance, the boost in the services of Hotels and Restaurants without a matching boost in real productive activities in the economy implies that financial resources are obtained from non-productive activities and expended for the consumption and the Hotels and Restaurant tend to be a key beneficiary. It implies also that the booming Hotels and Restaurants does not significantly absorb from other sectors of the economy. Therefore, a change in the pattern of demand that creates a basis for a higher level of interdependence with other sectors can lead to high multipliers. That is, the lopsidedness may have stifled the potential effect of a change in demand. In the case of the two oil and gas sectors, there are distortions arising from the fact that there is discordance between revenue earnings and real productive (value-adding) activities. As a result relatively small labour factor is involved. This can be described as gross underutilization of resources. It is therefore logical that a change to more value-adding productive activities could have a very high potential impact on the absorption of more labour inputs especially with a chain of other value activities that may spring up to further absorb more labour inputs. Other sectors with significant employment impact on the economy as indicated by their employment multipliers are; Cement: (8.98, R4) in 1997, (8.02, R4) in 1998, (4.06, R4) in 1999, (5.32, R4) in 2000 and (5.66, R4) in 2001; Other Manufacturing: (4.13, 5) in 1997, (4.06, R5) in 1998, (3.70, R5) in 1999, (3.56, R5) in 2000 and (3.40, R5) in 2001; Real Estate: (2.20, R6) in 1997, (2.23, R6) in 1998, (2.23, R6) in 1999, (2.21, R6 in 2000 and (2.15, R7) in 2001; Building and Construction: (1.82, R7) in 1997, (1.78, R7) in 1998, (1.75, R7) in 1999, (1.76, R8) in 2000 and (1.77, R9) in 2001; Public Administration: (1.52, R8) in 1997, (1.47, R9) in 1998, (1.45, R10) in 1999, (1.42, R11) in 2000 and (1.38, R12) in 2001 and Quarrying and Other Mining with (1.46, R9) in 1997, (1.71, R8) in 1998, (1.64, R8) in 1999, (1.77, R7) in 2000 and (1.97, R8) in 2001. All these sectors have direct relation with government expenditure activities, but the inclusion of the Cement, Other Manufacturing and Real Estate gives encouraging perception of possible spillover effects on other sectors of the economy.

In corollary, low employment effects and multipliers breeds low income effects and multipliers. The income effects, a measure of the ratio of change in income due to change in final demand (output), are presented in Table 7.13. It shows that the income effects of sectors of the economy are generally very low, with the exception of the Rail Transport and Pipelines sector with 5.320 in 1997, 9.668 in 1998, 9.102 in1999, 12.710 in 2000 and 11.828 in 2001 ranking 1 in all the years. These very high figures of the income effects reflects the existing distortions of the Rail Transport and Pipelines sector in terms of high income claims with little activities in the sector. Juxtaposing the high levels of the income effects with the virtual non relevance of the sector in terms of employment effects (for all the years) further illustrates this argument. The remaining sectors have income effects ranging between 0.000 for Coal Mining and the Transport Service sectors for all the years and 2.628 (R2) for the Health sector in 2001. It can be observed that the income effect significance of the Health sector changed from (0.324, R4) in 1997 to (0.740, R2) in 1998, (2.263, R2) in 1999, (2.418, R2) in 2000 and (2.628, R2) in 2001. Some other sectors that are with high income effects are; Broadcasting: (0.347, R3) in 1997, (0.607, R4) in 1998, (0.545, R6) in 1999, (0.735, R6) in 2000 and (0.659, R5) in 2001; Education: (0.230, R6) in 1997, (460, R5) in 1998, (1.376, R3) in 1999, (1.440, R3) in 2000 and (1.534, R3) in 2001; Public Administration: (0.197, R7) in 1997, (0.377, R6) in 1998, (1.109, R4) in 1999, (1.108, R4) in 2000 and (1.168, R4) in 2001; Post: (0.371, R2) in 1997, (0.684, R3) in 1998, (0.634, R5) in 1999, (0.737, R5) in 2000 and (0.638, R6) in 2001. The pattern of significance is different for the income multipliers, which measures the economy wide change in income as a result of change in output (final demand) of a sector. The income multipliers are presented in Table 7.14 showing that the Real Estate, Oil Refining, Hotel and Restaurants, Quarrying and Other Mining, Livestock and Road Transport sectors are the most income multiplier significant sectors of the economy. The Real Estate sector ranked 1 for all the years with 6.01 in 1997, 6.55 in 1998, 6.74 in 1999, 6.86 in 2000 and 6.81 in 2001. Oil Refining exhibits (3.42, R2) in 1997, (4.41, R2) in 1998, (4.17, R2) in 1999, (2.50, R5) in 2000 and (2.33, R6) in 2001; Hotel and Restaurants: (2.82, R3) in 1997, (2.94, R4) in 1998, (2.91, R4) in 1999, (3.01, R3) in 2000 and (3.15, R4) in 2001; Quarrying and Other Mining: (2.58, R4) in 1997, (3.14, R3) in 1998, (3.11, R3) in 1999, (3.68, R2) in 2000 and (5.44, R2) in 2001; Livestock: (2.41, R5) in 1997, (2.41, R5) in 1998, (2.28, R6) in 1999, (2.30, R7) in 2000 and (2.16, R7) in 2001 and Road Transport: (2.27, R6) in 1997, (2.22, R6) in 1998, (2.33, R5) in 1999, (2.78, R4) in 2000 and (5.00, R3) in 2001. The high income multiplier significance of the Oil Refining sector reflects the revenue earning influence of oil and gas activities on the economy.

Intuitively, employment and income are functions of value-added activities. Therefore the employment effects and multipliers as well as the income effects and multipliers are determined by value-added activities of sectors of the economy. The value-added effect is a measure of the ratio of change in value-added to a change in final demand. Table 7.15 presents the value-added effects while Table 7.16 presents the value-added multipliers of the sectors of the economy. Perhaps, due to its high labour absorption rate reflected in high employment effects, the Private Non Profit Organisations sector exhibits high value-added effects with rank of 1 for all the years and values of 0.985 in 1997, 0.988 in 1998, 0.988 in 1999, 0.989 in 2000 and 0.992 in 2001. Other high value-added sectors are; Water: (0.976, R2) in 1997, (0.982, R3) in 1998, (0.982, R3) in 1999, (0.982, R4) in 2000 and (0.979, R4) in 2001; Crude Petroleum: (0.973, R3) in 1997, (0.963, R5) in 1998, (0.975, R4) in 1999, (0.987, R3) in 2000 and (0.984, R2) in 2001; Forestry: (0.960, R4) in 1997, (0.970, R4) in 1998, (0.969, R5) in 1999, (0.976, R5) in 2000 and (0.975, R6) and Livestock: (0.951, R5) in 1997, (0.959, R6) in 1998, (0.944, R8) in 1999, (0.955, R8) in 2000 and (0.970, R8) in 2001. The Oil Refining sector exhibits very low level of value-added effects with (0.902, R9) in 1997, (0.865, R15) in 1998, (0.894, R13) in 1999, (0.946, R9) in 2000 and (0.962, R9) in 2001. While this is consistent with the employment effects of the sector, it does not conform to the operational process of the sector which is largely a value-adding activity sector. It therefore suggests that the sector is saddled with constrained absorptive capacity. The high level of value-added effects by the Crude Petroleum sector can be hinged on the fact that the products of the sector are key inputs as such a positive change in value-added activities by other sectors of the economy will logically exert demand pressure on the sector. In terms of value-added multipliers, a measure of the economy wide impact of change in value-added activities of a sector, the Oil Refining sector exhibits very high significance even though it declined in 2000 and 2001. The value-added multipliers and rankings of the sector for the sector are: (3.68, R1) in 1997, (4.45, R1) in 1998, (15.97, R1) in 1999, (3.04, R3) in 2000 and (1.37, R9) in 2001. The decline could be due to shrinking in the refining activities which results in constraints in absorptive capacity of the sector. The value-added multipliers of the Crude Petroleum are quite low at (1.07, R19) in 1997, (1.13, R16) in 1998, (1.10, R16) in 1999, (1.06, R22) in 2000 and (1.11, R18) in 2001. The most likely reasons for this value-added multiplier insignificance of the Crude Oil sector are the high export of crude oil with little deliveries to other sectors of the economy, low absorptive capacity of other sectors of the economy arising from inadequate domestic capabilities which also lead to inability of other sectors to contribute to the activities of the sector. The Hotel and Restaurants sector has high value-added significance with (3.40, R2) in 1997, (3.31, R2) in 1998, (2.54, R2) in 1999, (2.40, R4) in 2000 and (3.76, R1) in 2001. Other sectors with relatively high value-added multipliers are; Building and Construction (2.20, 3) in 1997, (2.51, R3) in 1998, (1.60, R5) in 1999, (1.92, R6) in 2000 and (2.17, R4) in 2001; Road Transport: (2.13, R4) in 1997, (1.41, R7) in 1998, (1.50, R6) in 1999, (7.73, R1) in 2000 but with a negative multiplier value of (-0.61, R31) in 2001. The negative multiplier for 2001 appears strange but declining oil refining activities which have adherent relatedness to transportation, coupled with high import content of transport equipments can lead to adverse net value-added impact of increase in transportation activities. The Other Manufacturing sector, a key source of value-adding activities for sustainable growth process exhibits relatively low value-added multipliers with (1.37, R9) in 1997, (1.40, R8) in 1998, (1.33, R10) in 1999, (1.33, R13) in 2000 but remarkably improved to (2.24, R3) in 2001.

From the expositions, inter-industry linkage process of the economy is characterized by very low levels of backward linkages but with relatively high levels of forward linkages both in terms of direct linkages and also Rasmussen's powers of dispersion and sensitivity. Thus comparatively, sectors of the economy are more able to deliver than absorb from other sectors of the economy. This implies that there is high level of sourcing of inputs from outside the economy while the relatively high level of deliveries could be as a result of high levels of consumption in the economy. There are a number of sectors with multipliers less than one and very few sectors with multipliers value of above 1.5. There are low levels of employment, income and value-added effects. The very high Forward linkage indicators of the household sector throughout the period points to the potential of the sector as catalyst for inter-industry linkage process of the economy. This is a reflection of the enormous human resource availability that can form the basis for a formidable inter-industry linkage process. The inability of the formal sectors of the economy to effectively use the available human resources has led to the resort to the informal sector, which explains the high employment and value-added significance of the Private Non Profit Organisation sector as reflected in high values for employment and value added effects but very low multiplier effects on the economy. There are few cases of outliers of the employment multipliers of the Hotel and Restaurants and Crude Petroleum and few others, which are attributable to the lopsidedness of the activities of these sectors. This give rise to distortions in the input-output data and may have reflected in limitations of the input-output table. Traditionally, manufacturing activities are regarded as the most potent source of value-adding activities. Three sectors comprising manufacturing are Oil Refining, Cement and Other manufacturing. The Oil Refining sector appears to have relatively high rankings for the backward and forward linkages, as well as for the *Type 1* output multipliers while the Cement and Other Manufacturing sectors performed far low in their rankings. Similarly the performance of these sectors in terms of *Type 2* multipliers is not better and even worse in terms of employment, income and value-added effects, though better in terms of employment, income and value-added multipliers. The other oil and gas sector, Crude Petroleum, have significant linkage relevance in employment and value-added multipliers as well as forward linkage indicators but very low and insignificant relevance in backward linkages and other linkage measures.

The undulation in the pattern of linkage significance of the Oil and Gas sectors especially the sharp decline in 2001, coupled with associated low values and rankings of other linkage measures illustrates a lack of cohesive integration of the sector with other sectors of the economy. Considering the nature of oil and gas activities and the dominance of the sector in the economy, the coefficients and spread of linkage relevance of the two oil and gas sectors is inadequate and could be the reason for the overall low level of inter-industry linkage process of the economy. A discernible analysis of the impact of the oil and gas industry in generating linkage stimuli to other sectors for enhancing the inter-industry linkage processes is discussed further in the next section.

7.3: STIMULI AND IMPACT OF THE OIL AND GAS INDUSTRY

Applying the *Hypothetical Extraction* method, the linkage measures of the reduced (31x31) matrix (after extracting the Crude Petroleum and Oil Refining sectors) is determined. The differences in the linkage measures of the two scenarios are stimuli indicators of the oil and gas industry. Table 7.17 presents the backward linkage stimuli effects of the oil and gas industry (in positive differences). The Air Transport sector rank 1 for all the years except 1999 with rank of 6, making it the most oil and gas stimuli effect sector. It is followed by the Road and Water Transport sectors ranking between 2 and 3 interchangeably for the years except 1999. The Electricity and Fishing sectors ranked 4 and 5 respectively throughout the years except 1999. Apart from the Transport Services sector which is presented by the input-output table as inactive, some other sectors indicate complete lack of any backward linkage stimuli effect from the oil and gas industry (i.e. zero stimuli indicators). These are the Livestock, Coal Mining, Metal Ores, Hotel and Restaurants, Real Estate, Business Services, Public Administration, Education, Health, Private Non Profit Organisation, Other Services and Broadcasting. Similarly, Table 7.18, which presents the forward linkage stimuli, shows that, the Public Administration, Education, Health, Private Non Profit Organisation and Broadcasting sectors do not derive any forward linkage stimulus from the oil and gas industry with zero forward linkage stimuli and rank of 1. It means that even after extracting the two oil and gas sectors, their forward linkage indicators remain unchanged. The Road Transport sector is the most dependent on the oil and gas industry for its forward linkage capability followed by Other Manufacturing, Financial Institutions and Crop Production sectors. From Table 7.19, there seem to be virtually no stimuli from the oil and gas sectors to other sectors of the economy for the Rasmussen's power of dispersion. There are few minuscule stimuli indicators such as 0.31 in Water and Air Transport in 2001; 0.09 and 0.025 for Road Transport in 1997 and 2001 respectively in case of the power of dispersion. The stimuli for Rasmussen sensitivity index as illustrated in Table 7.20 shows a relatively higher response for few sectors but with many sectors indicating zero stimuli, pointing to the fact that their ability to deliver to other sectors, as the sensitivity index implies, is not affected by other oil and gas sectors. Table 7.21 presents the multiplier stimuli (showing negative differences). It can be observed that virtually all the sectors with the exception of the two indolent sectors (Coal Mining and Transport Service), are affected by the absence of the oil and gas sectors implying that all the sectors and by extension the economy is affected by linkage stimuli from the oil and gas industry. The differences are indicated in negatives because the pre-extraction values were subtracted from the post-extraction values as such the ranking order is reversed so that the rank of 1 will imply least while 31 indicates the highest stimuli from the oil and gas industry. The most affected is the Road Transport sector with the multiplier stimuli of rank 31 followed by the Electricity, Fishing and Air Transport. The least affected are the Telecommunication, Livestock and the Private Non Profit Organisation.

The output impact of the oil and gas sectors is presented in Table 7.22 using absolute (positive) changes. It shows that the Road Transport is the most affected with the highest level of 46.95 per cent in 2001 followed by the Rail Transport and Pipelines and Financial Institutions. While the high level of impact on the transport related sectors is consistent with basic requirements of modern contemporary economies, the high impact on the Financial Institutions sector which was found to have very insignificant level of integration with other sectors of the economy, suggests that the activities of the financial institutions are largely influenced by oil revenues but without healthy intermediation that involves channeling accumulated savings to productive investments thereby accentuating the weak inter-industry linkage process. The Private Non Profit Organisations, Health, Education, Public Administration and Wholesale and Retail sectors are not affected by the absence of the oil and gas sectors. This implies that while revenues derived from oil and gas may have influenced the activities of these sectors, the actual activities of the sectors do not directly use inputs nor deliver outputs to the oil and gas industry. Considering the essentiality of the Health and Education sectors in human resource development and in addition to the R&D potentials of the Education sector, this is not healthy for inter-industry linkage process more so that it is capable of undermining effective utilisation of resources.

In order to evaluate the extent to which the existing inter-industry linkage structure can be improved by expansion in oil refining activities, a policy simulation of 25 per cent increase in the activities of the Oil Refining sector is carried out. The perspective for this simulation is hinged on the fact that oil refining activities are manufacturing by nature and manufacturing is regarded as the most viable source of endogenous value-adding stimuli with high level of spillover effects on other sectors of the economy. Also, the ultimate importance of oil and gas resources lies in the essentiality of the end products to virtually all aspects of economic activities from the oil and gas industry which are obtained from oil refining activities. Furthermore, even though the general level of inter-industry linkage process is not cohesive enough, the Oil Refining sector exhibited high levels of some basic linkage measures such as the output multipliers and forward linkage indicators thus prompting the applicability of the high linkage hypothesis, which says that identified high linkage sectors should be focused and given strategic policy priority for expansion in the activities of such sectors in order to boost inter-industry linkage processes towards sustainable economic growth process.

The direct backward linkage impact of import substitution is presented in Table 7.23 and it shows that there is no impact on the Coal Mining,, Hotel and Restaurants, Real Estate, Business Services, Public Administration, Education, Health, Private Non Profit Organisation, Other Services, and Broadcasting sectors, in addition to the obviously inactive Transport Services sector. The Road Transport sector has the highest impact ranking of 1 throughout the years with 20.38 percent in 1997, 18.66 percent in 1998, 19.39 percent in 1999, 22.50 percent in 2000 and 24.21 percent in 2001. It is followed by the Water Transport, ranking 2 throughout with 17.12 percent in 1997, 14.57 percent in 1998, 15.36 percent in 1999, 20.16 percent in 2000 and 23.27 percent in 2001; Air Transport ranked 3 in all the years with 16.60 percent in 1997, 13.98 percent in 1998, 14.79 percent in 1999, 19.77 percent in 2000 and 23.27 percent in 2001; Forestry ranked 5 for all the years with 14.03 percent in 1997, 11.71 percent in 1998, 12.98 percent in1999, 18.45 percent in 2000 and 22.70 percent in 2001; and Electricity ranked 6 throughout with 11.90 percent in 1997, 9.42 percent in 1998, 10.03 percent in 1999, 16.11 percent in 2000 and 21.41 percent in 2001. The backward linkage impacts of the oil and gas sectors are very low with the Crude Petroleum sector with: (3.91%, R11) in 1997, (2.52%, R12) in 1998, (2.86%, R12) in 1999, (6.30%, R12) in 2000 and (12.64%, R12) in

2001 while Oil Refining has: (0.02%, R20) in 1997, (0.01%, 19) in 1998, (0.01%, R19) in 1999, (0.02%, R20) in 2000 and (1.14%, R19) in 2001. The low levels of backward linkage impacts of import substitution of the oil and gas sectors could have stemmed from the fact that the inputs of the sectors are capital equipments intensive, coupled with the low level of technology of the economy, which meant that the domestic economy cannot deliver the equipment and machinery needs of the oil and gas sectors.

Extending the analysis to forward linkage impacts of import substitution presented in Table 7.24, it shows that refining activities have no impact on the Public Administration, Education, Health, Water and Private Non Profit Organisations. Interestingly, the same sectors showed indifference in the hypothetical extraction scenario. The Oil Refining sector itself leads in the forward linkage impacts of increase refining activities. This is expected since more refining activities means more ability to deliver products to other sectors of the economy but a 26 percent increase in refining activities resulting into 15.7 percent increase in forward linkage effects in 1997, 15.1 percent in 1998, 15.4 percent in 1999, 18.9 percent in 2000 and 24.0 percent in 2001 points to defects in the absorptive capacity of the refining sector. While a direct linear functional relationship is not expected, the levels and pattern of disproportion is not inspiring enough to suggest the existence of effective use of available stimulus from different sectors of the economy. Accordingly, the Crude Petroleum sector follows in ranking since more refining means more use of crude and thus more deliveries of Crude Petroleum to domestic refineries. The impacts of 10.3 per cent in 1997, 8.5 per cent in 1998, 10.3 percent in 1999, 14.6 percent in 2000 and 18.6 percent in 2001 appear to be disproportionate with the level of increase in refining activities. The Road Transport sector follows with a range of 2.5 percent in 1997 to 10.8 percent in 2001 and Other Manufacturing sector ranging from 0.3 percent in 1997 to 4.0 per cent in 2001.

The impact of import substitution on the Rasmussen dispersion index is presented in Table 7.25 and it shows that the highest response in 1997 is from the Road Transport sector with 2.36 percent followed by Air Transport with 2.36 percent and the Water Transport sector with 2.28 percent. The Air Transport has the highest response in 1998 and 1999 with 2.25 percent and 2.39 percent respectively but declined to 2 in 2000 with 2.81 and to 7 with 2.55 in 2001. The Road Transport sector declined in ranking to 5 in both 1998 and 1999 with 1.37 percent and 1.63 percent respectively and marginally improve to 4 in 2000 and 2001 with 2.74 and 2.82 respectively. The Water Transport sector ranked 2 in 1998 and 1999 with 2.04 percent and 2.32 percent, 1 in 2000 with 2.87 and 5 in 2001 with 2.80. The relative significance of the Transportation sectors reflects both their networking role and the direct consumption of refined products as a basic requisite of transportation services. Curiously, the response from the two oil and gas sectors is negative. For the Oil Refining sector, it can deduced that the negativity is reflection of the inability of the sector based on existing structures and operational mechanisms to cope with the import substitution requirement and also the fact that the domestic economy cannot serve it's import needs. For the Crude Petroleum sector, its high technology inclination implies that any additional activity cannot lead to little or additional inputs from the domestic economy.

The import substitution impact on the Rasmussen sensitivity index is presented in Table 7.26. It shows Oil Refining with the highest response of 3.41 percent in 1997, 3.14 percent in 1998, 3.34 percent in1999, 3.40 percent in 2000 and 1.75 percent in 2001 with rank of 1for four years and 2 only in 2001. This is followed by the Crude Petroleum with 1.94 percent in 1997, 1.64 in 1998, 1.89 in 1999, 2.34 in 2000 and 2.71 in 2001 with rank of 2 for four years and 1 only in 2001. These points to the fact that the delivery capability of these key sectors is low as all responses by other sectors are even much lower and in some cases negative.

The multiplier impacts of the import substitution is presented in Table 7.27 and it shows a very marginal increase in the multipliers of the sectors of the economy with the highest impact of 21 per cent in 2001 while others range between 0.1 to 15.1 per cent. Consistent with previous impact analysis, the Road Transport sector also have the most output impact as a result of import substitution, followed by Electricity, Fishing, Oil Refining, and Air Transport sectors. Apart from Fishing, all these sectors with high levels of import substitution impact have direct need for end products of oil and gas resources for their effective operations. It can be argued that given the nature of underutilization of resources of the economy, the level of response to the increase in refining activities, ranging from 0.1 to 11.3 percent in 1997, 0.1 to 8.8 percent in 1998, 0.1 to 9.8 percent in 1999, 0.3 to 14.3 percent in 2000 and 0.6 to 21.0 percent in 2001 does not point to a large enough additional productive synergy of the sectors of the economy.

Table 7.28 illustrates the output response to import substitution. The Oil Refining and Crude Petroleum sectors exhibit the highest response ranging between 22.97 per cent and 30.38 per cent across the years for Oil Refining and 2.76 percent and 5.12 percent for the Crude Petroleum. The low output response of the Crude Petroleum sector could be as a result of output restriction policies of OPEC to which Nigeria is a member. Again, in consonance with high petroleum products use analogy, the Road Transport, Electricity, Water Transport and Rail Transport and Pipelines follow in the order of response to increase in refining activities as simulated. However, with the level response of these sectors ranging from 1.10 percent to 9.97 percent, it is obvious that the 25 percent increase in refining activities has resulted in a far less disproportionate impact on output by sectors of the economy.

Thus from the measurement impacts of backward and forward linkages and output multipliers, increase in oil refining activities will not significantly improve the inter-industry linkage and output performance of the economy. This implies that the low level of integration of the oil and gas industry and low level of inter-industry linkages of sectors of the economy is not merely because of lack of adequate refining activities but rather and more fundamentally, as a result of incapability of existing productive structures to absorb linkage and productive stimulus. In essence, much as refining activities are crucial in generating stimuli for value-adding activities that can spearhead effective inter-industry linkages and efficient productive activities, the structures for making use of linkage and productive opportunities are necessary preconditions for benefiting from the linkage and productive opportunities.

Overall, the empirical expositions of inter-industry linkages in the Nigerian economy and the impacts of the oil and gas industry are not robust enough to generate and absorb productive incentives. The analysis of traditional linkage measures, the hypothetical extraction scenario and the import substitution simulation all tend to converge on this conclusion. Table 7.29 presents the aggregates of all the scenarios as summary; pre-extraction, post-extraction and import substitution aggregate backward linkage indicators, forward linkage indicators, Rasmussen's dispersion and sensitivity indices as well as multipliers and outputs. It also shows the average impacts of the hypothetical extraction and import substitution. Noticeably, the output impacts of import substitution range between 0.79 percent to 7.64 percent implying that a 25 percent increase in refining will lead to a mere change in output by a measure of 0.79 to 7.64 percent while the impacts of hypothetical extraction range between 15.13 percent and 40.03 percent, suggesting that a complete non existence of the oil and gas industry will affect the activities of other sectors of the economy by a measure of 15.13 to 40.03 percent reduction in output.

In all, it shows that substantial number of sectors derives very low backward and forward linkage as well as multiplier stimuli from the oil and gas sectors of the economy. The preponderance of low linkage stimuli sectors could be a reflection of the fact that the linkage stimulus from the oil and gas industry to other sectors of the economy does not involve core activities of the oil and gas industry. This amplifies the argument that the level of inter-industry linkages is not inspiring enough and the oil and gas industry, a veritable source of linkage stimulus tend to be inadequately integrated with other sectors of the economy. As an *ex post* (against an *ex ante*) linkage measures, the inter-industry linkage indicators presented and analysed represent actual inducements offering sectors or a group of sectors (if final demand is considered) opportunities for enhancing their productive activities through inter-industry linkages.

Previous inter-industry linkage analysis by Ajakaiye (1990); 1973-1977, revealed a weakening inter-industry linkages and associated low level of absorptive capacity of the sectors during the period and argued that the economy did not benefit from the opportunities of growth derivable from the expansion of activities in the oil and gas industry that was brought about by increased demand and prices of oil in the international market. From Falokun's (1998) factor decomposition analysis, the crude petroleum sector was the most dominant in output expansion between 1973 and 1980 due mainly to export of crude petroleum (E-effect). This changed during the period 1980-1985 as a result of the prolonged glut in the international market which led to the collapse of the international oil prices. Sectors such as Agriculture, Distributive Trade and Fabricated Metals emerged as "key" industries in terms of gross output expansion stimulated mainly by the domestic final demands (F_d-effect). The crude petroleum sector re-emerged as a dominant sector in output expansion between 1985 and 1990 driven by increased export (E-effect) as propelled by increased demand and prices of oil in the international market. Both strands of analysis show the extent to which potential stimuli for inter-industry linkages, which could generate endogenous growth of the economy, have been frittered by large and increasing export of crude oil and decreasing domestic utilisation of crude oil.

Inter-industry linkage analysis carried out for the period 1997-2001 based on direct backward and forward linkage indicators, Rasmussen's indices of dispersion and sensitivity, as well as multipliers and other linkage measures indicates that the activities of the oil and gas industry are not adequately integrated with sectors of the economy leading to low levels of inter-industry linkages. This is further amplified by the use of hypothetical extraction methods to determine the stimuli from the oil and gas sectors to other sectors of the economy and also the imposition of 25 per cent import substitution of downstream activities. The activities of the industry do not seem to be propelling other sectors for a formidable inter-industry linkage process.

As observed by Bulmer-Thomas (1982), linkage coefficients are not guarantees that the stimuli of inter-industry linkages are translated into actual growth of the economy. The stimuli may be simply absorbed as increased imports or higher prices of under-utilised capacity unless there is a given market size that is consistent with capacity expansion, availability of complementary inputs (credit, skilled labour, etc). A protection policy that discourages firms from responding to any stimuli could undermine the growth process of the economy that could be driven by inter-industry linkage coefficients. Linkage analysis does not permit us to distinguish between cases where; (a) the stimulus is big enough to justify establishing a supplying or a using industry which is efficient; (b) the stimulus is big enough to justify establishing a supplying or using industry which is not efficient and (c) the stimulus is not big enough to justify establishing a supplying or using industry. It implies therefore that while linkage coefficients provide insights into the interdependent absorption of goods and services among different sectors/industries of the economy, it does not sufficiently illuminate the possibilities of additional opportunities that are constrained by policy and operational inadequacies that could be tackled to enhance the levels of inter-industry linkages and the growth performance of the economy. It is therefore necessary to complement the discussion of inter-industry linkages with a qualitative analysis of the contributions of the oil and gas industry to the growth process of the Nigerian economy based on evaluation of the operations and performance indicators of the industry as well as the growth performance of the Nigerian economy. This is carried out in chapter 8 that follows.

Table 7.3: TYPE 1 BACKWARD LINKAGE INDICATORS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.17	23	0.16	22	0.16	23	0.17	23	0.17	24
Livestock	0.20	20	0.19	20	0.19	19	0.19	21	0.16	25
Forestry	0.15	24	0.10	28	0.10	28	0.15	24	0.32	16
Fishing	0.37	14	0.29	18	0.34	15	0.66	7	1.36	5
Coal Mining	0.00	32	0.00	32	0.00	32	0.00	32	0.00	32
Crude Petroleum & Natural Gas	0.09	28	0.15	24	0.11	26	0.07	30	0.12	27
Metal Ores	0.09	29	0.11	27	0.12	25	0.13	26	0.13	26
Quarrying & Other Mining	0.20	21	0.16	21	0.18	21	0.23	19	0.36	13
Oil Refining	0.76	4	0.81	1	0.94	1	0.69	6	0.30	17
Cement	0.70	5	0.66	4	0.68	3	0.71	5	0.81	6
Other Manufacturing	0.55	10	0.53	6	0.54	6	0.56	11	0.75	8
Electricity	0.58	9	0.46	9	0.53	7	0.85	4	2.04	4
Water	0.07	30	0.06	30	0.07	30	0.11	27	0.25	22
Building & Construction	0.65	6	0.67	3	0.51	9	0.58	9	0.62	9
Wholesale and Retail Trade	0.29	18	0.30	16	0.32	17	0.32	16	0.33	15
Hotel and Restaurants	0.76	3	0.75	2	0.67	4	0.65	8	0.77	7
Road Transport	0.60	7	0.37	12	0.40	13	0.88	3	2.40	3
Rail Transport & Pipelines	0.81	1	0.29	17	0.27	18	0.31	17	0.55	11
Water Transport	0.60	8	0.48	8	0.57	5	1.12	2	2.82	2
Air Transport	0.77	2	0.62	5	0.72	2	1.34	1	3.39	1
Transport Services	0.00	32	0.00	32	0.00	32	0.00	32	0.00	32
Telecommunications	0.41	13	0.45	10	0.51	8	0.56	10	0.57	10
Post	0.31	17	0.35	13	0.40	12	0.36	12	0.33	14
Financial Institutions	0.13	26	0.12	26	0.13	24	0.17	22	0.28	20
Insurance	0.17	22	0.16	23	0.17	22	0.22	20	0.36	12
Real Estate	0.12	27	0.10	29	0.09	29	0.08	29	0.07	30
Business Services	0.33	16	0.34	14	0.34	16	0.33	15	0.28	19
Public Administration	0.53	11	0.50	7	0.47	10	0.35	13	0.27	21
Education	0.46	12	0.43	11	0.41	11	0.30	18	0.23	23
Health	0.21	19	0.19	19	0.18	20	0.14	25	0.11	28
Private Non Profit Organisations	0.04	31	0.04	31	0.04	31	0.04	31	0.03	31
Other Services	0.14	25	0.13	25	0.11	27	0.10	28	0.07.	29
Broadcasting	0.35	15	0.34	15	0.34	14	0.35	14	0.29	18

Table 7.4: TYPE 2 BACKWARD LINKAGE INDICATORS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.19	29	0.19	26	0.19	26	0.20	27	0.19	27
Livestock	0.20	25	0.20	24	0.20	24	0.20	28	0.17	28
Forestry	0.26	23	0.19	25	0.18	28	0.22	26	0.38	21
Fishing	0.43	19	0.34	20	0.38	20	0.71	14	1.40	9
Coal Mining	0.00	33	0.00	33	0.00	33	0.00	33	0.00	33
Crude Petroleum & Natural Gas	0.09	32	0.16	30	0.12	31	0.08	32	0.12	30
Metal Ores	0.45	18	0.48	17	0.49	17	0.56	19	0.57	18
Quarrying & Other Mining	0.20	26	0.16	29	0.18	27	0.24	25	0.36	23
Oil Refining	0.76	6	0.81	8	0.95	7	0.69	15	0.30	26
Cement	0.71	11	0.68	12	0.69	11	0.72	13	0.82	13
Other Manufacturing	0.58	16	0.56	15	0.57	15	0.60	18	0.78	14
Electricity	0.80	3	0.68	11	0.76	9	1.17	7	2.34	6
Water	0.20	28	0.18	27	0.19	25	0.32	23	0.46	20
Building & Construction	0.71	10	0.73	10	0.54	16	0.63	17	0.67	17
Wholesale and Retail Trade	0.31	22	0.32	21	0.34	21	0.34	22	0.34	24
Hotel and Restaurants	0.78	5	0.76	9	0.68	12	0.66	16	0.78	15
Road Transport	0.61	15	0.37	19	0.40	18	0.89	11	2.40	5
Rail Transport & Pipelines	6.13	1	9.95	1	9.36	1	13.02	1	12.37	1
Water Transport	0.65	14	0.53	16	0.62	14	1.19	6	2.89	4
Air Transport	0.79	4	0.64	13	0.74	10	1.36	5	3.41	2
Transport Services	0.00	33	0.00	33	0.00	33	0.00	33	0.00	33
Telecommunications	0.53	17	0.58	14	0.64	13	0.75	12	0.72	16
Post	0.68	13	1.03	3	1.03	5	1.09	8	0.96	11
Financial Institutions	0.24	24	0.22	23	0.23	23	0.28	24	0.37	22
Insurance	0.31	21	0.29	22	0.29	22	0.36	21	0.47	19
Real Estate	0.13	31	0.10	32	0.09	32	0.08	31	0.07	32
Business Services	0.38	20	0.39	18	0.38	19	0.38	20	0.33	25
Public Administration	0.72	9	0.86	7	1.57	4	1.45	4	1.43	8
Education	0.72	8	0.94	5	1.94	3	1.84	3	1.86	7
Health	0.72	7	1.21	2	3.25	2	3.20	2	3.35	3
Private Non Profit Organisations	0.20	27	0.18	28	0.17	29	0.17	29	0.14	29
Other Services	0.17	30	0.15	31	0.13	30	0.12	30	0.09	31
Broadcasting	0.68	12	0.93	6	0.88	8	1.07	9	0.94	12
Household	1	2	1	4	1	6	1	10	1	10

Table 7.5: TYPE 1 FORWARD LINKAGE INDICATORS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	2.58	3	2.56	1	2.22	4	2.28	3	2.52	4
Livestock	1.50	6	1.50	6	1.42	7	1.36	7	1.42	7
Forestry	1.05	12	1.06	12	1.04	13	1.07	11	1.07	11
Fishing	0.97	22	1.01	15	0.99	23	0.96	23	1.03	14
Coal Mining	0.01	33	0.06	32	0.21	28	0.85	25	0.75	27
Crude Petroleum & Natural Gas	2.58	2	2.11	5	2.71	1	3.76	2	3.58	2
Metal Ores	0.03	32	1.00	20	1.00	19	1.00	19	1.00	20
Quarrying & Other Mining	1.12	9	1.33	7	1.14	9	1.28	8	1.35	8
Oil Refining	2.98	1	2.24	4	2.50	2	4.86	1	14.14	1
Cement	0.82	24	0.80	25	0.46	27	0.59	28	0.63	28
Other Manufacturing	2.49	4	2.37	2	2.09	5	1.87	5	1.58	5
Electricity	1.08	10	1.06	11	1.05	11	1.05	12	1.05	13
Water	1.01	15	1.00	17	1.00	16	1.00	16	1.00	17
Building & Construction	1.13	8	1.12	9	1.19	8	1.15	9	1.14	10
Wholesale and Retail Trade	1.00	18	1.00	21	1.00	20	1.00	20	1.00	21
Hotel and Restaurants	0.99	21	1.03	13	1.05	12	1.04	13	1.05	12
Road Transport	1.96	5	2.30	3	2.33	3	2.24	4	2.93	3
Rail Transport & Pipelines	1.00	17	1.00	19	1.00	18	1.00	18	1.00	19
Water Transport	0.15	29	0.16	30	0.17	31	0.17	31	0.18	31
Air Transport	0.18	27	0.20	28	0.21	29	0.22	29	0.23	29
Transport Services	1.00	18	1.00	21	1.00	20	1.00	20	1.00	21
Telecommunications	0.04	31	0.04	33	0.04	33	0.04	33	0.05	33
Post	1.00	16	1.00	18	1.00	17	1.00	17	1.00	18
Financial Institutions	0.68	25	0.75	26	0.77	25	0.77	27	0.88	25
Insurance	0.08	30	0.10	31	0.10	32	0.11	32	0.13	32
Real Estate	1.21	7	1.33	8	1.42	6	1.49	6	1.42	6
Business Services	0.15	28	0.18	29	0.19	30	0.20	30	0.20	30
Public Administration	1.01	13	1.01	14	1.01	14	1.02	14	1.02	15
Education	0.86	23	0.88	24	0.89	24	0.93	24	0.94	24
Health	0.63	26	0.73	27	0.74	26	0.79	26	0.81	26
Private Non Profit Organisations	1.00	18	1.00	21	1.00	20	1.00	20	1.00	21
Other Services	1.08	11	1.10	10	1.13	10	1.13	10	1.16	9
Broadcasting	1.01	14	1.01	16	1.01	15	1.01	15	1.01	16

Table 7.6: TYPE 2 FORWARD LINKAGE INDICATORS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	8.92	3	11.63	3	13.07	3	14.34	3	16.29	3
Livestock	2.51	7	2.81	8	2.89	8	3.17	9	3.45	8
Forestry	1.17	21	1.26	20	1.34	18	1.50	17	1.52	14
Fishing	1.81	10	2.25	11	2.46	10	2.79	10	3.03	9
Coal Mining	1.57	14	1.07	24	1.02	27	1.00	28	1.00	28
Crude Petroleum & Natural Gas	3.91	5	3.16	6	4.53	6	7.68	5	7.16	5
Metal Ores	1.01	29	1.00	31	1.00	31	1.00	30	1.00	30
Quarrying & Other Mining	1.68	13	1.75	13	1.67	13	1.77	12	1.85	12
Oil Refining	5.50	4	4.36	4	5.17	4	11.76	4	33.68	1
Cement	1.32	16	1.33	17	1.38	17	1.38	18	1.37	18
Other Manufacturing	10.68	2	12.79	2	14.24	2	17.79	2	14.42	4
Electricity	1.14	22	1.13	21	1.13	21	1.14	21	1.14	21
Water	1.03	26	1.05	25	1.05	24	1.06	25	1.06	25
Building & Construction	1.29	19	1.34	16	1.54	14	1.52	16	1.50	17
Wholesale and Retail Trade	1.00	32	1.00	32	1.00	32	1.00	31	1.00	31
Hotel and Restaurants	2.45	8	3.13	7	3.49	7	3.74	7	3.65	7
Road Transport	3.38	6	4.26	5	4.59	5	4.72	6	5.35	6
Rail Transport & Pipelines	1.00	31	1.00	30	1.00	30	1.00	29	1.00	29
Water Transport	1.04	25	1.04	26	1.03	26	0.99	34	1.00	34
Air Transport	1.36	15	1.45	14	1.46	16	1.52	15	1.52	15
Transport Services	1.00	32	1.00	32	1.00	32	1.00	31	1.00	31
Telecommunications	1.31	17	1.31	18	1.27	20	1.23	20	1.20	20
Post	1.01	30	1.01	29	1.01	29	1.01	26	1.01	26
Financial Institutions	2.27	9	2.42	9	2.42	11	2.49	11	2.57	11
Insurance	1.30	18	1.30	19	1.30	19	1.33	19	1.30	19
Real Estate	1.70	12	2.26	10	2.73	9	3.28	8	2.91	10
Business Services	1.80	11	1.76	12	1.68	12	1.59	14	1.51	16
Public Administration	1.03	27	1.04	27	1.05	25	1.06	24	1.07	24
Education	1.06	23	1.09	22	1.09	22	1.10	23	1.11	23
Health	1.05	24	1.08	23	1.08	23	1.12	22	1.11	22
Private Non Profit Organisations	1.00	32	1.00	32	1.00	32	1.00	31	1.00	31
Other Services	1.23	20	1.35	15	1.50	15	1.61	13	1.66	13
Broadcasting	1.01	28	1.01	28	1.01	28	1.01	27	1.01	27
Household	10.72	1	16.79	1	20.19	1	25.04	1	24.01	2

Table 7.7: RASMUSSEN COEFFICIENT OF DISPERSION

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.31	32	0.31	33	0.33	32	0.34	31	0.32	31
Livestock	0.45	27	0.45	28	0.46	26	0.47	27	0.46	28
Forestry	0.54	17	0.52	17	0.52	18	0.54	19	0.58	18
Fishing	0.58	11	0.55	14	0.57	12	0.65	4	0.73	4
Coal Mining	0.39	29	0.48	24	0.50	24	0.50	25	0.50	25
Crude Petroleum & Natural Gas	0.31	33	0.36	31	0.30	33	0.23	33	0.27	32
Metal Ores	0.54	16	0.54	16	0.55	15	0.57	15	0.62	12
Quarrying & Other Mining	0.47	26	0.45	26	0.49	25	0.51	23	0.55	21
Oil Refining	0.39	30	0.46	25	0.46	27	0.27	32	0.10	33
Cement	0.59	8	0.58	8	0.58	11	0.59	9	0.63	10
Other Manufacturing	0.31	31	0.33	32	0.35	31	0.37	30	0.45	29
Electricity	0.63	3	0.60	6	0.62	3	0.69	3	0.80	3
Water	0.52	18	0.52	19	0.52	19	0.54	18	0.58	19
Building & Construction	0.60	7	0.61	4	0.55	14	0.59	11	0.63	9
Wholesale and Retail Trade	0.58	10	0.58	11	0.58	9	0.60	7	0.65	7
Hotel and Restaurants	0.63	4	0.62	3	0.60	4	0.61	5	0.65	6
Road Transport	0.50	23	0.40	30	0.42	30	0.52	21	0.62	11
Rail Transport & Pipelines	0.57	13	0.56	13	0.57	13	0.60	8	0.66	5
Water Transport	0.66	2	0.63	2	0.66	2	0.74	2	0.85	2
Air Transport	0.68	1	0.64	1	0.67	1	0.76	1	0.86	1
Transport Services	0.50	22	0.50	22	0.50	22	0.50	24	0.50	24
Telecommunications	0.56	14	0.57	12	0.59	8	0.61	6	0.65	8
Post	0.57	12	0.58	9	0.59	7	0.59	10	0.61	13
Financial Institutions	0.43	28	0.43	29	0.44	28	0.47	28	0.49	27
Insurance	0.52	19	0.52	18	0.53	17	0.55	16	0.60	15
Real Estate	0.48	25	0.45	27	0.43	29	0.42	29	0.44	30
Business Services	0.48	24	0.49	23	0.50	21	0.53	20	0.55	20
Public Administration	0.61	5	0.61	5	0.60	5	0.59	13	0.59	16
Education	0.60	6	0.60	7	0.59	6	0.58	14	0.59	17
Health	0.55	15	0.55	15	0.55	16	0.54	17	0.54	22
Private Non Profit Organisations	0.51	21	0.51	21	0.51	20	0.51	22	0.51	23
Other Services	0.52	20	0.51	20	0.50	23	0.50	26	0.50	26
Broadcasting	0.58	9	0.58	10	0.58	10	0.59	12	0.61	14

Table 7.8: RASMUSSEN COEFFICIENT OF SENSITIVITY

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.69	2	0.69	1	0.67	2	0.66	3	0.68	3
Livestock	0.55	7	0.55	6	0.54	8	0.53	7	0.54	6
Forestry	0.46	17	0.48	17	0.48	16	0.46	15	0.42	16
Fishing	0.42	23	0.45	20	0.43	22	0.35	30	0.27	30
Coal Mining	0.61	5	0.52	10	0.50	10	0.50	9	0.50	9
Crude Petroleum & Natural Gas	0.69	1	0.64	3	0.70	1	0.77	1	0.73	2
Metal Ores	0.46	18	0.46	18	0.45	19	0.43	19	0.38	22
Quarrying & Other Mining	0.53	8	0.55	8	0.51	9	0.49	11	0.45	13
Oil Refining	0.61	4	0.54	9	0.54	7	0.73	2	0.90	1
Cement	0.41	26	0.42	26	0.42	23	0.41	25	0.37	24
Other Manufacturing	0.69	3	0.67	2	0.65	3	0.63	4	0.55	5
Electricity	0.37	31	0.40	28	0.38	31	0.31	31	0.20	31
Water	0.48	16	0.48	15	0.48	15	0.46	16	0.42	15
Building & Construction	0.40	27	0.39	30	0.45	20	0.41	23	0.37	25
Wholesale and Retail Trade	0.42	24	0.42	23	0.42	25	0.40	27	0.35	27
Hotel and Restaurants	0.37	30	0.38	31	0.40	30	0.39	29	0.35	28
Road Transport	0.50	11	0.60	4	0.58	4	0.48	13	0.38	23
Rail Transport & Pipelines	0.43	21	0.44	21	0.43	21	0.40	26	0.34	29
Water Transport	0.34	32	0.37	32	0.34	32	0.26	32	0.15	32
Air Transport	0.32	33	0.36	33	0.33	33	0.24	33	0.14	33
Transport Services	0.50	12	0.50	12	0.50	12	0.50	10	0.50	10
Telecommunications	0.44	20	0.43	22	0.41	26	0.39	28	0.35	26
Post	0.43	22	0.42	25	0.41	27	0.41	24	0.39	21
Financial Institutions	0.57	6	0.57	5	0.56	6	0.53	6	0.51	7
Insurance	0.48	15	0.48	16	0.47	17	0.45	18	0.40	19
Real Estate	0.52	9	0.55	7	0.57	5	0.58	5	0.56	4
Business Services	0.52	10	0.51	11	0.50	13	0.47	14	0.45	14
Public Administration	0.39	29	0.39	29	0.40	29	0.41	21	0.41	18
Education	0.40	28	0.40	27	0.41	28	0.42	20	0.41	17
Health	0.45	19	0.45	19	0.45	18	0.46	17	0.46	12
Private Non Profit Organisations	0.49	13	0.49	13	0.49	14	0.49	12	0.49	11
Other Services	0.48	14	0.49	14	0.50	11	0.50	8	0.50	8
Broadcasting	0.42	25	0.42	24	0.42	24	0.41	22	0.39	20

Table 7.9: TYPE 1 OUTPUT MULTIPLIERS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	1.16	16	1.16	17	1.10	19	1.18	17	1.20	20
Livestock	1.22	13	1.21	13	1.20	14	1.22	16	1.20	21
Forestry	1.22	14	1.14	19	1.14	16	1.24	15	1.51	13
Fishing	1.33	10	1.24	12	1.34	10	1.77	4	2.79	3
Coal Mining	0.01	33	0.05	32	0.21	30	0.85	27	0.75	30
Crude Petroleum & Natural Gas	1.14	19	1.20	14	1.16	15	1.14	19	1.30	19
Metal Ores	0.03	32	1.17	15	1.21	13	1.31	13	1.60	10
Quarrying & Other Mining	0.99	24	1.10	20	1.10	20	1.32	12	1.65	8
Oil Refining	1.89	2	1.90	1	2.09	1	1.84	3	1.63	9
Cement	1.16	17	1.10	21	0.62	26	0.87	26	1.06	24
Other Manufacturing	1.14	18	1.17	16	1.11	18	1.11	21	1.32	18
Electricity	1.81	3	1.60	4	1.75	2	2.35	2	4.31	2
Water	1.09	21	1.07	23	1.09	21	1.17	18	1.40	16
Building & Construction	1.71	4	1.76	2	1.46	6	1.67	5	1.94	6
Wholesale and Retail Trade	1.37	8	1.36	9	1.40	8	1.51	7	1.86	7
Hotel and Restaurants	1.66	5	1.67	3	1.60	4	1.66	6	1.99	4
Road Transport	1.92	1	1.55	6	1.68	3	2.47	1	4.75	1
Rail Transport & Pipelines	1.31	12	1.26	11	1.32	11	1.47	8	1.96	5
Water Transport	0.29	28	0.28	29	0.33	29	0.50	30	1.00	26
Air Transport	0.38	27	0.36	28	0.43	28	0.69	28	1.42	15
Transport Services	1.00	23	1.00	25	1.00	24	1.00	24	1.00	27
Telecommunications	0.05	31	0.05	33	0.06	33	0.07	33	0.10	33
Post	1.33	9	1.38	7	1.45	7	1.46	9	1.56	12
Financial Institutions	0.52	26	0.56	27	0.60	27	0.67	29	0.85	29
Insurance	0.09	30	0.10	31	0.12	32	0.14	32	0.19	32
Real Estate	1.10	20	1.08	22	1.08	22	1.09	22	1.12	23
Business Services	0.14	29	0.17	30	0.19	31	0.22	31	0.25	31
Public Administration	1.62	6	1.57	5	1.53	5	1.45	10	1.49	14
Education	1.31	11	1.32	10	1.30	12	1.29	14	1.34	17
Health	0.77	25	0.88	26	0.89	25	0.92	25	0.96	28
Private Non Profit Organisations	1.04	22	1.04	24	1.04	23	1.05	23	1.06	25
Other Services	1.16	15	1.14	18	1.12	17	1.13	20	1.15	22
Broadcasting	1.39	7	1.38	8	1.38	9	1.44	11	1.57	11

Table 7.10: TYPE 2 OUTPUT MULTIPLIERS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	1.34	29	1.32	27	1.33	28	1.38	28	1.37	28
Livestock	1.33	30	1.31	28	1.31	29	1.33	29	1.29	30
Forestry	1.61	23	1.45	26	1.42	26	1.51	25	1.78	25
Fishing	1.89	19	1.69	20	1.82	19	2.44	14	3.57	11
Coal Mining	1.00	33	1.00	33	1.00	33	1.00	33	1.00	33
Crude Petroleum & Natural Gas	1.20	32	1.29	31	1.23	31	1.18	31	1.37	29
Metal Ores	2.23	13	2.21	11	2.26	12	2.62	12	3.10	13
Quarrying & Other Mining	1.41	27	1.30	29	1.34	27	1.50	26	1.86	24
Oil Refining	2.12	16	2.21	12	2.34	10	1.98	19	1.76	26
Cement	2.16	14	2.05	16	2.08	14	2.21	16	2.49	17
Other Manufacturing	1.97	18	1.90	17	1.92	17	2.06	18	2.52	16
Electricity	2.78	4	2.49	8	2.67	8	3.61	8	5.75	6
Water	1.49	26	1.45	25	1.48	24	1.84	22	2.13	20
Building & Construction	2.33	11	2.28	10	1.99	16	2.25	15	2.57	15
Wholesale and Retail Trade	1.66	22	1.61	22	1.69	20	1.85	21	2.25	19
Hotel and Restaurants	2.14	15	2.07	15	1.99	15	2.06	17	2.45	18
Road Transport	2.26	12	1.78	18	1.90	18	2.76	11	5.31	8
Rail Transport & Pipelines	17.03	1	27.94	1	26.80	1	39.22	1	39.89	1
Water Transport	2.37	10	2.10	14	2.34	11	3.43	9	6.37	5
Air Transport	2.63	6	2.29	9	2.55	9	3.70	7	7.27	3
Transport Services	1.00	33	1.00	33	1.00	33	1.00	33	1.00	33
Telecommunications	2.10	17	2.11	13	2.20	13	2.53	13	2.77	14
Post	2.61	7	3.45	3	3.40	5	3.80	6	3.76	10
Financial Institutions	1.56	24	1.49	23	1.50	23	1.66	24	1.87	23
Insurance	1.73	21	1.63	21	1.65	22	1.85	20	2.12	21
Real Estate	1.23	31	1.17	32	1.14	32	1.14	32	1.19	32
Business Services	1.75	20	1.70	19	1.69	21	1.77	23	1.89	22
Public Administration	2.53	9	2.89	6	4.90	4	4.97	4	5.45	7
Education	2.60	8	3.16	5	6.01	3	6.17	3	6.83	4
Health	2.84	2	4.13	2	9.85	2	10.34	2	11.63	2
Private Non Profit Organisations	1.53	25	1.46	24	1.42	25	1.47	27	1.44	27
Other Services	1.36	28	1.30	30	1.26	30	1.27	30	1.27	31
Broadcasting	2.65	5	3.26	4	3.14	6	3.90	5	3.97	9
Household	2.82	3	2.74	7	2.78	7	2.96	10	3.19	12

Table 7.11: EMPLOYMENT EFFECTS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.018	6	0.017	6	0.015	6	0.015	5	0.011	5
Livestock	0.019	4	0.018	4	0.017	4	0.016	4	0.012	4
Forestry	0.005	15	0.004	17	0.003	16	0.002	16	0.002	18
Fishing	0.002	20	0.002	20	0.002	19	0.002	19	0.001	20
Coal Mining	0.000	32	0.000	32	0.000	32	0.000	32	0.000	32
Crude Petroleum & Natural Gas	0.000	29	0.000	27	0.000	29	0.000	31	0.000	31
Metal Ores	0.000	31	0.000	30	0.000	30	0.000	29	0.000	29
Quarrying & Other Mining	0.001	21	0.001	22	0.001	22	0.001	21	0.001	21
Oil Refining	0.001	22	0.001	21	0.001	21	0.000	26	0.000	28
Cement	0.005	17	0.004	16	0.002	17	0.002	17	0.002	16
Other Manufacturing	0.006	14	0.005	14	0.005	14	0.004	14	0.004	14
Electricity	0.008	13	0.007	13	0.007	13	0.006	10	0.006	10
Water	0.005	16	0.004	15	0.004	15	0.004	15	0.004	15
Building & Construction	0.004	18	0.004	18	0.002	18	0.002	18	0.002	17
Wholesale and Retail Trade	0.009	12	0.008	12	0.007	12	0.006	11	0.005	12
Hotel and Restaurants	0.010	11	0.009	11	0.008	11	0.007	9	0.007	9
Road Transport	0.003	19	0.002	19	0.002	20	0.002	20	0.002	19
Rail Transport & Pipelines	0.188	2	0.169	2	0.152	2	0.137	2	0.124	2
Water Transport	0.000	26	0.000	26	0.000	25	0.000	24	0.000	24
Air Transport	0.000	28	0.000	29	0.000	28	0.000	28	0.000	25
Transport Services	0.000	32	0.000	32	0.000	32	0.000	32	0.000	32
Telecommunications	0.000	30	0.000	31	0.000	31	0.000	30	0.000	30
Post	0.018	5	0.017	5	0.015	5	0.012	6	0.010	6
Financial Institutions	0.001	24	0.001	23	0.001	23	0.001	22	0.001	22
Insurance	0.000	27	0.000	28	0.000	27	0.000	25	0.000	26
Real Estate	0.001	23	0.001	25	0.000	26	0.000	27	0.000	27
Business Services	0.001	25	0.001	24	0.001	24	0.001	23	0.001	23
Public Administration	0.011	10	0.010	9	0.009	10	0.006	12	0.005	11
Education	0.011	9	0.010	10	0.009	9	0.006	13	0.005	13
Health	0.014	8	0.011	8	0.010	8	0.008	8	0.007	8
Private Non Profit Organisations	0.278	1	0.240	1	0.208	1	0.174	1	0.143	1
Other Services	0.043	3	0.032	3	0.022	3	0.018	3	0.014	3
Broadcasting	0.014	7	0.012	7	0.011	7	0.009	7	0.008	7

Table 7.12: EMPLOYMENT MULTIPLIERS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	1.09	19	1.10	19	1.04	20	1.09	19	1.10	19
Livestock	1.14	15	1.14	16	1.12	17	1.14	17	1.14	16
Forestry	1.08	20	1.08	20	1.07	19	1.07	20	1.09	20
Fishing	1.20	13	1.25	12	1.27	12	1.24	13	1.46	11
Coal Mining		31	0.00	31	0.00	31	0.00	31	0.00	31
Crude Petroleum & Natural Gas	34.18	2	33.44	2	29.78	2	32.63	2	38.43	3
Metal Ores	0.00	31	0.00	31	0.00	31	0.00	31	0.00	31
Quarrying & Other Mining	1.46	9	1.71	8	1.64	8	1.77	7	1.97	8
Oil Refining	28.62	3	24.03	3	23.87	3	23.27	3	59.38	2
Cement	8.98	4	8.02	4	4.06	4	5.32	4	5.66	4
Other Manufacturing	4.13	5	4.06	5	3.70	5	3.56	5	3.40	5
Electricity	1.24	12	1.20	13	1.20	13	1.20	14	1.27	13
Water	1.04	21	1.04	21	1.04	21	1.04	21	1.04	21
Building & Construction	1.82	7	1.78	7	1.75	7	1.76	8	1.77	9
Wholesale and Retail Trade	1.18	14	1.16	15	1.16	14	1.17	15	1.20	15
Hotel and Restaurants	63.95	1	65.47	1	62.51	1	66.04	1	67.45	1
Road Transport	1.41	11	1.38	11	1.38	11	1.42	10	1.77	10
Rail Transport & Pipelines	1.00	23	1.00	23	1.00	23	1.00	23	1.00	23
Water Transport	0.25	27	0.27	27	0.28	27	0.29	27	0.36	27
Air Transport	1.42	10	1.47	10	1.53	9	1.72	9	2.51	6
Transport Services		31	0.00	31	0.00	31	0.00	31	0.00	31
Telecommunications	0.05	30	0.06	30	0.07	30	0.07	30	0.09	30
Post	1.10	18	1.11	18	1.11	18	1.12	18	1.12	18
Financial Institutions	0.57	26	0.63	26	0.67	26	0.69	26	0.76	26
Insurance	0.08	29	0.10	29	0.11	29	0.12	29	0.13	29
Real Estate	2.20	6	2.23	6	2.23	6	2.21	6	2.15	7
Business Services	0.14	28	0.17	28	0.19	28	0.20	28	0.22	28
Public Administration	1.52	8	1.47	9	1.45	10	1.42	11	1.38	12
Education	1.13	17	1.18	14	1.15	15	1.27	12	1.25	14
Health	0.67	25	0.79	25	0.80	25	0.85	25	0.87	25
Private Non Profit Organisations	1.00	24	1.00	24	1.00	24	1.00	24	1.00	24
Other Services	1.02	22	1.02	22	1.02	22	1.02	22	1.02	22
Broadcasting	1.13	16	1.13	17	1.13	16	1.14	16	1.13	17

Table 7.13: INCOME EFFECTS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.029	17	0.029	18	0.027	17	0.034	16	0.026	18
Livestock	0.010	24	0.009	26	0.009	25	0.011	24	0.008	26
Forestry	0.115	10	0.095	11	0.081	11	0.075	11	0.064	11
Fishing	0.055	12	0.050	14	0.046	13	0.054	14	0.047	15
Coal Mining	0.000	32	0.000	32	0.000	32	0.000	32	0.000	32
Crude Petroleum & Natural Gas	0.004	28	0.010	24	0.007	27	0.004	30	0.005	30
Metal Ores	0.010	23	0.371	7	0.370	7	0.432	7	0.448	7
Quarrying & Other Mining	0.004	30	0.004	30	0.003	30	0.005	29	0.005	29
Oil Refining	0.012	21	0.015	21	0.014	20	0.009	26	0.008	27
Cement	0.020	19	0.019	20	0.010	24	0.015	21	0.015	22
Other Manufacturing	0.031	15	0.032	16	0.029	16	0.032	17	0.031	16
Electricity	0.242	5	0.240	8	0.245	8	0.339	8	0.323	8
Water	0.129	9	0.127	10	0.126	10	0.214	9	0.213	9
Building & Construction	0.072	11	0.071	12	0.039	15	0.059	13	0.056	12
Wholesale and Retail Trade	0.029	18	0.032	15	0.041	14	0.048	15	0.048	14
Hotel and Restaurants	0.031	14	0.030	17	0.026	18	0.031	18	0.029	17
Road Transport	0.015	20	0.012	23	0.011	22	0.015	22	0.024	19
Rail Transport & Pipelines	5.320	1	9.668	1	9.102	1	12.710	1	11.828	1
Water Transport	0.009	25	0.010	25	0.011	23	0.015	20	0.017	20
Air Transport	0.006	27	0.006	28	0.007	28	0.009	27	0.012	24
Transport Services	0.000	32	0.000	32	0.000	32	0.000	32	0.000	32
Telecommunications	0.004	29	0.005	29	0.005	29	0.008	28	0.008	28
Post	0.371	2	0.684	3	0.634	5	0.737	5	0.638	6
Financial Institutions	0.050	13	0.051	13	0.051	12	0.059	12	0.054	13
Insurance	0.011	22	0.012	22	0.012	21	0.015	23	0.014	23
Real Estate	0.004	31	0.003	31	0.002	31	0.002	31	0.002	31
Business Services	0.007	26	0.008	27	0.008	26	0.010	25	0.009	25
Public Administration	0.197	7	0.377	6	1.109	4	1.108	4	1.168	4
Education	0.230	6	0.460	5	1.376	3	1.440	3	1.534	3
Health	0.324	4	0.740	2	2.263	2	2.418	2	2.628	2
Private Non Profit Organisations	0.162	8	0.144	9	0.128	9	0.135	10	0.114	10
Other Services	0.030	16	0.026	19	0.021	19	0.020	19	0.017	21
Broadcasting	0.347	3	0.607	4	0.545	6	0.735	6	0.659	5

Table 7.14: INCOME MULTIPLIERS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	1.15	11	1.16	11	1.10	11	1.15	11	1.15	13
Livestock	2.41	5	2.41	5	2.28	6	2.30	7	2.16	7
Forestry	1.03	15	1.03	16	1.02	14	1.04	14	1.06	15
Fishing	0.99	22	1.03	17	1.04	13	1.03	15	1.20	10
Coal Mining	0.00	32	0.00	32	0.00	32	0.00	32	0.00	32
Crude Petroleum & Natural Gas	1.73	7	1.37	9	1.34	8	1.45	8	1.67	8
Metal Ores	0.03	31	1.00	22	1.00	20	1.00	21	1.01	19
Quarrying & Other Mining	2.58	4	3.14	3	3.11	3	3.68	2	5.44	2
Oil Refining	3.42	2	4.41	2	4.17	2	2.50	5	2.33	6
Cement	1.66	8	1.55	7	0.86	24	1.16	10	1.22	9
Other Manufacturing	1.02	17	1.05	14	0.99	22	0.95	23	0.94	24
Electricity	1.09	13	1.08	13	1.07	12	1.07	13	1.10	14
Water	1.02	18	1.02	18	1.02	15	1.01	17	1.02	16
Building & Construction	1.15	12	1.15	12	1.15	10	1.15	12	1.16	12
Wholesale and Retail Trade	1.45	9	1.53	8	2.16	7	2.36	6	3.05	5
Hotel and Restaurants	2.82	3	2.94	4	2.91	4	3.01	3	3.15	4
Road Transport	2.27	6	2.22	6	2.33	5	2.78	4	5.00	3
Rail Transport & Pipelines	1.00	21	1.00	23	1.00	21	1.00	22	1.00	22
Water Transport	0.18	27	0.19	28	0.20	28	0.20	28	0.24	28
Air Transport	0.27	26	0.29	27	0.32	27	0.37	27	0.54	27
Transport Services	0.00	32	0.00	32	0.00	32	0.00	32	0.00	32
Telecommunications	0.03	30	0.04	31	0.04	31	0.04	31	0.05	31
Post	1.02	19	1.01	20	1.01	18	1.01	19	1.01	18
Financial Institutions	0.46	25	0.51	26	0.54	26	0.55	26	0.60	26
Insurance	0.08	29	0.09	30	0.10	30	0.11	30	0.12	30
Real Estate	6.01	1	6.55	1	6.74	1	6.86	1	6.81	1
Business Services	0.13	28	0.15	29	0.17	29	0.18	29	0.20	29
Public Administration	1.08	14	1.04	15	1.01	17	1.01	18	1.01	20
Education	0.90	23	0.90	24	0.89	23	0.94	24	0.94	23
Health	0.63	24	0.73	25	0.74	25	0.79	25	0.81	25
Private Non Profit Organisations	1.01	20	1.01	21	1.01	19	1.01	20	1.00	21
Other Services	1.16	10	1.17	10	1.17	9	1.19	9	1.17	11
Broadcasting	1.03	16	1.02	19	1.02	16	1.01	16	1.01	17

Table 7.15: VALUE-ADDED EFFECTS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.934	8	0.947	9	0.898	12	0.941	10	0.956	10
Livestock	0.951	5	0.959	6	0.944	8	0.955	8	0.970	8
Forestry	0.960	4	0.970	4	0.969	5	0.976	5	0.975	6
Fishing	0.778	17	0.814	21	0.805	20	0.774	23	0.802	22
Coal Mining	0.006	32	0.055	31	0.206	27	0.849	20	0.746	24
Crude Petroleum & Natural Gas	0.973	3	0.963	5	0.975	4	0.987	3	0.984	2
Metal Ores	0.028	30	0.988	2	0.988	2	0.987	2	0.982	3
Quarrying & Other Mining	0.725	19	0.871	14	0.841	18	0.903	14	0.916	15
Oil Refining	0.902	9	0.865	15	0.894	13	0.946	9	0.962	9
Cement	0.545	23	0.553	25	0.306	26	0.409	27	0.444	27
Other Manufacturing	0.618	21	0.658	24	0.615	24	0.582	25	0.563	25
Electricity	0.835	14	0.862	16	0.864	16	0.867	18	0.836	20
Water	0.976	2	0.982	3	0.982	3	0.982	4	0.979	4
Building & Construction	0.772	18	0.820	20	0.781	21	0.809	22	0.818	21
Wholesale and Retail Trade	0.896	10	0.910	10	0.908	9	0.911	13	0.918	13
Hotel and Restaurants	0.801	16	0.832	19	0.827	19	0.851	19	0.857	19
Road Transport	0.854	13	0.890	11	0.902	11	0.894	15	0.858	18
Rail Transport & Pipelines	0.347	25	0.855	17	0.905	10	0.924	11	0.925	12
Water Transport	0.130	27	0.143	28	0.149	29	0.152	29	0.150	30
Air Transport	0.141	26	0.158	27	0.168	28	0.179	28	0.175	28
Transport Services	0.000	33	0.000	33	0.000	33	0.000	33	0.000	33
Telecommunications	0.027	31	0.031	32	0.034	32	0.036	32	0.043	32
Post	0.875	11	0.886	12	0.891	14	0.919	12	0.932	11
Financial Institutions	0.427	24	0.476	26	0.501	25	0.516	26	0.554	26
Insurance	0.070	29	0.084	30	0.092	31	0.099	31	0.113	31
Real Estate	0.937	7	0.957	7	0.967	6	0.974	6	0.976	5
Business Services	0.094	28	0.112	29	0.129	30	0.141	30	0.155	29
Public Administration	0.816	15	0.851	18	0.852	17	0.886	16	0.917	14
Education	0.719	20	0.769	22	0.776	22	0.840	21	0.873	17
Health	0.581	22	0.683	23	0.696	23	0.754	24	0.784	23
Private Non Profit Organisations	0.985	1	0.988	1	0.988	1	0.989	1	0.992	1
Other Services	0.944	6	0.956	8	0.960	7	0.963	7	0.972	7
Broadcasting	0.861	12	0.882	13	0.876	15	0.870	17	0.890	16

Table 7.16: VALUE-ADDED MULTIPLIERS

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	1.12	17	1.13	17	1.07	19	1.14	18	1.15	15
Livestock	1.19	15	1.19	14	1.17	14	1.18	15	1.16	14
Forestry	1.13	16	1.08	20	1.07	18	1.15	17	1.44	6
Fishing	1.23	14	1.14	15	1.21	13	2.27	5	-2.24	33
Coal Mining	0.01	32	0.05	32	0.21	29	0.85	26	0.75	24
Crude Petroleum & Natural Gas	1.07	19	1.13	16	1.10	16	1.06	22	1.11	18
Metal Ores	0.03	31	1.11	18	1.13	15	1.13	19	1.13	17
Quarrying & Other Mining	0.91	23	1.04	23	1.02	23	1.18	16	1.42	7
Oil Refining	3.68	1	4.45	1	15.97	1	3.04	3	1.37	9
Cement	1.80	7	1.65	5	0.95	24	1.41	8	2.35	2
Other Manufacturing	1.37	9	1.40	8	1.33	10	1.33	13	2.24	3
Electricity	2.00	5	1.60	6	1.83	3	5.71	2	-0.80	32
Water	1.05	21	1.04	22	1.05	21	1.10	20	1.30	11
Building & Construction	2.20	3	2.51	3	1.60	5	1.92	6	2.17	4
Wholesale and Retail Trade	1.27	13	1.30	12	1.33	8	1.35	11	1.37	10
Hotel and Restaurants	3.40	2	3.31	2	2.54	2	2.40	4	3.76	1
Road Transport	2.13	4	1.41	7	1.50	6	7.63	1	-0.61	31
Rail Transport & Pipelines	1.85	6	1.21	13	1.24	12	1.35	10	2.07	5
Water Transport	0.32	27	0.27	28	0.34	28	-1.28	33	-0.08	30
Air Transport	0.62	25	0.41	27	0.59	26	-0.53	32	-0.07	29
Transport Services	0.00	33	0.00	33	0.00	33	0.00	31	0.00	28
Telecommunications	0.05	30	0.06	31	0.07	32	0.08	30	0.10	27
Post	1.27	12	1.37	9	1.49	7	1.44	7	1.39	8
Financial Institutions	0.49	26	0.54	26	0.58	27	0.62	27	0.77	23
Insurance	0.08	29	0.10	30	0.11	31	0.13	29	0.18	26
Real Estate	1.07	20	1.06	21	1.06	20	1.05	23	1.05	19
Business Services	0.14	28	0.17	29	0.19	30	0.21	28	0.22	25
Public Administration	1.75	8	1.70	4	1.61	4	1.37	9	1.26	12
Education	1.33	10	1.35	10	1.31	11	1.21	14	1.14	16
Health	0.73	24	0.85	25	0.85	25	0.87	25	0.88	22
Private Non Profit Organisations	1.02	22	1.03	24	1.03	22	1.03	24	1.02	21
Other Services	1.10	18	1.09	19	1.08	17	1.07	21	1.05	20
Broadcasting	1.32	11	1.33	11	1.33	9	1.34	12	1.25	13

Table 7.17: BACKWARD LINKAGE STIMULI OF THE OIL AND GAS INDUSTRY

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.005	15	0.004	15	0.324	20	0.012	15	0.030	15
Livestock	0.000	19	0.000	19	0.385	18	0.000	19	0.000	19
Forestry	0.084	6	0.047	6	0.146	27	0.112	7	0.293	7
Fishing	0.228	5	0.150	5	0.482	17	0.512	5	1.252	5
Coal Mining	0.000	19	0.000	19	0.000	30	0.000	19	0.000	19
Metal Ores	0.000	19	0.000	19	0.246	23	0.000	19	0.000	19
Quarrying & Other Mining	0.053	8	0.030	9	0.322	21	0.091	9	0.241	9
Cement	0.030	12	0.019	12	1.329	2	0.062	12	0.175	12
Other Manufacturing	0.015	13	0.010	13	1.062	3	0.033	13	0.111	13
Electricity	0.277	4	0.174	4	0.844	8	0.547	4	1.749	4
Water	0.031	11	0.020	11	0.110	28	0.069	11	0.211	10
Building & Construction	0.001	18	0.000	18	1.021	5	0.001	18	0.003	18
Wholesale and Retail Trade	0.006	14	0.004	14	0.633	14	0.013	14	0.039	14
Hotel and Restaurants	0.000	19	0.000	19	1.349	1	0.000	19	0.000	19
Road Transport	0.489	2	0.274	3	0.489	15	0.795	3	2.322	3
Rail Transport & Pipelines	0.063	7	0.041	7	0.488	16	0.128	6	0.382	6
Water Transport	0.411	3	0.278	2	0.788	11	0.902	2	2.625	2
Air Transport	0.512	1	0.345	1	1.011	6	1.058	1	3.132	1
Transport Services	0.000	19	0.000	19	0.000	30	0.000	19	0.000	19
Telecommunications	0.004	17	0.002	17	1.026	4	0.008	16	0.026	16
Post	0.004	16	0.003	16	0.797	10	0.008	17	0.022	17
Financial Institutions	0.037	10	0.024	10	0.232	24	0.073	10	0.195	11
Insurance	0.046	9	0.030	8	0.302	22	0.092	8	0.247	8
Real Estate	0.000	19	0.000	19	0.172	26	0.000	19	0.000	19
Business Services	0.000	19	0.000	19	0.674	13	0.000	19	0.000	19
Public Administration	0.000	19	0.000	19	0.942	7	0.000	19	0.000	19
Education	0.000	19	0.000	19	0.813	9	0.000	19	0.000	19
Health	0.000	19	0.000	19	0.364	19	0.000	19	0.000	19
Private Non Profit Organisations	0.000	19	0.000	19	0.079	29	0.000	19	0.000	19
Other Services	0.000	19	0.000	19	0.223	25	0.000	19	0.000	19
Broadcasting	0.000	19	0.000	19	0.683	12	0.000	19	0.000	19

Table 7.18: FORWARD LINKAGE STIMULI OF THE OIL AND GAS INDUSTRY

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	-0.049	28	-0.048	28	-0.038	28	-0.032	28	-0.079	28
Livestock	-0.019	27	-0.018	25	-0.015	25	-0.012	25	-0.031	26
Forestry	-0.001	16	-0.002	17	-0.002	17	-0.002	18	-0.005	19
Fishing	-0.002	17	-0.002	18	-0.002	18	-0.002	17	-0.003	17
Coal Mining	0.000	7	0.000	7	0.000	7	0.000	7	0.000	7
Metal Ores	0.000	8	0.000	8	0.000	8	0.000	8	0.000	8
Quarrying & Other Mining	-0.004	19	-0.005	20	-0.005	20	-0.004	20	-0.008	20
Cement	-0.001	15	-0.001	16	-0.001	15	-0.001	15	-0.001	13
Other Manufacturing	-0.174	30	-0.161	30	-0.134	30	-0.110	30	-0.213	30
Electricity	-0.015	24	-0.011	24	-0.010	22	-0.008	23	-0.019	23
Water	-0.001	14	-0.001	13	-0.001	13	-0.001	14	-0.002	15
Building & Construction	-0.007	21	-0.007	22	-0.011	23	-0.007	22	-0.010	21
Wholesale and Retail Trade	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Hotel and Restaurants	-0.015	25	-0.020	26	-0.020	26	-0.016	26	-0.022	24
Road Transport	-0.437	31	-0.548	31	-0.542	31	-0.468	31	-1.157	31
Rail Transport & Pipelines	-0.015	26	0.000	10	0.000	10	0.000	10	0.000	10
Water Transport	-0.001	13	-0.001	14	-0.001	14	0.000	13	-0.001	14
Air Transport	-0.005	20	-0.006	21	-0.006	21	-0.005	21	-0.012	22
Transport Services	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Telecommunications	0.000	11	0.000	12	0.000	12	0.000	12	0.000	12
Post	0.000	10	0.000	11	0.000	11	0.000	11	0.000	11
Financial Institutions	-0.050	29	-0.057	29	-0.053	29	-0.045	29	-0.114	29
Insurance	-0.001	12	-0.001	15	-0.001	16	-0.001	16	-0.002	16
Real Estate	-0.013	23	-0.021	27	-0.025	27	-0.027	27	-0.051	27
Business Services	-0.004	18	-0.004	19	-0.004	19	-0.003	19	-0.005	18
Public Administration	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Education	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Health	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Private Non Profit Organisations	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Other Services	-0.007	22	-0.009	23	-0.012	24	-0.011	24	-0.024	25
Broadcasting	0.000	9	0.000	9	0.000	9	0.000	9	0.000	9

Table 7.19: OIL AND GAS STMIULI OF RASMUSSEN POWER OF DISPERSION

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.00	1	0.00	1	0.00	1	0.00	1	0.01	1
Livestock	0.00	30	0.00	29	0.00	29	0.00	27	0.00	27
Forestry	0.04	31	0.02	30	0.02	30	0.05	30	0.10	32
Fishing	0.08	7	0.06	7	0.08	8	0.15	9	0.25	9
Coal Mining	0.00	6	0.00	5	0.00	4	0.00	5	0.00	6
Metal Ores	0.02	29	0.01	27	0.02	27	0.04	32	0.08	31
Quarrying & Other Mining	0.03	12	0.02	12	0.02	12	0.05	12	0.11	12
Cement	0.01	8	0.01	9	0.01	9	0.03	8	0.06	8
Other Manufacturing	-0.01	14	-0.01	14	-0.01	14	0.01	14	0.02	14
Electricity	0.09	32	0.06	32	0.07	32	0.14	25	0.25	24
Water	0.01	5	0.01	4	0.01	5	0.03	6	0.08	4
Building & Construction	0.01	13	0.01	13	0.00	13	0.02	13	0.04	13
Wholesale and Retail Trade	0.02	16	0.01	19	0.02	20	0.04	18	0.09	18
Hotel and Restaurants	0.00	11	0.00	11	0.00	11	0.01	11	0.03	11
Road Transport	0.09	23	0.03	25	0.05	23	0.15	23	0.25	22
Rail Transport & Pipelines	0.03	4	0.02	6	0.03	6	0.06	4	0.13	5
Water Transport	0.12	9	0.09	8	0.12	7	0.20	7	0.31	7
Air Transport	0.14	3	0.10	3	0.12	3	0.21	3	0.31	3
Transport Services	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2
Telecommunications	0.01	28	0.00	26	0.01	26	0.02	31	0.05	30
Post	0.01	20	0.01	20	0.01	19	0.02	17	0.04	17
Financial Institutions	0.00	19	-0.01	18	0.00	18	0.02	21	0.05	21
Insurance	0.02	26	0.01	31	0.02	28	0.04	15	0.09	16
Real Estate	0.00	10	0.00	10	0.00	10	0.00	10	0.01	10
Business Services	0.01	25	0.00	28	0.00	31	0.02	29	0.04	29
Public Administration	0.01	22	0.01	22	0.01	22	0.02	20	0.04	19
Education	0.01	15	0.01	15	0.01	15	0.02	19	0.03	20
Health	0.01	17	0.00	17	0.00	17	0.01	22	0.02	23
Private Non Profit Organisations	0.00	21	0.00	21	0.00	21	0.00	24	0.01	25
Other Services	0.00	27	0.00	23	0.00	24	0.00	28	0.01	28
Broadcasting	0.01	24	0.01	24	0.01	25	0.02	26	0.05	26

Table 7.20: THE OIL AND GAS STIMULI OF RASMUSSEN SENSITIVITY

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.00	3	0.00	4	0.00	4	0.00	6	-0.01	6
Livestock	0.00	2	0.00	3	0.00	3	0.00	3	0.00	1
Forestry	-0.04	26	-0.02	26	-0.02	25	-0.05	24	-0.10	24
Fishing	-0.08	27	-0.06	28	-0.08	29	-0.15	28	-0.25	27
Coal Mining	0.00	4	0.00	6	0.00	6	0.00	1	0.00	2
Metal Ores	-0.02	21	-0.01	21	-0.02	21	-0.04	21	-0.08	21
Quarrying & Other Mining	-0.03	25	-0.02	24	-0.02	24	-0.05	25	-0.11	25
Cement	-0.01	19	-0.01	19	-0.01	19	-0.03	19	-0.06	19
Other Manufacturing	0.01	1	0.01	1	0.01	1	-0.01	8	-0.02	9
Electricity	-0.09	28	-0.06	29	-0.07	28	-0.14	27	-0.25	29
Water	-0.01	20	-0.01	20	-0.01	20	-0.03	20	-0.08	20
Building & Construction	-0.01	17	-0.01	14	0.00	13	-0.02	15	-0.04	15
Wholesale and Retail Trade	-0.02	22	-0.01	22	-0.02	22	-0.04	22	-0.09	22
Hotel and Restaurants	0.00	10	0.00	8	0.00	10	-0.01	10	-0.03	11
Road Transport	-0.09	29	-0.03	27	-0.05	27	-0.15	29	-0.25	28
Rail Transport & Pipelines	-0.03	24	-0.02	25	-0.03	26	-0.06	26	-0.13	26
Water Transport	-0.12	30	-0.09	30	-0.12	30	-0.20	30	-0.31	30
Air Transport	-0.14	31	-0.10	31	-0.12	31	-0.21	31	-0.31	31
Transport Services	0.00	5	0.00	7	0.00	7	0.00	2	0.00	3
Telecommunications	-0.01	13	0.00	13	-0.01	14	-0.02	16	-0.05	16
Post	-0.01	14	-0.01	15	-0.01	15	-0.02	12	-0.04	12
Financial Institutions	0.00	7	0.01	2	0.00	5	-0.02	18	-0.05	17
Insurance	-0.02	23	-0.01	23	-0.02	23	-0.04	23	-0.09	23
Real Estate	0.00	8	0.00	5	0.00	2	0.00	4	-0.01	4
Business Services	-0.01	11	0.00	11	0.00	11	-0.02	13	-0.04	14
Public Administration	-0.01	18	-0.01	18	-0.01	18	-0.02	14	-0.04	13
Education	-0.01	16	-0.01	16	-0.01	16	-0.02	11	-0.03	10
Health	-0.01	12	0.00	12	0.00	12	-0.01	9	-0.02	8
Private Non Profit Organisations	0.00	6	0.00	10	0.00	9	0.00	5	-0.01	5
Other Services	0.00	9	0.00	9	0.00	8	0.00	7	-0.01	7
Broadcasting	-0.01	15	-0.01	17	-0.01	17	-0.02	17	-0.05	18

Table 7.21: MULTIPLIER STIMULI OF THE OIL AND GAS INDUSTRY

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	-0.02	10	-0.01	9	-0.01	9	-0.04	11	-0.08	11
Livestock	-0.01	5	0.00	4	0.00	4	-0.01	5	-0.02	4
Forestry	-0.16	27	-0.09	26	-0.11	25	-0.21	23	-0.49	23
Fishing	-0.38	29	-0.26	29	-0.36	29	-0.82	29	-1.84	29
Coal Mining	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
Metal Ores	0.00	4	-0.06	22	-0.08	22	-0.18	22	-0.47	22
Quarrying & Other Mining	-0.12	25	-0.08	24	-0.10	24	-0.25	25	-0.59	25
Cement	-0.06	20	-0.04	18	-0.03	12	-0.09	14	-0.24	15
Other Manufacturing	-0.05	15	-0.03	13	-0.04	15	-0.09	15	-0.26	17
Electricity	-0.57	30	-0.35	30	-0.47	30	-1.08	30	-3.04	30
Water	-0.06	19	-0.04	19	-0.06	21	-0.14	21	-0.37	21
Building & Construction	-0.08	22	-0.05	21	-0.04	14	-0.12	20	-0.34	20
Wholesale and Retail Trade	-0.10	23	-0.07	23	-0.10	23	-0.21	24	-0.57	24
Hotel and Restaurants	-0.05	18	-0.04	17	-0.05	19	-0.11	19	-0.31	19
Road Transport	-0.88	31	-0.51	31	-0.63	31	-1.43	31	-3.71	31
Rail Transport & Pipelines	-0.15	26	-0.10	27	-0.14	27	-0.30	27	-0.80	27
Water Transport	-0.12	24	-0.09	25	-0.13	26	-0.30	26	-0.79	26
Air Transport	-0.17	28	-0.13	28	-0.18	28	-0.42	28	-1.15	28
Transport Services	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1
Telecommunications	0.00	3	0.00	3	0.00	3	-0.01	3	-0.02	3
Post	-0.05	14	-0.03	14	-0.05	17	-0.09	13	-0.22	14
Financial Institutions	-0.04	13	-0.03	12	-0.04	13	-0.09	16	-0.24	16
Insurance	-0.01	8	-0.01	7	-0.01	7	-0.02	7	-0.06	7
Real Estate	-0.02	11	-0.01	8	-0.01	8	-0.02	8	-0.07	8
Business Services	-0.01	7	0.00	6	-0.01	6	-0.02	6	-0.04	6
Public Administration	-0.07	21	-0.04	20	-0.06	20	-0.10	17	-0.22	13
Education	-0.05	16	-0.03	15	-0.04	16	-0.08	12	-0.17	12
Health	-0.02	9	-0.01	10	-0.02	11	-0.03	9	-0.07	9
Private Non Profit Organisations	-0.01	6	0.00	5	-0.01	5	-0.01	4	-0.03	5
Other Services	-0.02	12	-0.01	11	-0.02	10	-0.03	10	-0.07	10
Broadcasting	-0.05	17	-0.03	16	-0.05	18	-0.11	18	-0.28	18

Table 7.22: IMPACT OF OIL AND GAS INDUSTRY ON SECTORAL OUTPUTS (%)

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.84%	23	0.80%	23	0.66%	23	0.78%	23	1.20%	23
Livestock	1.64%	21	1.51%	20	1.34%	20	1.41%	20	2.76%	20
Forestry	1.09%	22	1.02%	22	0.96%	22	1.07%	22	2.18%	22
Fishing	0.63%	24	0.62%	24	0.54%	24	0.58%	24	0.69%	24
Coal Mining	4.03%	13	3.80%	13	3.15%	14	2.39%	16	4.31%	15
Metal Ores	2.10%	18	1.17%	21	1.05%	21	1.09%	21	2.20%	21
Quarrying & Other Mining	5.19%	12	5.05%	12	4.99%	12	5.10%	12	6.86%	12
Cement	7.65%	10	7.06%	10	8.23%	10	7.71%	9	8.39%	11
Other Manufacturing	2.02%	19	1.87%	18	1.66%	18	1.71%	18	3.63%	18
Electricity	13.70%	7	12.80%	7	11.98%	6	12.73%	6	28.38%	4
Water	2.02%	20	1.67%	19	1.47%	19	1.54%	19	3.81%	17
Building & Construction	8.48%	9	7.79%	9	9.38%	8	8.61%	8	9.34%	9
Wholesale and Retail Trade	0.00%	26	0.00%	26	0.00%	26	0.00%	26	0.00%	26
Hotel and Restaurants	2.78%	16	2.79%	16	2.55%	16	2.78%	15	3.11%	19
Road Transport	28.34%	1	27.13%	1	25.33%	1	27.57%	1	46.95%	1
Rail Transport & Pipelines	22.31%	2	20.94%	2	18.75%	2	19.93%	2	31.95%	2
Water Transport	14.02%	6	13.02%	6	10.80%	7	7.64%	10	13.66%	8
Air Transport	9.11%	8	9.43%	8	9.05%	9	9.72%	7	16.22%	6
Transport Services	0	26	0	26	0	26	0	26	0	26
Telecommunications	3.42%	15	3.41%	15	3.10%	15	2.97%	14	5.60%	14
Post	2.38%	17	2.28%	17	2.07%	17	2.18%	17	4.11%	16
Financial Institutions	19.49%	3	19.52%	3	18.30%	3	19.02%	3	31.65%	3
Insurance	15.27%	5	15.09%	5	13.49%	5	14.41%	4	19.56%	5
Real Estate	3.44%	14	3.57%	14	3.51%	13	3.99%	13	6.17%	13
Business Services	16.57%	4	16.46%	4	14.18%	4	13.26%	5	14.54%	7
Public Administration	0.00%	26	0.00%	26	0.00%	26	0.00%	26	0.00%	26
Education	0.00%	26	0.00%	26	0.00%	26	0.00%	26	0.00%	26
Health	0.00%	26	0.00%	26	0.00%	26	0.00%	26	0.00%	26
Private Non Profit Organisations	0.00%	26	0.00%	26	0.00%	26	0.00%	26	0.00%	26
Other Services	6.29%	11	6.32%	11	6.05%	11	6.22%	11	8.71%	10
Broadcasting	0.16%	25	0.17%	25	0.18%	25	0.20%	25	0.29%	25

Table 7.23: BACKWARD LINKAGE IMPACT OF IMPORT SUBSTITUTION

SECTORS	1997	Rank	1998	Rank	1998	Rank	2000	Rank	2001	Rank
Crop Production	0.81%	14	0.56%	14	0.70%	14	1.77%	14	4.45%	14
Livestock	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Forestry	14.03%	5	11.71%	5	12.98%	5	18.45%	5	22.70%	5
Fishing	15.41%	4	13.04%	4	14.26%	4	19.39%	4	23.04%	4
Coal Mining	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Crude Petroleum & Natural Gas	3.91%	11	2.52%	12	2.86%	12	6.30%	12	12.64%	12
Metal Ores	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Quarrying & Other Mining	6.61%	10	4.54%	10	5.01%	10	9.76%	11	16.91%	11
Oil Refining	0.02%	20	0.01%	19	0.01%	19	0.02%	20	0.14%	19
Cement	1.09%	13	0.73%	13	0.89%	13	2.17%	13	5.40%	13
Other Manufacturing	0.68%	15	0.46%	15	0.57%	15	1.45%	15	3.69%	15
Electricity	11.90%	6	9.42%	6	10.03%	6	16.11%	6	21.41%	6
Water	10.71%	7	8.82%	7	9.48%	7	15.59%	7	21.13%	7
Building & Construction	0.02%	19	0.01%	20	0.01%	20	0.04%	19	0.12%	20
Wholesale and Retail Trade	0.52%	16	0.34%	16	0.40%	16	0.99%	16	2.99%	16
Hotel and Restaurants	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Road Transport	20.38%	1	18.66%	1	19.39%	1	22.50%	1	24.21%	1
Rail Transport & Pipelines	1.92%	12	3.52%	11	4.65%	11	10.20%	10	17.29%	10
Water Transport	17.12%	2	14.57%	2	15.36%	2	20.16%	2	23.27%	2
Air Transport	16.60%	3	13.98%	3	14.79%	3	19.77%	3	23.11%	3
Transport Services	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Telecommunications	0.22%	18	0.13%	18	0.15%	18	0.36%	18	1.14%	18
Post	0.33%	17	0.20%	17	0.22%	17	0.54%	17	1.69%	17
Financial Institutions	6.94%	8	4.84%	8	5.47%	8	10.46%	8	17.45%	8
Insurance	6.74%	9	4.70%	9	5.34%	9	10.29%	9	17.29%	9
Real Estate	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Business Services	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Public Administration	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Education	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Health	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Private Non Profit Organisations	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Other Services	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21
Broadcasting	0.00%	21	0.00%	21	0.00%	21	0.00%	21	0.00%	21

Table 7.24: FORWARD LINKAGE IMPACT OF IMPORT SUBSTITUTION

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.12%	11	0.29%	8	0.28%	9	0.31%	8	0.94%	8
Livestock	0.07%	16	0.20%	11	0.18%	11	0.20%	11	0.69%	9
Forestry	0.01%	22	0.03%	19	0.03%	19	0.04%	19	0.14%	19
Fishing	0.02%	19	0.02%	20	0.03%	21	0.03%	20	0.08%	20
Coal Mining	0.00%	31	0.00%	25	0.00%	27	0.00%	27	0.00%	27
Crude Petroleum & Natural Gas	10.26%	2	8.54%	2	10.29%	2	14.60%	2	18.57%	2
Metal Ores	0.00%	23	0.00%	27	0.00%	26	0.00%	26	0.00%	26
Quarrying & Other Mining	0.03%	18	0.05%	18	0.06%	18	0.06%	17	0.18%	18
Oil Refining	15.74%	1	15.05%	1	15.39%	1	18.89%	1	24.03%	1
Cement	0.01%	20	0.02%	22	0.03%	20	0.02%	21	0.05%	21
Other Manufacturing	0.34%	5	1.13%	5	1.11%	5	1.32%	4	4.04%	4
Electricity	0.12%	10	0.18%	12	0.16%	12	0.18%	13	0.57%	12
Water	0.01%	21	0.02%	21	0.01%	22	0.02%	22	0.05%	22
Building & Construction	0.06%	17	0.08%	17	0.13%	15	0.11%	15	0.24%	16
Wholesale and Retail Trade	0.00%	24	0.00%	28	0.00%	27	0.00%	27	0.00%	28
Hotel and Restaurants	0.17%	9	0.21%	10	0.23%	10	0.27%	10	0.53%	13
Road Transport	2.48%	3	3.48%	3	3.61%	3	4.32%	3	10.79%	3
Rail Transport & Pipelines	0.00%	33	0.00%	24	0.00%	24	0.00%	24	0.00%	24
Water Transport	0.08%	15	0.10%	16	0.08%	17	0.06%	18	0.21%	17
Air Transport	0.34%	6	0.45%	6	0.43%	6	0.48%	6	1.49%	6
Transport Services	0.00%	24	0.00%	28	0.00%	27	0.00%	27	0.00%	28
Telecommunications	0.10%	12	0.11%	15	0.09%	16	0.09%	16	0.29%	15
Post	0.00%	24	0.00%	23	0.00%	23	0.00%	23	0.01%	23
Financial Institutions	1.12%	4	1.17%	4	1.12%	4	1.26%	5	3.82%	5
Insurance	0.10%	12	0.15%	13	0.13%	14	0.15%	14	0.39%	14
Real Estate	0.20%	8	0.23%	9	0.29%	8	0.38%	7	1.09%	7
Business Services	0.21%	7	0.31%	7	0.29%	7	0.29%	9	0.64%	10
Public Administration	0.00%	24	0.00%	28	0.00%	27	0.00%	27	0.00%	28
Education	0.00%	24	0.00%	28	0.00%	27	0.00%	27	0.00%	28
Health	0.00%	24	0.00%	28	0.00%	27	0.00%	27	0.00%	28
Private Non Profit Organisations	0.00%	24	0.00%	28	0.00%	27	0.00%	27	0.00%	28
Other Services	0.09%	14	0.12%	14	0.16%	13	0.19%	12	0.62%	11
Broadcasting	0.00%	32	0.00%	26	0.00%	25	0.00%	25	0.00%	25

Table 7. 25: IMPACT OF IMPORT SUBSTITUTION (RASMUSSEN POWER OF DISPERSSION)

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.06%	23	0.00%	29	0.02%	26	0.13%	26	0.26%	26
Livestock	0.01%	25	-0.03%	30	-0.02%	31	0.02%	29	-0.03%	31
Forestry	0.89%	6	0.59%	6	0.68%	7	1.18%	8	2.47%	8
Fishing	1.80%	4	1.47%	3	1.83%	3	2.81%	3	3.76%	1
Coal Mining	0.00%	26	0.00%	28	0.00%	29	0.00%	31	0.00%	30
Crude Petroleum & Natural Gas	-1.94%	32	-1.64%	32	-1.89%	32	-2.34%	32	-2.71%	33
Metal Ores	0.47%	11	0.35%	11	0.46%	11	0.95%	11	2.23%	11
Quarrying & Other Mining	0.60%	8	0.52%	8	0.66%	8	1.33%	7	2.79%	6
Oil Refining	-3.41%	33	-3.14%	33	-3.34%	33	-3.40%	33	-1.75%	32
Cement	0.14%	17	0.25%	13	0.33%	13	0.70%	13	1.67%	13
Other Manufacturing	0.15%	15	-0.07%	31	-0.01%	30	0.25%	23	0.61%	23
Electricity	1.74%	5	1.47%	4	1.71%	4	2.56%	5	3.09%	2
Water	0.36%	12	0.28%	12	0.38%	12	0.81%	12	2.05%	12
Building & Construction	0.11%	18	0.19%	15	0.17%	21	0.48%	17	1.28%	17
Wholesale and Retail Trade	0.33%	13	0.37%	10	0.48%	10	0.96%	10	2.24%	10
Hotel and Restaurants	0.14%	16	0.11%	21	0.16%	22	0.39%	22	1.04%	22
Road Transport	2.36%	1	1.37%	5	1.63%	5	2.74%	4	2.82%	4
Rail Transport & Pipelines	0.75%	7	0.58%	7	0.95%	6	1.39%	6	2.85%	3
Water Transport	2.28%	3	2.04%	2	2.32%	2	2.87%	1	2.80%	5
Air Transport	2.36%	2	2.15%	1	2.39%	1	2.81%	2	2.55%	7
Transport Services	0.00%	27	0.00%	27	0.00%	28	0.00%	30	0.00%	29
Telecommunications	-0.71%	30	0.17%	19	0.22%	17	0.49%	16	1.32%	15
Post	-0.80%	31	0.17%	18	0.22%	18	0.42%	20	1.11%	20
Financial Institutions	0.55%	10	0.09%	23	0.20%	19	0.68%	14	1.30%	16
Insurance	0.58%	9	0.43%	9	0.55%	9	1.13%	9	2.40%	9
Real Estate	0.10%	20	0.02%	26	0.01%	27	0.06%	28	0.21%	27
Business Services	-0.05%	28	0.13%	20	0.19%	20	0.46%	18	1.24%	18
Public Administration	0.11%	19	0.20%	14	0.25%	14	0.46%	19	1.15%	19
Education	0.10%	21	0.18%	17	0.23%	16	0.42%	21	1.05%	21
Health	0.06%	24	0.10%	22	0.13%	23	0.23%	24	0.58%	24
Private Non Profit Organisations	-0.09%	29	0.03%	25	0.04%	25	0.08%	27	0.21%	28
Other Services	0.15%	14	0.06%	24	0.06%	24	0.15%	25	0.38%	25
Broadcasting	0.09%	22	0.18%	16	0.24%	15	0.53%	15	1.42%	14

Tabe 7.26: IMPACT OF IMPORT SUBSTITUTION (RASMUSSEN SENSITIVITY INDEX)

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	-0.06%	11	0.00%	5	-0.02%	8	-0.13%	8	-0.26%	8
Livestock	-0.01%	9	0.03%	4	0.02%	3	-0.02%	5	0.03%	3
Forestry	-0.89%	28	-0.59%	28	-0.68%	27	-1.18%	26	-2.47%	26
Fishing	-1.80%	30	-1.47%	31	-1.83%	31	-2.81%	31	-3.76%	33
Coal Mining	0.00%	8	0.00%	6	0.00%	5	0.00%	3	0.00%	4
Crude Petroleum & Natural Gas	1.94%	2	1.64%	2	1.89%	2	2.34%	2	2.71%	1
Metal Ores	-0.47%	23	-0.35%	23	-0.46%	23	-0.95%	23	-2.23%	23
Quarrying & Other Mining	-0.60%	26	-0.52%	26	-0.66%	26	-1.33%	27	-2.79%	28
Oil Refining	3.41%	1	3.14%	1	3.34%	1	3.40%	1	1.75%	2
Cement	-0.14%	17	-0.25%	21	-0.33%	21	-0.70%	21	-1.67%	21
Other Manufacturing	-0.15%	19	0.07%	3	0.01%	4	-0.25%	11	-0.61%	11
Electricity	-1.74%	29	-1.47%	30	-1.71%	30	-2.56%	29	-3.09%	32
Water	-0.36%	22	-0.28%	22	-0.38%	22	-0.81%	22	-2.05%	22
Building & Construction	-0.11%	16	-0.19%	19	-0.17%	13	-0.48%	17	-1.28%	17
Wholesale and Retail Trade	-0.33%	21	-0.37%	24	-0.48%	24	-0.96%	24	-2.24%	24
Hotel and Restaurants	-0.14%	18	-0.11%	13	-0.16%	12	-0.39%	12	-1.04%	12
Road Transport	-2.36%	33	-1.37%	29	-1.63%	29	-2.74%	30	-2.82%	30
Rail Transport & Pipelines	-0.75%	27	-0.58%	27	-0.95%	28	-1.39%	28	-2.85%	31
Water Transport	-2.28%	31	-2.04%	32	-2.32%	32	-2.87%	33	-2.80%	29
Air Transport	-2.36%	32	-2.15%	33	-2.39%	33	-2.81%	32	-2.55%	27
Transport Services	0.00%	7	0.00%	7	0.00%	6	0.00%	4	0.00%	5
Telecommunications	0.71%	4	-0.17%	15	-0.22%	17	-0.49%	18	-1.32%	19
Post	0.80%	3	-0.17%	16	-0.22%	16	-0.42%	14	-1.11%	14
Financial Institutions	-0.55%	24	-0.09%	11	-0.20%	15	-0.68%	20	-1.30%	18
Insurance	-0.58%	25	-0.43%	25	-0.55%	25	-1.13%	25	-2.40%	25
Real Estate	-0.10%	14	-0.02%	8	-0.01%	7	-0.06%	6	-0.21%	7
Business Services	0.05%	6	-0.13%	14	-0.19%	14	-0.46%	16	-1.24%	16
Public Administration	-0.11%	15	-0.20%	20	-0.25%	20	-0.46%	15	-1.15%	15
Education	-0.10%	13	-0.18%	17	-0.23%	18	-0.42%	13	-1.05%	13
Health	-0.06%	10	-0.10%	12	-0.13%	11	-0.23%	10	-0.58%	10
Private Non Profit Organisations	0.09%	5	-0.03%	9	-0.04%	9	-0.08%	7	-0.21%	6
Other Services	-0.15%	20	-0.06%	10	-0.06%	10	-0.15%	9	-0.38%	9
Broadcasting	-0.09%	12	-0.18%	18	-0.24%	19	-0.53%	19	-1.42%	20

Table 7.27: MULTIPLIER IMPACTS OF IMPORT SUBSTITUTION

SECTORS	1997	%	Rank	1998	%	Rank	1999	%	Rank	2000	%	Rank	2001	%	Rank
Crop Production	0.005	0.4%	21	0.003	0.3%	25	0.004	0.4%	26	0.010	0.9%	23	0.026	2.1%	23
Livestock	0.001	0.1%	25	0.001	0.1%	30	0.001	0.1%	31	0.003	0.3%	29	0.007	0.6%	30
Forestry	0.044	3.5%	6	0.027	2.4%	7	0.032	2.7%	9	0.061	4.7%	9	0.166	9.9%	9
Fishing	0.103	7.2%	3	0.077	5.8%	3	0.105	7.3%	4	0.237	11.8%	3	0.624	18.3%	3
Coal Mining	0.000	0.0%	27	0.000	0.0%	32	0.794	79.4%	1	-0.088	-11.5%	33	0.000	0.0%	32
Crude Petroleum & Natural Gas	0.018	1.5%	11	0.021	1.7%	10	0.020	1.7%	13	0.025	2.1%	21	0.083	6.0%	17
Metal Ores	0.001	1.9%	26	0.017	1.4%	12	0.023	1.8%	12	0.052	3.8%	11	0.160	9.1%	10
Quarrying & Other Mining	0.025	2.4%	9	0.024	2.1%	9	0.030	2.7%	10	0.073	5.2%	7	0.202	10.9%	7
Oil Refining	0.048	2.5%	4	0.070	3.5%	4	0.066	3.1%	5	0.058	3.1%	10	0.117	6.7%	12
Cement	0.007	0.6%	18	0.012	1.1%	16	0.009	1.4%	23	0.026	2.9%	19	0.080	7.0%	19
Other Manufacturing	0.012	1.0%	14	0.010	0.8%	21	0.012	1.1%	20	0.027	2.4%	18	0.089	6.4%	16
Electricity	0.144	7.3%	2	0.105	6.2%	2	0.137	7.3%	3	0.312	11.7%	2	1.033	19.3%	2
Water	0.016	1.4%	12	0.012	1.1%	15	0.017	1.5%	14	0.039	3.2%	12	0.125	8.2%	11
Building & Construction	0.009	0.5%	15	0.016	0.9%	13	0.012	0.8%	21	0.036	2.1%	13	0.115	5.6%	13
Wholesale and Retail Trade	0.019	1.3%	10	0.021	1.5%	11	0.028	2.0%	11	0.062	3.9%	8	0.195	9.5%	8
Hotel and Restaurants	0.013	0.8%	13	0.011	0.7%	17	0.014	0.9%	16	0.032	1.9%	14	0.106	5.0%	14
Road Transport	0.245	11.3%	1	0.150	8.8%	1	0.183	9.8%	2	0.414	14.3%	1	1.260	21.0%	1
Rail Transport & Pipelines	0.041	3.0%	7	0.030	2.3%	6	0.052	3.8%	7	0.088	5.6%	5	0.273	12.2%	5
Water Transport	0.032	9.9%	8	0.026	8.6%	8	0.037	10.1%	8	0.086	14.6%	6	0.269	21.1%	6
Air Transport	0.045	10.7%	5	0.037	9.5%	5	0.052	10.9%	6	0.123	15.1%	4	0.391	21.6%	4
Transport Services	0.000	0.0%	27	0.000	0.0%	32	0.000	0.0%	33	0.000	0.0%	32	0.000	0.0%	32
Telecommunications	-0.002	-4.1%	29	0.000	0.8%	31	0.001	1.0%	32	0.002	2.2%	31	0.006	6.0%	31
Post	-0.043	-3.3%	31	0.010	0.7%	20	0.013	0.9%	18	0.026	1.7%	20	0.076	4.6%	20
Financial Institutions	0.008	1.5%	16	0.009	1.5%	22	0.012	1.9%	22	0.027	3.9%	17	0.081	8.7%	18
Insurance	0.002	1.8%	24	0.002	1.8%	27	0.003	2.3%	28	0.007	4.6%	27	0.021	10.0%	27
Real Estate	-0.980	-797.6%	33	0.003	0.3%	26	0.003	0.3%	27	0.007	0.6%	26	0.022	1.9%	26
Business Services	-0.049	-51.7%	32	0.001	0.8%	28	0.002	1.0%	29	0.005	2.1%	28	0.015	5.5%	28
Public Administration	0.007	0.5%	17	0.013	0.8%	14	0.016	1.0%	15	0.028	1.9%	16	0.073	4.7%	21
Education	0.005	0.4%	19	0.010	0.7%	19	0.012	0.9%	19	0.022	1.7%	22	0.059	4.2%	22
Health	0.002	0.2%	23	0.004	0.4%	24	0.005	0.5%	24	0.008	0.9%	25	0.023	2.3%	25
Private Non Profit Organisations	-0.004	-0.4%	30	0.001	0.1%	29	0.001	0.1%	30	0.003	0.3%	30	0.009	0.8%	29
Other Services	0.002	0.2%	22	0.004	0.3%	23	0.004	0.4%	25	0.009	0.8%	24	0.025	2.1%	24
Broadcasting	0.005	0.4%	20	0.010	0.7%	18	0.014	1.0%	17	0.032	2.2%	15	0.097	5.8%	15

Table 7.28: OUTPUT IMPACT OF IMPORT SUBSTITUTION

SECTORS	1997	Rank	1998	Rank	1999	Rank	2000	Rank	2001	Rank
Crop Production	0.06%	25	0.08%	25	0.07%	25	0.09%	24	0.24%	25
Livestock	0.16%	20	0.22%	21	0.21%	21	0.25%	20	0.71%	21
Forestry	0.11%	21	0.16%	23	0.16%	23	0.19%	22	0.58%	23
Fishing	0.02%	26	0.02%	26	0.02%	26	0.03%	25	0.06%	26
Coal Mining	0.21%	18	0.42%	12	386.65%	1	-10.02%	33	0.95%	19
Crude Petroleum & Natural Gas	2.76%	2	2.86%	2	3.70%	3	4.03%	2	5.12%	6
Metal Ores	0.21%	17	0.18%	22	0.17%	22	0.20%	21	0.58%	22
Quarrying & Other Mining	0.30%	15	0.35%	15	0.39%	16	0.43%	16	1.07%	15
Oil Refining	22.97%	1	23.17%	1	23.51%	2	26.12%	1	30.38%	1
Cement	0.33%	11	0.33%	18	0.46%	14	0.47%	13	0.92%	20
Other Manufacturing	0.21%	19	0.30%	19	0.28%	19	0.32%	18	0.98%	17
Electricity	2.07%	4	2.56%	4	2.47%	5	2.92%	4	8.26%	3
Water	0.30%	13	0.33%	17	0.30%	18	0.35%	17	1.11%	14
Building & Construction	0.36%	10	0.37%	14	0.53%	12	0.53%	12	1.03%	16
Wholesale and Retail Trade	0.00%	28	0.00%	28	0.00%	28	0.00%	27	0.00%	28
Hotel and Restaurants	0.09%	24	0.10%	24	0.11%	24	0.14%	23	0.25%	24
Road Transport	2.42%	3	2.65%	3	2.74%	4	3.29%	3	9.97%	2
Rail Transport & Pipelines	1.10%	6	1.82%	6	1.82%	7	2.14%	6	6.30%	5
Water Transport	1.20%	5	1.27%	7	1.16%	8	0.91%	10	2.90%	9
Air Transport	0.78%	8	0.92%	9	0.98%	9	1.16%	7	3.44%	7
Transport Services	0.00%	28	0.00%	28	0.00%	28	0.00%	27	0.00%	28
Telecommunications	0.24%	16	0.42%	13	0.41%	15	0.44%	15	1.35%	12
Post	0.01%	27	0.28%	20	0.27%	20	0.32%	19	0.98%	18
Financial Institutions	0.45%	9	2.08%	5	2.14%	6	2.46%	5	7.06%	4
Insurance	0.10%	22	0.94%	8	0.97%	10	1.14%	8	2.95%	8
Real Estate	1.10%	6	0.34%	16	0.37%	17	0.46%	14	1.28%	13
Business Services	0.30%	14	0.89%	10	0.90%	11	0.93%	9	1.94%	10
Public Administration	0.00%	28	0.00%	28	0.00%	28	0.00%	27	0.00%	28
Education	0.00%	28	0.00%	28	0.00%	28	0.00%	27	0.00%	28
Health	0.00%	28	0.00%	28	0.00%	28	0.00%	27	0.00%	28
Private Non Profit Organisations	0.00%	28	0.00%	28	0.00%	28	0.00%	27	0.00%	28
Other Services	0.32%	12	0.44%	11	0.48%	13	0.54%	11	1.45%	11
Broadcasting	0.10%	22	0.01%	27	0.01%	27	0.02%	26	0.05%	27

Table 7.29: AGGREGATE LINKAGE MEASURES AND OUTPUTS

	1997	1998	1999	2000	2001
			Backward Linkage Indicators		
Pre-Extraction	0.3521	0.3124	0.3215	0.3861	0.6225
Post-Extraction	0.2734	0.2549	0.2511	0.2408	0.2281
Import Substitution	0.3696	0.3236	0.3350	0.4204	0.7219
			Forward Linkage Indicators		
Pre-Extraction	1.0408	1.0613	1.0640	1.1896	1.4935
Post-Extraction	0.9026	0.9594	0.9361	0.9638	0.9612
Import Substitution	1.0341	1.0836	1.1160	1.2457	1.6701
			Rasmussen's Power of Dispersion		
Pre-Extraction	0.5194	0.5175	0.5215	0.5360	0.5670
Post-Extraction	0.5055	0.5092	0.5101	0.5104	0.5099
Import Substitution	0.5222	0.5202	0.5249	0.5425	0.5799
			Rasmussen's Sensitivity Index		
Pre-Extraction	0.4806	0.4825	0.4785	0.4640	0.4330
Post-Extraction	0.4945	0.4908	0.4899	0.4896	0.4901
Import Substitution	0.4778	0.4798	0.4751	0.4575	0.4201
			Multipliers		
Pre-Extraction	1.0408	1.0613	1.0640	1.1896	1.4935
Post-Extraction	0.9026	0.9594	0.9361	0.9638	0.9612
Import Substitution	1.0341	1.0836	1.1160	1.2457	1.6701
			Output Impacts		
Hypothetical Extraction	22.15%	15.13%	18.29%	32.29%	40.03%
Import Substition	0.79%	1.48%	1.81%	3.25%	7.64%

Chapter 8

ANALYSIS OF THE CONTRIBUTION OF THE OIL AND GAS INDUSTRY TO THE GROWTH OF THE NIGERIAN ECONOMY

8.1: PERFOMANCE INDICATORS OF THE OIL AND GAS INDUSTRY

The oil and gas industry has evolved over the years with several policy prescriptions applied at different stages of its development to enhance its performance and usefulness in stimulating economic growth. The industry has been the main determinant of the overall performance of the economy due to high international demand for oil and gas resources, which translates into high revenue-yielding of the industry. The production, and by extension, the revenue earning profiles of the oil and gas industry, both in the upstream and downstream sub-sectors are determined by the activities in the sector. From the review of regulatory and operational framework, activities in the oil and gas industry are based on distortions and asymmetry between the multinational oil firms as operators on one hand, and the various government agencies as managers of the economy on the other. The operators have strategic advantage derived from their technological capabilities, which they use to enhance their profit maximisation objective. Given the defective regulatory regimes that permeate, the production of crude oil is wholly under the purview of the operators, who determine the quantity for production and export subject to the OPEC stipulations and in accordance with joint venture commitments. Considering that there is no effective check on their activities, couple with their drive to maximise operational benefits, the official output data may not reflect the actual levels of activities in the sector. In addition, the flaring of associated gas that could have been harnessed tends to impose artificial production restrictions. Each oil well drilled produces a mixer of crude oil and gas with an estimated 36.23 cubic metres associated with a barrel of crude oil produced (Garba and Garba, 2001). In the downstream sub-sector, activities are not steady with frequent plant closures and therefore difficult to establish proper record of activities.

As a result of these deficiencies therefore, the data on the oil and gas industry that is presented and used for evaluating the performance of the oil and gas industry may not absolutely reflect the actual activities in the sector. However, these are the officially published data by the relevant institutions and agencies and can thus be regarded as reasonable representation of the activities in the oil and gas industry. Some of the data were obtained from different sources using different unit of measurements but a conversion ratio is applied to ensure uniform unit of measurements.

Over the years, the Nigerian economy has derived tremendous benefits from increases in crude oil production but the contribution of the industry to real GDP growth has not been steadily appreciable. Table 8.1 shows crude oil production from 1970 to 2000, Table 8.2 illustrates the proportion of crude oil exported and utilised domestically, Table 8.3 illustrates the levels of use of associated gas while Table 8.4 shows the trend in GDP and revenue growth rates. The average contribution of the oil and gas industry to GDP increased from an average of 19.6 per cent during the period 1981-1990 to 36.8 per cent within the period of 1991-2000. From 1970 to 1979, the percentage contribution of the oil and gas industry to government revenue was 59 per cent. This increased to 70.2 per cent within the period 1980 to 1989 and increased further to 77.7 per cent for the period 1990 to 2000. This shows a mismatch in the impact of the oil and gas industry on revenue earnings as compared to GDP. This indicates that the quantum of revenue generated by the oil and gas industry and contributed to the national income did not reflect the real economic activities of the sector but rather represents a high level of rents derived from crude oil extraction and exports due to rising international demand and prices of crude oil. This could explain the wide disparities in the rate of growth of nominal GDP and real GDP within the economy. The average growth rate of nominal GDP was 26.42 between 1970 and 1980, 19.28 percent between 1981 and 1990 and 37.58 per cent between 1991 and 2000 while the average growth rate of real GDP was 6.18 per cent, -0.01 per cent and 2.94 per cent between 1970 and 1980, 1981 to 1990 and 1991 to 2000 respectively. This deduction does not imply the existence of linear impact relationship between national income and GDP; rather a positive movement of one should reflect a commensurate positive movement in the other under the condition of real productive activities that ascribes to the effective utilisation of available resources. Annual output of crude oil increased consistently; from 395.7 million barrels 1970 to 558.7 million barrels in 1971, 665.3 million barrels in 1972, 719.4 million barrels in 1973, and 823.3 million barrels in 1974. In terms of daily output, there was a rise to up to 1.5 million bpd in 1971, 2.3 million bpd in 1974, and 2.1 million bpd in 1977 and peaked at 2.4 million bpd in 1979.

The astronomical rise in the level of crude oil production during the period of the 1970s is largely due to the Middle East crisis of 1973/74 and its after-effects. The international oil market suffered severe gluts during the early and mid 1980s which led to severe cut in prices and reduced output quotas of crude oil production for all members of OPEC to which Nigeria became a member in 1971. It can be observed from Table 8.1 that the growth rate of Nigeria's crude oil output was 10.1 per cent in 1980, 30.9 per cent in 1981, 10.5 per cent in 1982 and 4.2 per cent in 1993. The table also shows that, apart from few occasions such as 1986, 1987 and 1983, the average growth rate of crude oil output has been 1.2 per cent between 1980 and 1990. Crude oil production grew by 4.4 per cent in 1992 and 3.1 per cent in 1992 and declined by 2.8 per cent in 1993 but rose by 0.8 and 2.7 per cent in 1994 and 1995 respectively. The table also shows that a very large portion of the total crude oil production have been exported over the years and this trend has not change significantly even during the period after which refineries were established. The volume of crude oil absorption by domestic refineries grew significantly in the 1970s, rising from 7.611 million barrels in 1970 to 20.98 million barrels in 1973. It thereafter fluctuated to 18.864 million barrels in and 17.667 million barrels in 1975 due to major breakdown and eventual temporary closure of the Port Harcourt refinery. It fluctuated again from 21.320 million barrels in 1976 to 19.888 in 1977 but rose continuously thereafter to 24.868 in 1978, 32.667 in 1979, 50.852 in 1980, 58.542 in 1981 and peaked at 62.323 in 1982 before declining in 1983 to 59.300. After 1983, it experienced an unsteady path of increases and decreases up to 1987 and began a trend of continuous increases from 1988 to 1995 with a slight decline from 96.00 in 1993 to 88.10 in 1994 and rising to 99.73 in 1995.

The output level of the four refineries with total installed capacity of 445,000 bpd of crude oil has not been steady from the year 1988 to 2000. The product yield of the four refineries include premium motor spirit (gasoline), dual purpose kerosene, liquefied petroleum gas, automotive gas oil (diesel), high pour fuel oil (HIPFO), low pour fuel oil (LFO) and base oil. As table 8.2 shows, output of petroleum products rose from 62.25 million barrels in 1988 to 72.75 million barrels in 1989 and to an all-time peak of 89.25 million barrels in 1990 and thereafter declined continuously to 86.25, 84.0, 78.75 and 53.25 million tonnes in 1991, 1992, 1993 and 1994, respectively and rose to 66.75 million barrels in 1995. The performance of the refineries can be measured by their combined average capacity utilisation. In 1988 for instance, the Kaduna and Warri refineries were the only refineries in operation with a combined average capacity utilisation of 71.2 per cent. The Port Harcourt II joined the stream in 1989 and raised the aggregate output in spite of declined output from both the Kaduna and Warri refineries leading to a combined peaked average capacity utilisation of the refineries at 76.6 per cent in 1990, declining afterwards to 69.1 per cent in 1991. In 1992, the combined capacity utilisation rate was 72.4 per cent, it decreased to 67.1 per cent in 1993, 49.7 per cent in 1994 and rose to 58.8 per cent in 1995. Operational difficulties arising from poor maintenance standards are the causes of the unsteady rates of capacity utilisation of the refineries and by extension the output levels of the refineries. For instance, as Ojo and Adebusuyi (1996) recounted, the fire which gutted the old Port Harcourt refinery in 1989 rendered it non-operational until 1993. Production at the Warri refinery was constrained as a result of the recurring malfunctioning and breakdowns of its Fluid Catalytic Cracking Unit (FCCU) in 1997, 1990 and 1994, as well as prolonged turn-around maintenance (TAM) in 1994. Similarly, the Kaduna refinery was incapacitated by a prolonged TAM in 1992, the non-utilisation of its Crude Distillation Unit for 218 days in 1993 owing to non availability of imported heavier blend and breakdown of its FCCU, as well as a fire disaster in 1995.

Domestic consumption of petroleum products have increased over the years. This is in line with the changing pattern of the economy as a result of increase in national income brought about by increase in revenue from oil and associated change in taste towards commodities that uses petroleum products. The bulk of the increase in domestic consumption of petroleum products has been in Premium Motor Spirit (PMS) or gasoline, Automotive Gas Oil (AGO) or diesel and dual purpose kerosene, which together accounts for more than 60 per cent of the total consumption of petroleum products. The PMS and AGO are major fuels being used for road transportation as well as for small and medium size electricity generation plants. Consumption of petroleum products rose from 104.3 million barrels in 1981 to 106.5 million barrels in 1982 representing 2.0 per cent rise. It decreased to 80.3 million barrels in 1983 and fluctuated periodically through to 57.8 million barrels in 1990, 80.5 million barrels in 1992 and 57.5 million barrels in 1995. Occasional production difficulties of the four refineries have given rise to the importation of refined products to meet the demands of domestic consumption.

The oil and gas industry has been a source of enormous revenue to the Nigerian government. The essential sources of revenue from the industry consist of petroleum profit tax, rent, royalties and NNPC earnings. From contributing 27.8 per cent of total federally-collected revenue in 1970, the industry's contribution to government revenue rose to 43.6 per cent in 1971. It rose further to 82.1 per cent of total revenue in 1974 and fluctuated afterwards between 77.4 and 61.8 per cent in the period 1975-1978 with a sharp rise to 81.4 per cent in 1979. The average contribution of the industry for the period 1971-1980 was 69.9 per cent, rose to 73.4 per cent during the period 1981-1990 and rose further to 78.4 per cent of total federally-collected revenue during the period 1991-1995. In terms of contribution to GDP however, the average contribution of the industry increased from 19.6 per cent during the period 1981-1990 to 36.8 per cent within the period of 1991-2000. The dominant role of the industry has increased to a level where virtually every aspect of public expenditure is tied to fortunes of the oil and gas industry as determined by international prices and output quota of crude oil allocated to the country by OPEC. Given the significance of public expenditure in generating economic growth it implies that the growth process of the economy is tied to OPEC policies to a very large extent. Thus while membership of OPEC is useful in creating a stable revenue yield path, effective domestic macroeconomic management is required to complement OPEC strategies to inspire oil and gas sector driven process of sustainable economic growth.

The performance indicators of the industry illustrate its growing relevance to the Nigerian economy, which consigns on it a crucial role for spearheading economic growth process. An increase in crude oil production provides opportunities for expansion of domestic processing of crude oil into final petroleum products. An increase in export leads to increase in revenue to the government, but intensive domestic utilisation of oil and gas resources also leads to increase in revenue with additional benefits to the economy that could be derived from inter-industry linkages. Technological innovation can evolve from robust inter-industry linkages. Other key macroeconomic variables such as employment (reduction in unemployment) and productivity will be enhanced. Thus the benefits of domestic utilisation of oil and gas resources far outweighs the benefits of export revenue but both present potential sources for generating economic growth at varying magnitudes thus pointing to the existence of a high potential for the industry as a veritable source for generating sustainable economic growth. However, domestic utilisation of oil and gas resources can be viable only if the requisite conditions for viable investments in the downstream sector exists to ensure cost-effectiveness, profitability and other safety guarantees since investors tend to be risk-averse in their investment decisions. Effective implementation of appropriate policies is required to provide incentives for viable investments to be complemented by policies for developing human capital to facilitate the synergy for harnessing available resources.

8.2: ECONOMIC GROWTH IMPLICATIONS OF OIL AND GAS ACTIVITIES

The convergent points of the economic growth models as discussed under chapters 2 and 3 amplify the fact that economic growth is generated by the production function given by *Y=A (L K)*; that is output, *Y*, which is the measure of productivity in the economy is a function of the "effectiveness of labour" (*L*), which depends on the level of technology, *A* and also the level of capital that is injected into the production process. The key convergent point is that *A* is critical and thus regarded as the engine of growth of the economy. The main point of divergence by the various growth models is the means of acquiring *A*; whether exogenous or endogenous.

The application of appropriate technology for exploration and extraction of oil and gas resources by the multinational oil companies, acting in a contractual agreement, reflects the use of exogenous technology. The financing of the exploration and extraction projects (venture capital), which are in most cases provided by the multinational oil companies as part of the contractual agreements represents capital in the standard economic growth production function. The personnel engaged in the direct use of the facilities in all the processes of exploration, drilling and production of crude oil represents the labour element in the standard production function. These are the basic ingredients of the standard production function that is embodied in all the economic growth models reviewed. Variations in the arguments for the economic growth process are reflected by additional variables or parameters to illustrate the dimension of the impact of a particular variable within the function and/or the transmission mechanism for generating sustainable economic growth. If we consider the economic growth model that incorporates natural resources into the basic production function, the oil and gas resources represent the *R* in the function; *Y=F (K, L, R)*. Beyond identifying the basic ingredients of economic growth, the extent to which the activities within the industry impacts on the larger economy is very significant in analysing the contribution of the oil and gas industry to economic growth.

Thus the economic growth implication of oil and gas activities lies not in the growth in output of crude oil *per se* but the processes and the value-adding functions of the basic ingredients of economic growth. Oil and gas are depleting and non-renewable natural resources, implying that a constant rate of extraction cannot be guaranteed. Rational utilisation of the oil and gas resources within the confluence of accessible factors of production and utility adding consumption pattern is the fountain that could nurture the process of economic growth. The economic growth models, the neoclassical and the endogenous expositions, as well as the natural resource variant of economic growth analysis, subscribe to attaining a persistent level of output, higher level of consumption by households and a steady level of saving and discount rate that propels an increase in the level of capital as the conditions for generating economic growth. A persistent increase in output in the oil and gas industry implies a higher level of extraction, high depletion rate and a persistent reduction in the stock of oil and gas resources (crude oil). In the absence of a regeneration strategy, a constant level of consumption is not possible and the inter-temporal utility maximisation ascribed by the RCK and the overlapping generation argument becomes impossible. This could compromise intergenerational equity and steady state levels of output and consumption cannot be sustained.

Economic growth can be achieved only if a regeneration mechanism is established to benefit from the advantages of the available oil and gas resources that could lead to persistent increase in not only the level of output of crude oil, but also effectiveness of the factors of production as a reflection of positive technological change. This will not only be exhibited by the oil and gas industry but also by the entire economy through the effective use of resources from other sectors of the economy. The main derivative of such a regeneration mechanism is technological progress, the catalyst for persistent increase in output in all the sectors of the economy that leads to economic growth. The complete reliance on the use of exogenous technology to extract crude oil at a persistently increased level, with little value-adding activities weakens the stimulus for learning-by-doing and limits the synergy for generating economic growth. This perception is not completely similar to the Hotelling's (1931) depletion rate strategy and Hartwick's (1976 and 1992) and Rawls' (1974) argument of saving and investing of rents for future consumption requirements so as to fulfil the ethical obligation of intergenerational equity by ensuring a steady state consumption path. Rather it contends that given the high level of activities involved in the drive to increase output of crude oil and the chain of activities involved in the transformation of crude oil into final petroleum products, endogenous technology acquisition could evolve from appropriate response to the growing market for petroleum products, rather than a restriction of crude oil supply. Furthermore, versatile use of the by-products of oil and gas resources provides more opportunities for productive activities within the economy, which reinforces the learning-by-doing and R&D stimuli for endogenous technology acquisition. This breeds spill-over effects on the entire economy and the multiplier effect will encompass generations to offset the effects of depleting the stock of natural (oil and gas) resources over time. The availability of the natural (oil and gas) resources does not lead to economic growth automatically but it could be a source of attaining the requisite stimulus for economic growth by establishing a mechanism that makes effective use of opportunities for harnessing the resources of the entire economy. This is considered to be a dominant strategy of attaining a natural resource driven economic growth. Contemporary economic dispensation can hardly permit the policy of controlled extraction for a generational balance with surging industrialisation of developed and emerging economies of the world and the attendant increase in demand for oil and gas resources, which are complementary commodities to advancing technologies associated with industrial successes. Therefore, the argument for quantum control as an optimal depletion strategy for attaining economic growth is untenable, even though it could be useful for attaining price advantage. The stock of natural resource endowment is not absolutely determinable, more so in that scientific evidence points to the fact that human activities on earth, which is never ending, is responsible for the formation of particles that coalesce into natural resources such crude oil and natural gas. Besides, Kemp and Stephen (2005) averred that Hoetelling's (1931) prescription of optimal depletion rate based on the equalisation of present value returns through time in a steady manner, which requires timely adjustment of volume of production to correspond, has been found to be less illuminating

The scope of technology acquisition in the upstream sector activities, which dwells on extraction of crude oil with the use of exogenous technology, is limited. The upstream sector activities are essential but not sufficient for endogenous technology effects that could spiral a chain of inter-industry linkages that could lead to effective and efficient resource utilisation and economic growth. The upstream sector provides two potential mutually reinforcing opportunities for stimulating economic growth; crude oil sales generate needed revenue for financing infrastructural development and investment in the services sector to produce the human resource requirement of the economic growth process; crude oil is vital input for production activities in the downstream sector of the oil and gas industry as well as a source of derived input for production activities in the other industries within the economy. The downstream sector activities are thus crucial in facilitating the chain of linkages of productive activities across all sectors of the economy. Inter-industry linkage chain benefits of downstream activities can occur if incentives for investments in the downstream activities sector exist to ensure reasonably high returns on investment. The existence of large and expanding market for petroleum products brought about by advancing technologies and surging industrialisation of world economies requires dynamism in the acquisition and use of technology as a safeguard for inter-generational equity. To establish a balanced safeguard for inter-generational equity while pursuing sustainable growth, revenue from export of crude oil should be invested in social and economic services such as education, health and physical infrastructure, which can enhance the investment attractiveness of the economy that could form the basis for innovation, endogenous technology and sustainable economic growth, the benefits of which will encompass different generations of infinite-horizon.

Norre (1976), in reviewing the efficacy of British Oil Policies, espoused that, bargaining for oil surplus between nation states and oil companies revolves around five critical considerations; (1) Upstream *(that is in extraction)*; (2) Downstream *(refining and petrochemical production)*; (3) Retailing; (4) Associated activities *(necessary joint products to extraction and backward spin-offs such as production platforms, drilling rigs, and barges)* and; (5) Technology and Expertise. He argued that control over volume of production is a necessary strategy for long-run maximisation of oil surplus to the nation state as against oil companies. The reason for this argument is that a slower rate of extraction could lead to higher level of domestic involvement in the spin-off activities within the oil and gas industries with due recognition of the fact that oil and gas industry activities has inherent displacement effects on macroeconomic behaviours. Apart from volume control in the upstream extraction activities, oil companies have firm control of virtually all aspects. Due basically to their possession of technology and expertise, coupled with the uncertainties in initial exploration which geological investigation cannot completely remove, oil companies tend to gain higher bargaining power in contract terms that gives them higher level of oil surplus than the nation states. While acknowledging production difficulties and the need for new technologies usually used by the oil companies, Norre (ibid) argued that the financial risks tends to be exaggerated due to relatively free risk process of production after discovery. In the absence of effective Petroleum Tax policy, this will imply lower revenue to the nation states and by extension a relatively higher fiscal burden. Instead of investment risks as the basis, the terms for sharing oil surplus should rather reflect the opportunity cost of investment for a major international oil company that is able to take advantage of its monopoly position on a worldwide scale. Steady access to oil should be seen as an attractive incentive to oil and gas companies. He therefore averred that a renegotiation of contract instrument that pay compensation based on historic capital costs, which is totally acceptable within the context of international Law could be used to circumvent the disadvantages afflicting nation states in oil and gas industry activities. In addition active participation by nation states in value-adding activities such as refining, petrochemicals, retailing and supply of technology in a drive for real nationalisation could enhance the surplus share of the nation state from oil and gas industry activities. Empirical evidence suggests that downstream activities are more profitable than upstream activities. According to the Financial Times, "there is a difference of $52/tonne between the value of crude and refined products like naphtha; $232/tonne when compared with basic petrochemical inputs (ethylene), while crude transformed to textiles gives a value added of up to sixty times the original value"[53]. Kemp and Stephen (ibid) argued that showering the depletion rate of oil extraction can be justifiable for the United Kingdom on the grounds of energy policy.

[53] Norre (1976) referred to the *Financial Times* of 14 May, 1976, when Naphtha sell for $140/tonne, ethylene $320/tonne, compared with the price of crude of $88/tonne.

Intuition from basic economic principles implies that, more of downstream activities will lead to more taxable profits due to the expansionary effects of the chain of activities involved. OPEC reveals that from 1996 to 2000; the estimated oil taxes accrued to the G7 countries was $1.3 trillion while total oil revenue that accrued to all OPEC member countries for the same period was $850 billion[54]. The annual estimates for the same period were $270 billion for the G7 countries and $170 billion for the OPEC countries. The G7 countries comprises of USA, Canada, Japan, France, Germany, Italy and the United Kingdom, who are the most industrialised countries in the world, engage in more value-adding activities and with the highest level of absorptive capacity for oil and gas resources. Thus low level of value-adding activities tends to limit the absorptive capacity of the economy and strains balance of payment optimality. Incongruence between the interest of the nation state and that of oil companies arises when it is cheaper and more profitable to export crude oil and import refined petroleum products as such it is very critical for governments to create the requisite conditions for cost-effectiveness based on healthy competition for domestic investments.

Underlying these expositions is the need for acquiring technological capabilities through appropriate measures so as to ensure substantial domestic activities in the oil and gas industry operations. There is a convergence among technology experts on the crucial role of innovation in transforming sectors into dynamic systems through adaptation and interaction of factors of production based on co-ordinated (National) System of Innovation (Oyeyinka, 2004). All agents within the innovation system are active partakers in the process of learning as economic activities continue over time. Learning takes place heuristically over a long period of time and possesses an incremental character. The notion of knowledge (technology) "producer" and "user" is not useful for conceptualising appropriate policies for generating economic growth from a technologically dependent natural resource abundant economy. Technology is by and large, a by-product that is acquired through the process of active participation in the process of production, complemented by R&D activities. The hallmark of the processes of System of Innovation is "the network of institutions in the public and private sectors

[54] http://www.opec.org/newsinfo/whogetswhat.

whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987). The diffusion mechanism takes cognisance of knowledge or technology that is useful to the activities and sectors within the economy. The process of technological capability can be skewed to reflect the functional performance of firms, sectors, countries and regions based on the efficiency of the institutions that embody the innovation system. This emphasises the crucial role of institutions in achieving technological change in firms, sectors, countries and regions. Technology systems emerge from interdependent dynamics of generation and diffusion of complementary bits of technological knowledge. Theoretical and empirical studies emphasize the systemic localised character of dynamics of technological knowledge, attributing the production and diffusion of technological knowledge to industry-specific and region specific interactions among technological, institutional and social factors (Patrucco, 2005, 38). Geographical agglomeration is crucial to stimulating effective diffusion and accumulation among local firms, technical externalities that are generated through peculiar industrial conditions. Patrucco (2005), based on empirical study of the Emilian Plastics districts, established that complementary interactions in the Emilian Plastics districts involved the process of endogenous spin-off, division of labour and the role of R&D in the creation and distribution of codified knowledge and technological complementarities as well as the systemic recombination of external knowledge.

The System of Innovation conception is applicable to the operations of the oil and gas industry and could lead to technological progress within the industry that could spill-over to other sectors of the economy. To achieve this, the institutional processes, functions and policies need to play crucial roles of recognising the essence of evolving cognitive technological capability to enhance the value-adding performance of factors of production. The interdependent dynamics of the generation and diffusion of complementary technological process gives credence to the significance of inter- industry linkages as the pivot of the emergence of System of innovation and technological progress. For an economy without the requisite technological wherewithal to facilitate system of innovation in the oil and gas industry, technological progress can be achieved through output restrictions, which will tend to limit the reliance on expensive production platforms while using appropriate mechanisms to develop capabilities in recognition of the fact that direct and linear technological application of extraction installations could subvert technological change (Norre, op cit).

The relevance of the process of technological change from the oil and gas industry in Nigeria through the System of Innovation mechanism give rise to two fundamental issues; first is the reality of entrenched public sector inefficiency in management, which has constituted into the main stumbling block for growth of the economy; second is the fact that, as in most developing economies, the Nigerian economy is riddled with weak structures of production that are largely low-cost/low-wage, co-existing with high-cost, technology-intensive industrial systems especially in the oil and gas industry activities. However, Norre considers the accepted public sector management inefficacy as defeatist and not an empirically encompassing notion citing the example of the Norgean State Oil Corporation (Statoil), which was founded in 1972 but developed to attain effective operator status in 1975 with license to lead exploration and production in the fields of Northern Norway. Even in the case of less developed countries, Mexico is a good example where nationalisation of oil and gas activities occurred in 1938 and by the 1970s, there was evidence that the oil and gas industry has been effectively managed under the public sector. Beside, as Aspe and Gurria (1992) pointed out, the two most important principles of development are that; during the early phases of development when an economy is no more than a collection of fragmented markets and regions, the establishment of government institutions, the construction of infrastructure and the direct participation of the state in key areas of the economy are not only desirable but indispensable preconditions for the growth process; the second principle reflects the notion of the opening-up of investment opportunities through changes in the environment where individuals work, save and invest, in the process of which a basis for new ideas and investment opportunities are created. Romer (1992), emphasised the significance of proper application of ideas as a contingent part of the growth process, incorporated as a factor of production with a balanced need for using existing ideas and producing new ideas.

The System of Innovation paradigm and Norre's argument for effective domestic participation in value-adding activities in the oil and gas industry are tangential to the endogenous growth analogy. This further amplifies the crucial essence of the role of the public sector in providing the requisite platform for generating ideas (knowledge or technology) through learning-by-doing and R&D activities, as well as co-ordinated linkages among sectors of the economy. Thus, dependence on oil companies for linear application of digitally packaged technology for productive activities in the oil and gas industry subverts systemic innovation and creates the basis for persistent technological deficiency that could strangulate the process of growth of the economy.

8.3: CONTRIBUTION OF THE INDUSTRY TO GROWTH: AN EVALUATION

As a member of the oil producing cartel, OPEC, Nigeria's production (output of crude oil) is determined by the policies of OPEC. This implies that the depletion policies of oil and gas extraction are a function of quota allocation by OPEC[55]. The basis upon which inferences and deductions can be made to measure the economic growth relevance of the oil and gas industry activities should thus take due cognisance of this. The main benefit of OPEC membership is that it contributes towards steady output and prices and by extension revenues. However, the use of output and revenue by domestic structures and institutional process is the crucial determinant of economic growth. The trends in the output levels in the oil and gas industry, its proportion to GDP, the revenue earnings to the federal government from the industry and its proportion to total revenue earnings of the federal government provides insight into the contribution of the industry to the growth of the economy. As table 8.1 shows, the output in the industry has been steady with astronomical rise only between 1970 and 71 of 41.19 per cent, 19.08 in 1972 and 21.42 per cent in 1978/79. A negative growth rate of 30.89 per cent occurred in 1981. Apart from these few cases of high increase and decrease in output, the overall picture shows a steady output trend. In sharp contrast, the growth rate of revenue earnings from these levels of output has been tremendously high. Both variables (crude oil output and revenue from its exports) are hinged on OPEC policies. The increasing trend in the growth rate of revenue from oil while output is relatively steady reflects the increasing price of oil in the international market. The proportion of oil revenue contribution to total government revenue is relatively high and shows an increasing trend. Figure 8.1 provides a graphical illustration of the wide disparity between the rate of growth of crude oil output and the rate of growth of revenues accruing from crude oil output and sales. This phenomenon is an indication of the extent to which government revenue is determined by crude oil exports. It is possible to reduce the effects of macroeconomic shocks that could arise from volatility of the international oil market by creating a favourable atmosphere for investments that enhances the value-adding capabilities of factors of production using the opportunities afforded by availability of oil and gas resources.

[55] Even though membership of OPEC is voluntary, Nigeria's membership of the cartel means it has obligation towards its principles and policies.

The level of domestic utilisation of crude oil indicates the extent of value-adding activities of the production chain within the oil and gas industry, which could provide insights into the contribution of the industry to the growth and stability of the economy. Table 8.1 shows that on the average at any given year since commercial oil extraction began in Nigeria, more than 80 per cent of crude oil extracted in Nigeria is exported implying that less than 20 per cent is being utilised by the domestic economy. From 1970 to 1980, an average of 95.41 per cent of crude oil was exported meaning that only 4.59 per cent was utilised by the domestic economy. This improved to 85.97 per cent for exports and 14.03 per cent for domestic utilisation within the period 1981-1990, and marginally improved to 85.73 for exports and 14.27 per cent for domestic utilisation. This implies that activities within the oil and gas industry have been highly concentrated in extraction of crude oil for exports with a relatively very low level of value-adding chain of activities within the industry, which has detrimental implication for inter-industry linkage stimulus. Given the large differences in revenue earnings accruable from value-adding products of oil and gas resources ($52/tonne between crude and refined products; $232/tonne compared with petrochemical inputs, and sixty time the original value if transformed to textiles), it means that the revenue earning potential of the economy has been stultified by the low level of utilisation of oil and gas resources. Also the potential technological change that could have occurred in the process of value-adding activities and the associated multiple effects in the enhancement of the value-adding capabilities of factors of production has been stifled. This has the tendency to cripple the effectiveness of factors of production. By crippling the effectiveness of factors of production, real productive activities are stifled and with restriction in the real productive activities economic growth potential of the economy is being strangulated. Even though the revenue potential of the oil and gas industry has been far from being realised, the growth rate in revenue accruing from the oil and gas industry over the three decades of observation has been tremendously high relative to the rate of growth of output from the sector. This phenomenal increase in revenue over the period has not commensurately reflected in real growth of the economy. The total revenue of government constitutes a large component of national income.

There is a two-way positive relationship between national income and economic growth. An increase in national income is generally regarded as a reflection of an increase in the earnings of factors of production, which in turn implies increased utilisation of resources. The second dimension is that government revenue could be used to provide requisite infrastructure and other essential services that could facilitate increasing investment within the economy and enhance the efficiency of factors of production. This will create opportunities for expanding investment in different value-adding investments by firms through Foreign Direct Investment (FDI) and emerging domestic firms. According to Ishikawa et al (2005), foreign technology transfer raise productivity of firms that are partially foreign owned (JVs) and also that of firms that are 100 per cent domestically owned through technology spillovers from the partially foreign owned firms, citing the cases of Chinese automakers and the JV between the Malaysian Proton and Mitsubishi, with the degree of technology transfer and spill-over effects a positive function of corporate control by the foreign firms; the higher the corporate control by foreign firms, the greater the level of technology transfer and spill-over effects and vice versa.

Table 8.4 indicates that both the contribution of the industry to GDP and the changes in real GDP over the years do not match with the levels of increase in the revenue accrued from the industry and total national revenue. As figure 8.2 illustrates, changes in real GDP follows a remarkably different pattern from changes in total government revenue. The average contribution of the oil and gas industry to GDP increased from an average of 19.6 per cent during the period 1981 to 1990 to 36.8 per cent within the period of 1991 to 2000. From 1970 to 1979, the percentage contribution of the oil and gas industry to government revenue was 59 per cent. This increased to 70.2 per cent within the period 1980 to 89 and increased further to 77.7 per cent for the period 1990 to 2000. This shows a mismatch in the impact of the oil and gas industry on revenue earnings as compared to GDP and also indicates that the quantum of revenue did not emanate from real economic activities within the sector and other sectors of the economy. This could explain the wide disparities in the rate of growth of nominal GDP and real GDP of the economy as table 8.4 illustrates. The average growth rate of nominal GDP was 26.42 per cent between

1970 and 1980, 19.28 per cent between 1981 and 1990 and 37.58 per cent between 1991 and 2000 while the average growth rate of real GDP was 6.18 per cent, -0.01 per cent and 2.94 per cent between 1970 and 1980, 1981 to 1990 and 1991 to 2000 respectively. While economic theory does not suggest the existence of linear impact relationship between government revenue and GDP by the analogy of the relationship between national income and productivity a positive change in national income is expected to reflect in a positive change in real GDP and government revenue.

The most significant deduction from the trends in the activities of the oil and gas industry in Nigeria is that, high levels of exports of extracted natural resource could undermine effective utilisation of resources thereby stifling the economic growth process. Revenue yielding performance of the economy is not under the influence the domestic economy and can thus not be sustained. The versatile use of oil and gas resources in modern economies suggests that a growing economy tends to absorb increasing quantities of these resources in its real productive sectors. A low level of absorptive capacity for oil and gas resources is evident in the Nigerian economy. This reflects the lack of appropriate incentives for attracting viable investors that could lead to expansion in value-adding activities. Positive externalities that could create the conditions for generating economic growth through inter-industry linkages and regeneration mechanism are crippled thereby retarding economic growth. The lack of economic growth emanating from such disposition regenerates itself by cultivating a complacent consumption pattern in public expenditure, stultifying domestic markets, weakening of productive structures of the economy and rendering the factors of production inefficient. The "effectiveness of labour", the critical determinant of economic growth as emphasized by the neo-classical growth models will also be weak to accentuate the cycle of growth slowdown. A synthesis of the endogenous growth models (see for instance, Sandilands, 2000) points to the fact that the existence of industrial production on one hand, and demand for the products of the industries on the other hand, creates opportunities for market expansion, competition and specialization. Through a favourable "forward linkage" effects, an endogenous self-perpetuating process of growth emerges and feeds on it almost automatically. By the prompting of internal and external economies of scale, the process of industrial production evolves into higher and more sophisticated levels of production, giving rise to further specialization, new products and quality improvements, leading to technological acquisition and economic growth. Adaptation to a growing market, widened by international trade, stimulates industrial production and provides additional impetus to the attainment of economic growth.

Considering that structures for downstream activities have been established; four refineries with total installed capacity of 450, 000 bpd, a liquefied natural gas project, The Nigerian Liquefied Natural Gas Company (NLNG) and a Petrochemical industry, The *Eleme* Petrochemical Industry Limited, the low level of domestic utilisation of crude oil suggests operational inefficiency. Table 8.2 reveals that the refineries have been operating sub-optimally even with increasing levels of domestic demand as evidenced from increasing domestic total consumption of petroleum products. Apparently, the combined effects of the inefficiency of government management of the refineries and the lack of incentives for competitive investments in the refining activities in particular and the downstream activities in general is responsible for the low levels and declining capacity utilisation of the refineries and, as can be observed from the table, importations of refined petroleum products have increased to meet domestic consumption requirements.

Thus the recurrent low capacity utilisation of the refineries, the epileptic performance of the pipeline distribution network and the adverse impact of price regulation of petroleum products are combination of factors for a deep-rooted inefficiency in public sector management, which has rendered a potentially profitable venture such as refining unprofitable. Refining activities have become cost-ineffective and unprofitable in Nigeria due to unnecessarily very large cost outlay associated with direct government involvement in such activities. One of the main consequences of direct government involvement is that to refurbish the refineries and other maintenance services tend to cost much higher than international standard, yet they remain dysfunctional and obsolete with poor maintenance history. For instance, the World Bank (1992)[56] reveals that while the cost of turn around maintenance of the Port Harcourt II refinery to the Nigerian government was $37 million, the global standard rate was $5-$6 million. This has resulted in relatively very low value-adding productive activities in the downstream sector of the oil and gas industry. Given that refinery by-products are the key inputs for petrochemical production, the low level of refinery production activities would lead to low level of petrochemical productive activities. In addition the state of infrastructural development and other essential social and economic services is very poor and thus further illustrating the unfavourable investment climate in Nigeria. The International Monetary Fund (IMF) indicated in its 2005 preliminary report on the Nigerian economy that, Nigeria's infrastructure and public utilities rank among the worst in the world. In a private sector assessment survey by the world Bank (2002)[57], manufacturing firms considered inadequate infrastructure as their most severe business constraint in Nigeria; over 90 per cent of firms surveyed provide their own electricity power supply. The 2004 Africa Competitiveness Report[58] ranked Nigeria's infrastructure second to last among 25 African countries and third to last of 102 countries surveyed in the world.

Technological progress (positive technological change), the catalyst for economic growth, can be measured by improvement in efficiency of production that manifests in increasing levels of output over time, enhanced quality of products and increased sophistication of machineries and equipments being used in the production activities. Linkages of the sector that has gained technological change with other sectors leads to spill-over effects across sectors of the economy. The occurrence of technological change also leads to increases in investment within the particular sector of the economy and in other related sectors of the economy. Invariably, the declining levels of output and decreasing capacity utilisation of the refineries as well as the increasing dependence of the economy on imported refined petroleum products is an indication of deteriorating (negative) technological change. This implies that the possible linkage effect of the

[56] Quoted in Garba, A-G (2000)
[57] Cited in the IMF (2005) Report
[58] ibid

activities of the downstream sector will also be negative. Given the catalytic significance of technological change in economic growth process, the impact of the lack of effective value-adding production activities in the oil and gas industry on the economic growth of the economy is negative. This has given rise to decreasing level of output by the refineries, decreasing investment in refinery activities and crippling of the machinery and equipments in the refineries.

The key conclusion from this evaluation is that the operations in the oil and gas industry in Nigeria lack the synergy for efficient utilisation of oil and gas resources. Real and value-adding productive activities in the sector are very low which inflicts low spill-over effects on the sectors of the economy. By extension the relevance of the industry in stimulating inter-industry linkages is weakened which stultifies the potential contribution of the industry to economic growth, giving rise to deep-rooted distortions that prevent rational economic behaviours thereby facilitating the process of self-perpetuating lack of economic growth. Thus, the Nigerian economy lacks comparative advantage for value-adding downstream activities in the oil and gas industry. However, comparative advantage has dynamic attributes as such can be gained by evolving strategies for providing incentives for investments in value-adding downstream activities that ascribes to effective utilisation of available oil and gas resources. Forsid and Wooton (2003) argued that "agglomerative forces", the stimuli that draws workers and firms to locate in the same place could have significant impact on the cost of living of the people of the area, which creates the basis for gaining comparative advantage. Brand et al (2003) recounted that, the degree of embeddedness of the multiple activities of multinational corporations in a local economy especially manufacturing aspects determines the levels of linkage stimuli to be derived. The existence of backward linkages between multinational enterprises and domestically owned suppliers and subcontractors could form the foundation for the transmission of new knowledge in terms of products, technical process and new management ideas. The process of knowledge transmission is therefore more effective if incorporated into national policy on interaction between multinational and domestic enterprises based on the perception that getting the 'World's best' into the economy provides opportunities for learning from them as platforms for effective manufacturing activities in the economy (Brand, et al., ibid). It implies therefore that the low multipliers by the Crude Petroleum sector in particular, and the relatively inadequate level of integration of the oil and gas industry to the economy as a whole as empirical analysis of chapter 7 reveals, undermines effective manufacturing activities, stifles learning-by-doing and retards technological progress, and by extension limits the chances of attaining sustainable economic growth.

8.4: GROWTH PERFORMANCE OF THE ECONOMY

The growth performance of the economy between 1970 and 2000 can be deduced from Table 8.3. The growth rate of real GDP declined from 21.35 per cent in 1971 to 5.48 per cent in 1972, improved slightly to 6.42 per cent in 1973 and to 11.74 per cent in 1975. A comprehensive examination of the table throughout the period indicates that the fortunes of the economy from the 1970s and large part of the 1980s were significantly tied to growth in oil revenue; that is, increase in growth rate of oil revenue leads to increase in the growth rate of real GDP though not commensurately. Economic growth process is not merely about GDP indicators but the structural composition of production that determines the ability of the economy to sustain the process and gains of growth. In essence, the inclusiveness and the transformational mechanism of production structures, composition of output, absorptive capacity of the economy, all of which translates into increasing roles of the secondary and tertiary sectors while the role of the primary sectors of the economy decreases in contribution to GDP. It is therefore pertinent to evaluate the nature, contents and processes of GDP formation of the Nigerian economy over time.

Following Ajakaiye's (2003) performance review of the Nigerian economy between 1990 and 1999, it is possible to make inferences about the structure and growth of output (GDP); structure and growth of gross domestic income (value added); structure and growth of gross domestic expenditure; composition of investment expenditure, exports and imports; import intensities of production, consumption and investment; and relationships between savings and investment. It is also possible to make inferences about the measurement of the structure and growth of output on the basis of disaggregating the economy into three main activity sectors: the primary sector, comprising of crop agriculture, livestock, forestry, fishing and mining (including crude oil extraction); the secondary sector comprising of manufacturing (including oil refining), utilities and construction activities; and the tertiary sector comprising of service activities such as transport, communication, distributive trade, hotel and restaurant, finance and insurance, real estate and other business services, housing, community, social and personal services.

The framework of analysis is hinged on the intuition that the dominance of a particular sector over others could be used to measure the level of growth and development attained or being attained by the economy. For instance if the contributions of the primary sector to overall output, employment and income is dominant over that of the secondary and tertiary sectors, then the economy could be classified as being underdeveloped. It is expected that as the economy develops over time, the relative contribution of the primary sector declines while that of the secondary sector tends to increase. The economy reaches an advanced stage of development when the relative contribution of the tertiary sector becomes dominant over others in terms of contribution to overall output, employment and income. However, regardless of relative contribution, each of these sectors are expected to be growing, albeit at different rates, for a smooth and orderly development of the economy.

The review shows that within the period 1990 and 1999, the primary sector of the Nigerian economy was dominant in the overall contribution to GDP in relative terms at an increasing rate. This rising trend of the primary sector is attributed to the rising contribution of agriculture, which was 39.05 percent in 1990 and had exceeded 40 percent by 1999. The trend of contribution of the secondary sector to output declined from over 10 per cent between 1990 and 1993 to 8.5 percent by 1999. The contribution of the tertiary sector increased from around 37 percent during the early 1990s to over 39 percent by 1999. There was a systematic increase in the diversification index from 1.31 during the early 1990s to 1.36 by 1999 implying that the goal of diversification of the economic base was not reasonably achieved during the period. The review also reveals that the mining segment of the primary sector recorded large negative growth rates in 1994, 1998 and 1999, reflecting the unfavourable developments in the international oil market, especially in terms of prices of crude petroleum.

Growth performance of the secondary sector which was quite impressive in 1990 and 1991 became negative in 1992, 1993, 1995 and 1998. Overall growth rate of output exceeded the estimated population growth rate of around 2.8 percent between 1990 and 1992 as well as in 1996 and 1997, but not in other periods, implying that it was impossible to sustain growth in per capita income throughout the period, which partly explains the growing poverty situation in the country during the period. Poverty level rose from 42.7 percent in 1992 to 65.6 percent in 1996 and it is projected to have risen to 70 percent by 1999 (Ajakaiye, 2003).

The structure and pattern of growth of output in the Nigerian economy points to the fact that the economy has not been growing and developing. The excessive dominance of the primary sector following closely by the tertiary sector with the relatively very small contribution of the secondary sector to output, employment and income is an indication of an economy that is not generating growth through technology-driven productive activities. The further dominance of the agricultural segment, which is largely peasantry, is illustrative of the lack of in-built technology generating process of production that could engender growth of the economy. A technology intensive agricultural production will increase output, which will lead to surplus of agricultural products. It will also give rise to excess supply of labour in the sector but a corresponding expansion of the manufacturing sector is expected to absorb the excess labour supply to further stimulate the process of technology acquisition through learning-by-doing. The high contribution of the tertiary sector without a corresponding level of performance by the secondary sector suggests that the tertiary sector is not really servicing the Nigerian economy but indeed, the economies of trading partners. Nigeria has become a trading outpost for goods produced elsewhere with little domestic transformation (value-adding activities) of the output by the secondary sectors.

The composition of growth trends of the gross domestic income (GDI) provides additional insights into the workings and performance of the Nigerian economy. Income is decomposed into compensation of employees (wage income); operating surplus (profit income); consumption of fixed capital (depreciation allowance); indirect taxes and subsidies. The share of wage income, in terms of its contribution to the total and growth rates, peaked at 30.6 percent in 1991, declined rather gradually until 1995 when it plummeted from over 26 percent in the preceding year to about 11 percent (Ajakaiye, 2003). It further declined to single digit in 1996 and 1997 before rising slightly towards

16 percent in 1999. The relatively higher share of wage income in the total value-added between 1990 and 1994, as well as in 1999, is not so much a reflection of rising level of employment but a consequence of the frequent increases in wages influenced by the public sector. The immediate decline of the rates of contribution of wage income after these periods is indicative of this fact. It shows that increases in workers' welfare arising from increases in nominal wages without corresponding increase in real output is transitory and unsustainable, especially in a cost-push pricing environment. The share of operating surplus (profit income) which was around 67 percent between 1990 and 1991 increased to over 70 percent between 1993 and 1994 after which it jumped to over 80 percent for the rest of the period. This indicates that functional income distribution worsened which implies that the growth process of the economy could not have been inclusive. The situation also explains the rising poverty level during the period as mentioned earlier.

Consumption of fixed capital (depreciation allowance), indirect taxes and subsidies were really miniscule throughout the period. It can be deduced from the very low level of depreciation, which declined progressively from 2.73 per cent of total value-added of the economy in 1990 to 0.68 per cent in 1999, that there were no significant additions to national productive asset base and this particularly explains the relatively low growth rate of GDP recorded from 1992 onwards. The share of indirect taxes in total income increased dramatically in 1996 and it has remained relatively higher since then. This is attributable to the impact of value-added tax which was introduced during that period. From 0.26 per cent in 1990 to 0.28 per cent in 1991, it became 0.18 per cent in 1992, 0.16 per cent in 1993, 0.15 per cent in 1995, and rose dramatically to 0.57 per cent in 1996, 0.64 per cent in 1997, and 0.64 per cent in 1998 and fell marginally to 0.63 per cent of total value-added of the economy in 1999. In spite of this rising trend, the relative share of indirect tax is too low, suggesting that the economy is largely under taxed. It is a reflection of the small size of the secondary sector which is the most susceptible to taxation. The growth rates of wage and profit incomes were negative in 1992 and between 1995 and 1997 before recovering in 1998 and 1999. Operating surplus grew throughout the period with the exception of 1999. This pattern of growth in incomes further illustrates the fact that functional income distribution is skewed in favour of profit income earners.

The structure and growth of gross domestic expenditure (GDE) provides additional insights as to the performance of the economy and further illuminates the essential characteristics of the growth process embedded within the Nigerian economy. The composition of GDE involves the elements of gross domestic expenditure, which are decomposed into private and government consumption expenditure; gross capital formation (investment expenditure); exports and imports. Further decomposing investment expenditure into building and construction; land development; machinery and equipment; transport equipment and breeding stock; exports into oil and non-oil; imports into consumer goods; capital goods, raw materials and miscellaneous, provides a basis for appropriate evaluation of the inclusive growth process generated by the performance of the economy. The instruments of import dependence ratios such as import/consumption, import/investment and import/ raw material ratios could be derived to properly measure the growth performance of the economy. It was found that, the largest component of Nigeria's gross domestic expenditure (GDE) is consumption expenditure, accounting for over 80 per cent (meaning that saving rate is 20 per cent) of total GDE between 1991 and 1999, with private consumption expenditure being the dominant throughout the period. This implies that majority of Nigerians spend a large part of their income on consumption and also implies that majority of Nigerians save a very small portion of their income[59]. Recalling that operating surplus (profit income) dominated gross domestic income makes this revelation more poignant. For most of the period, gross capital formation, a measure for gross investment, accounted for less than 6 percent of gross domestic expenditure. Export accounted for 20 percent of GDE in 1990 but declined to around 10 percent by 1999 while the proportion of imports in total GDE was rather unstable between 1990 and 1994 after which it increased systematically between 1995 and 1997 before declining in subsequent years to about 5 percent in 1999. In terms of growth rates of the components of GDE, government consumption expenditure grew throughout the period except in

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[59] A saving rate of 20 per cent is not ordinarily low but given the high ratio of profits to GDP, it is relatively very low.

1995 and 1996 when it declined significantly. The growth rate of government consumption expenditure was 10.89 in 1990, 8.24 in 1991, 12.49 in1992, 13.70 in1993, 104.39 in 1994, -19.48 in 1995, -7.93 in 1996, 7.68 in 1997, 8.46 in1998 and 71.11 in 1999. However, the growth rates of private consumption expenditure over the period was rather erratic, as it was 5.05 in 1990, 10.75 in 1991, 7.21 in 1992, 1.32 in 1993, -10.78 in 1994, 10.00 in 1995, 6.61 in 1996, -1.58 in 1997, 9.56 in 1998, -14.73 in 1999.

The pattern of growth of gross capital formation, exports and imports also manifested this erratic trend but more illuminating is their composition. During the period, building and construction dominated gross capital formation accounting for between 60 and 70 percent of the total throughout. Land development accounted for between 11 and 13 percent of gross capital formation despite the fact that agriculture accounted for a large portion of gross domestic product during the period, which is in tandem with the peasantry nature of Nigerian agriculture. The share of machinery and equipment rose from 18.73 in 1990, peaked at 21 percent in 1993 and subsequently declined continuously, though erratically, to 10.52 percent in 1999. Considering the fact that machinery and equipment are required largely by the secondary sector, this trend is an indication that investment in the secondary sector has been declining, especially since 1995 and this corroborates the relatively small contribution of the secondary sector to the gross domestic product (GDP). The share of transport equipment in total capital formation was relatively low throughout the period under review, ranging from 7.55 in 1990, 8.53 in 1993, and 3.38 in 1996, to 4.76 in 1999. This minuscule share of transport equipment in total capital formation, if juxtaposed with the large contribution of the tertiary sector to GDP, raises some puzzles as to the functional linkages of the sectors towards generating sustainable growth within the economy.

Analysis of the composition of exports showed that oil export is, as expected, decidedly dominant. Oil exports (and non-oil exports) comprised of 97.03 (2.97) of total exports in 1990, 96.15 (3.85) in 1991, 97.94 (2.06) in 1992, 97.70 (2.30) in 1993, 97.40 (2.60) in1994, 97.57 (2.43) in 1995, 98.22 (1.78) in 1996, 97.65 (2.36) in 1997, 95.47 (4.53) in 1998 and 98.36 (1.64) in 1999. This trend is an indication that the policies of diversification of productive and revenue base of the economy did not achieve the objectives. As regards imports, the share of consumer goods in total imports increased systematically throughout the period from 25 percent in 1991 to about 40 percent in 1999. Consumer non-durable goods accounted for the bulk of the imported consumer goods, a trend that portrays the intensive import-dependent consumption pattern of the economy. The share of raw materials rose systematically and peaked at 45 percent in 1995 before declining to about 37 percent in 1999. On the other hand the share of capital goods declined from over 40 percent in 1990 to 23 percent by 1999. This pattern of imports, coupled with the stunted nature of the secondary sector of the economy explains the relatively low investment expenditures in capital goods. The import-dependent nature of the consumption pattern of the economy as manifested by the relatively high proportion of consumer goods in total imports is a reflection of the inability of the secondary sector to meet the domestic demands for consumer goods, especially consumption of non-durables. The import dependence ratios for consumption, investment and raw materials show that Nigerian consumers, producers and investors are chronically dependent on imports. While imports could be useful inputs in proper functioning of an economy, over reliance on importation especially for consumption could lead to unfavourable balance of payment disequilibrium and adversely affects domestic resource utilization. Despite the dominant contribution of agriculture to GDP, import-consumption ratio averaged over 10 percent throughout the period under review. Consumer non-durable goods tended to have a larger share of this dominance of imports on consumption. The import dependent ratios for consumer durable (and consumer non-durable) were 3.20 (23.50) in 1990, 4.20 (20.60) in 1991, 3.20 (30.60) in 1992, 4.20 (30.70) in 1993, 3.49 (32.41) in 1994, 3.10 (30.00) in 1995, 2.80 (35.90) in 1996, 3.00 (34.50) in 1997, 3.10 (3590) in 1998 and 3.60 (36.40) in 1999. The import dependent ratio of raw materials peaked at 57.92 percent in 1995 and declined to 27 percent by 1999. This trend could have been regarded as positive for the economy but taking into consideration the revelation that the secondary sector has been shrinking over the same period with the few surviving ones having to cope with low level of capacity utilization, the situation could not have been as a result of internal sourcing of raw materials but rather a decline in the use of raw materials arising from declining production in the secondary sector of the economy. The import dependent ratio of investment averaged over 80 percent during the period, suggesting that the capital goods segment of the secondary sector has completely collapsed.

Analysis of national savings, national investment, savings-investment gap, savings/GDP ratio, is also germane to the proper grasp of the growth generating attributes and performance of the Nigerian economy. The essence of financial intermediation by financial institutions in an economy is to channel savings towards viable investments so as to enhance productive activities. Therefore a strong correlation is expected to exist between the levels as well as changes in investment and savings. For a production driven process of economic growth, the gap between the savings rate and investment rate should be narrow and reducing over time especially as an indication that investment is yielding good returns as a result of increasing productive activities, which invariably leads to increase in capacity utilization and the employment of more factors of production. With the exception of 1992, national savings exceeded national investment throughout the period. The 1992 situation was as a result of unprecedented capital transfers from Nigeria to other parts of the world estimated at over N8.6 billion compared to N4.2 billion in 1991 (Ajakaiye, ibid). Savings-investment gap recorded for the period is 8.95 in 1990, 6.86 in 1991, -1.43 in 1992, 5.57 in 1993, 6.94 in 1994, 7.42 in 1995, 8.62 in 1996, 10.30 in 1997, 8.52 in 1998, and 10.57 in1999. Both the ratio of savings to GDP and investment to GDP were persistently low throughout the period 1990 to 1999. The savings/GDP ratio was 6.33 in 1990, 5.83 in 1991, 5.71 in 1992, 6.15 in 1993, 5.77 in 1994, 12.11 in 1995, 13.18 in 1996, 14.65 in 1997, 12.78 in 1998, and 14.46 in 1999. The investment/GDP ratio is 16.22 in 1990, 13.07 in 1991, 4.25 in 1992, 11.71 in 1993, 12.61 in 1994, 4.95 in 1995, 5.17 in 1996, 5.38 in 1997, 5.29 in 1998 and 5.40 in 1999. For an economy where operating surplus accounted for between 70 and 80 percent of GDP, the level of savings/GDP ratio is rather too low and given the equally very low level of investment/GDP ratio, it will be difficult, if not impossible to transform savings into investment. The Nigerian economy is thus clearly·afflicted by low savings, and even much lower investment, which hinders manufacturing activities in the secondary sector and undermines domestic resource utilisation of the economy for a production-driven process of technology acquisition and the attainment of economic growth. This situation is further worsened by the mismanagement of interest and exchange rates within the economy, leading to numerous profitable but non-investment ventures in the financial sector of the economy. Investible funds were not used for investment but for activities that promote quick returns in commerce and services[60] thereby swelling the tertiary sector without a corresponding increase in the level of activities in the secondary sector. Interest rates on savings declined from 17.8 percent in 1990 to 5.3 percent in 1999 while real interest rates on savings deposits were negative throughout the period, except in 1990 and 1991, due to high inflationary trend. On the other hand, interest rates on loans were generally high throughout the period. The minimum re-discount rate (MRR) which peaked at 26 percent in 1993 was reduced to 13.5 percent in 1994 and raised to 18 percent in 1999. There was thus a very high and widening difference between savings and lending rates which peaked at 22.4 percent in 1993 before declining to 7.9 percent in 1994, and rose systematically thereafter to about 22 percent by 1999. This system of interest on loans does not favour investment in the primary and secondary sectors of the economy, but tends to favour tertiary sector activities, the foremost of which is the distributive trade, where operators deal mainly in imported finished goods with short turnaround time, as against much higher turnaround time of the secondary sector operations more especially given the peculiar constraints of the secondary sector activities of the economy. This is further obvious from the maturity structure of the loans to the economy which reveals the preponderance of short-term loans which are more suitable for traders than producers. The implication is that, the effective bank lending rate is more affordable by traders in the tertiary sector compared to the manufacturers in the secondary sector. This situation further cripples domestic industry since domestically produced commodities for a non-industrially developed economy of Nigeria are less competitive if compared to their imported alternatives. The peasantry nature of agriculture, the dominant activity in the primary sector tends to consign the basically low literacy rate farmers to informal means of sourcing capital for their activities since they are not attuned to the patronage of formal financial institutions for loans in addition to the

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[60] It is necessary to state that not all commerce and service sector activities are unproductive. It is also noteworthy to mention that rising share of the service sector to GDP is a universal phenomenon. However when such a rising trend is occasioned by a dwindling secondary activities, it is an indication of declining productive activities and lack of growth of the economy.

high cost of capital that makes it virtually prohibitive to such group of farmers. This breeds high risks of crop failures and tends to unnecessarily increase the cost of production of peasant farmers, thereby stifling the potential of agricultural output in the primary sector.

The profile of key monetary aggregates of the economy shows that credit to the entire economy grew systematically between 1990 and 1993 before decelerating between 1994 and 1997, but credit to the government tended to dominate total credit to the economy. The growth rate of credit to the private sector peaked at about 52 percent in 1993 and declined thereafter but not absolutely, throughout the period. During 1998 and 1999, there was phenomenal growth in credit to both the government and the private sector. The exchange rate profile indicates that the premium of the parallel market was lowest in 1995 when in a bid to close the gap between the parallel market and the official market, government decided to raise the exchange rate from around N21: $1 to N85: $1. The premium continued to increase thereafter, reaching N7 or about 8 percent by 1999. The exchange rate depreciated continuously throughout the period. Given that the economy is highly import-dependent as implied by import-raw material and import-investment ratios, a depreciating exchange rate should have contributed to the low growth of output and low level of investment in the economy, in the sense that a depreciating exchange rate raises domestic cost of production and will thus make domestically produced goods less competitive compared to their imported alternatives. Expectedly, the allocations of foreign exchange for imports of raw materials and machinery and equipments were relatively low and declining between 1995 and 1999. This situation, combined with a high bank lending rate profile created an enabling environment for importation and distribution of finished goods while creating a disabling environment for existing producers and discouraging new investors. The profit drive of the banking system accentuated this situation since it is more profitable to finance and allocate foreign exchange to the import and distribution business than manufacturing business.

It is evident from the review of the profiles of gross domestic product (GDP), gross domestic investment (GDI), gross domestic expenditure (GDE), exports and imports, savings and investment and interest and foreign exchange rates of the Nigerian economy for the period 1990 to 1999, that the economy, to a large extent, did not witness the critical transformation that could inject dynamism for sustainable growth. The continued dependence of the economy on oil export for (foreign exchange) revenue is apparently manifested by the trend of output, exports and imports over the period. The dominance of GDP by agriculture and distributive trade prevailed while manufacturing remained an insignificant contributor to total output of the economy. Despite the numerous diversification policies implemented for several years, the economy remain undiversified and income remained dominated by operating surplus while the productive base of the economy remain weak. The Nigerian economy thus did not exhibit the attributes of inclusive growth process. The 2001 annual report of the Central Bank of Nigeria (CBN) indicates that GDP grew by 3.9 percent in 2001 compared with the growth rate of 3.8 percent achieved in 2000. Agricultural production recorded a growth rate of 3.1 percent in 2000 and 3.7 percent in 2001, while manufacturing production rose by 0.4 percent in 2000 and 2.9 percent in 2001. However, as in the previous years, services and commerce flourished which the CBN attributed to the expansion in the fiscal operations of government as well as substantial increase in aggregate demand arising from the wage increase in the 2000 fiscal year. The fact that increase in aggregate demand is not reflected in a corresponding manufacturing output but rather a flourishing of services and commerce attest to the persistent unproductive trend and distortions that characterise the Nigerian economy. Agriculture continued to dominate in contribution to GDP, accounting for 42[61] per cent in 2001, while the industrial sector, consisting of crude petroleum, mining and quarrying and manufacturing contributed 17.0 percent. The share of the services sector stood at 28.0 percent while the other sectors accounted for 13.0 percent. Thus, the Nigerian economy is deeply entrenched in a persistent non-inclusive non-growth process that has tended to ignore domestic production activities. Domestic expenditure remains consistently dominated by consumption expenditure leaving little for savings despite the fact that operating surplus dominate income of the economy. The capacity of the economy to meet up the challenges of contemporary global realities is therefore very weak. A fundamental transformation of the economy requires a reversal of

[61] The World Bank reported 30 per cent as the share of the agricultural sector to Nigeria's GDP for 2001.

the deep rooted consumption pattern of the economy to be replaced by production process that ensures the effective utilization of domestic resources.

Table 8.1: CRUDE OIL PRODUCTION, EXPORT AND UTILISATION

YEAR	OUTPUT *('000 barrels)*	GROWTH RATE *(%)*	EXPORT *('000 barrels)*	EXPORT (%)	DOMESTIC UTILISATION *('000 barrels)*	DOMESTIC UTILISATION *(%)*
1970	395689	-	383455	96.9	12234	3.1
1971	558689	41.2	542545	97.1	16144	2.9
1972	665295	19.1	650640	97.8	14655	2.2
1973	719379	8.1	695627	96.7	23752	3.3
1974	823320	14.4	795710	96.6	27610	3.4
1975	660148	-19.8	627638	95.1	32510	4.9
1976	758058	14.8	736822	97.2	21236	2.8
1977	766055	1.1	715240	93.4	50815	6.6
1978	696324	-9.1	674125	96.8	22199	3.2
1979	845463	21.4	807685	95.5	37778	4.5
1980	760117	-10.1	656260	86.3	103857	13.7
1981	525291	-30.9	469095	89.3	56196	10.7
1982	470638	-10.4	401658	85.3	68980	14.7
1983	450961	-4.2	392031	86.9	58930	13.1
1984	507487	12.5	450580	88.8	56907	11.2
1985	547088	7.8	486580	88.9	60508	11.1
1986	535929	-2.0	486584	90.8	49345	9.2
1987	483269	-9.8	390514	80.8	92755	19.2
1988	529602	9.6	435797	82.3	93805	17.7
1989	625908	18.2	522481	83.5	103427	16.5
1990	660559	5.5	548249	83.0	112310	17.0
1991	689850	4.4	585838	84.9	104012	15.1
1992	711340	3.1	604300	85.0	107040	15.0
1993	691400	-2.8	563614	81.5	127786	18.5
1994	696190	0.7	578044	83.0	118146	17.0
1995	715400	2.8	616900	86.2	98500	13.8
1996	740190	3.5	648690	87.6	91500	12.4
1997	759710	2.6	673340	88.6	86370	11.4
1998	776190	2.2	687390	88.6	88620	11.4
1999	778900	0.3	666490	85.6	112410	14.4
2000	797880	2.4	688080	86.2	109800	13.8

Source: Central Bank of Nigeria, STATISTICAL BULLETIN, Volume 11, NO 2, December, 200(

Table 8.2: DOMESTIC PRODUCTION AND CONSUMPTION OF REFINED PETROLEUM PRODUCTS

Year	Capacity Utilisation *(%)*	Total Output *(Million barrels)*	Total Domestic Consumption *(Million barrels)*	Net Exports *(Million barrels)*
1981	NA	NA	104.25	NA
1982	NA	NA	106.5	NA
1983	NA	NA	80.25	NA
1984	NA	NA	69	NA
1985	NA	NA	69.62	NA
1986	NA	NA	71.73	NA
1987	NA	NA	68.03	NA
1988	71.2	62.25	60.44	NA
1989	64.3	72.75	57.76	NA
1990	76.7	89.25	57.75	NA
1991	69.1	86.25	60.56	11.7
1992	72.4	84	80.46	10.47
1993	57.1	78.75	64.26	9.02
1994	49.7	53.25	59.02	4.66
1995	58.8	66.75	57.53	7.86
1996	NA	NA	62.65	NA
1997	43.3	70.26	41.11	-4.93
1998	29.6	41.46	11.72	-31.03
1999	29.5	47.85	69.03	-19.42
2000	19.9	32.34	69.03	-43.12

Source: Basic data obtained from several issues of the CBN Annual report and Statement of Accounts as well as other sources. Some of the original data were measured in tonnes but were converted using a conversion rate of 7.5 barrels=1 tonne as obtained fr

Table 8.3: PRODUCTION AND UTILISATION OF ASSOCIATED GAS
(Million Cubic Metres)

Year	Production	Utilisation	% Utilisation	Flared	%Flared
1970	8039	72	0.9	7957	99.0
1971	12975	185	1.4	12790	98.6
1972	17122	274	1.6	16848	98.4
1973	21882	395	1.8	21487	98.2
1974	27170	394	1.5	26776	98.5
1975	18656	323	1.7	18333	98.3
1976	21276	659	3.1	20617	96.9
1977	21924	972	4.4	20952	95.6
1978	21306	1866	8.8	19440	91.2
1979	27619	1546	5.6	26073	94.4
1980	24551	1647	6.7	22904	93.3
1981	17113	2951	17.2	14162	82.8
1982	15382	3442	22.4	11940	77.6
1983	15192	3244	21.4	11948	78.6
1984	16255	3438	21.2	12817	78.8
1985	18569	3723	20.0	14846	80.0
1986	18739	4822	25.7	13917	74.3
1987	17085	4794	28.1	12291	71.9
1988	20253	5516	27.2	14737	72.8
1989	25053	6323	25.2	18730	74.8
1990	28163	6343	22.5	21820	77.5
1991	31587	7000	22.2	24588	77.8
1992	32465	7058	21.7	25406	78.3
1993	33444.6	7536.2	22.5	25908.4	77.5
1994	32793	6577	20.1	26216	79.9
1995	32980	6910	21.0	26070	79.0
1996	36970	10150	27.5	26820	72.5
1997	36754.8	10207	27.8	26547.8	72.2
1998	36036.6	10886.5	30.2	25150.1	69.8
1999	36156.4	12664.6	35.0	23191.8	64.1
2000	47537.5	21945.45	46.2	25592.2	53.8

Source: CBN STATISTICAL BULLETIN, Volume 11, N0 2, December, 2000

Table 8.4: GDP AND OIL REVENUE GROWTH RATES (1970-2000)

Year	Growth rate of Nominal GDP(%)	Growth rate of Real GDP (%)	% of oil and gas to GDP	Growth rate of oil revenue (%)	% of oil revenue to total Government revenue	Growth rate of Government revenue (%)
1970		0.0	-		26.3	
1971	26.2	21.3	-	206.2	43.6	84.4
1972	9.7	5.5	-	49.8	54.4	20.2
1973	52.5	6.4	-	32.9	59.9	20.7
1974	66.5	11.7	-	266.5	82.1	167.6
1975	14.5	-3.0	-	14.7	77.5	21.5
1976	27.2	11.1	-	25.6	79.3	22.7
1977	18.2	8.2	-	13.3	75.6	18.9
1978	9.6	-7.4	-	-25.1	61.8	-8.3
1979	21.4	2.4	-	94.9	8.1	1380.5
1980	18.3	5.5	-	39.1	81.1	-86.0
1981	1.7	-26.8	20.3	-30.7	64.4	-12.8
1982	2.2	-0.3	16.3	-8.8	68.3	-14.0
1983	10.0	-5.4	13.7	-7.2	69.0	-8.1
1984	11.1	-5.1	15.2	14.0	73.5	7.1
1985	13.3	9.4	17.0	32.1	72.6	33.7
1986	1.1	3.1	13.6	-25.8	64.4	-16.3
1987	48.2	-0.5	23.8	134.7	75.0	101.5
1988	33.5	9.9	21.0	4.2	71.9	8.7
1989	55.9	7.4	35.4	97.3	72.6	95.2
1990	15.9	8.2	33.4	83.7	73.3	82.1
1991	24.2	4.7	37.5	15.0	81.9	2.9
1992	70.0	3.0	46.8	98.5	86.2	88.6
1993	27.1	2.7	35.5	-1.2	84.1	1.2
1994	31.7	1.3	24.8	-1.2	79.3	4.7
1995	115.2	2.2	40.4	102.6	70.6	127.8
1996	39.8	3.4	43.6	26.0	78.6	13.1
1997	3.4	3.2	38.9	2.0	71.5	12.0
1998	-4.0	2.3	27.9	-22.2	70.0	-20.5
1999	19.4	3.1	28.1	123.4	76.3	104.7
2000	49.0	3.6	47.5	119.7	83.5	100.8

Source: Underlying Data Obtained from CBN Statistical Bulletin, Vol.11, No 2, December, 2000

Figure 8.1 Percentage Growth rates of oil output and revenue

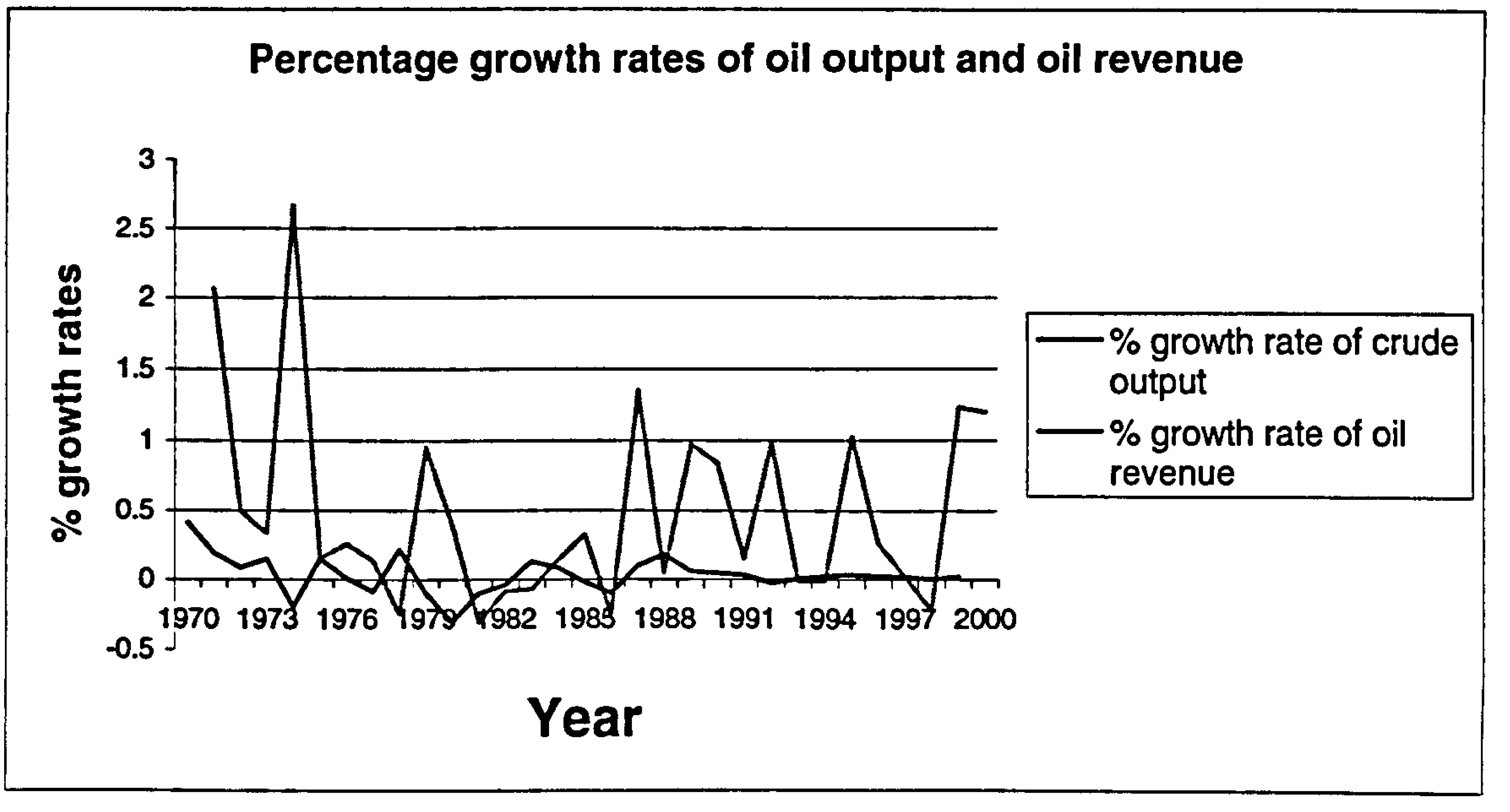
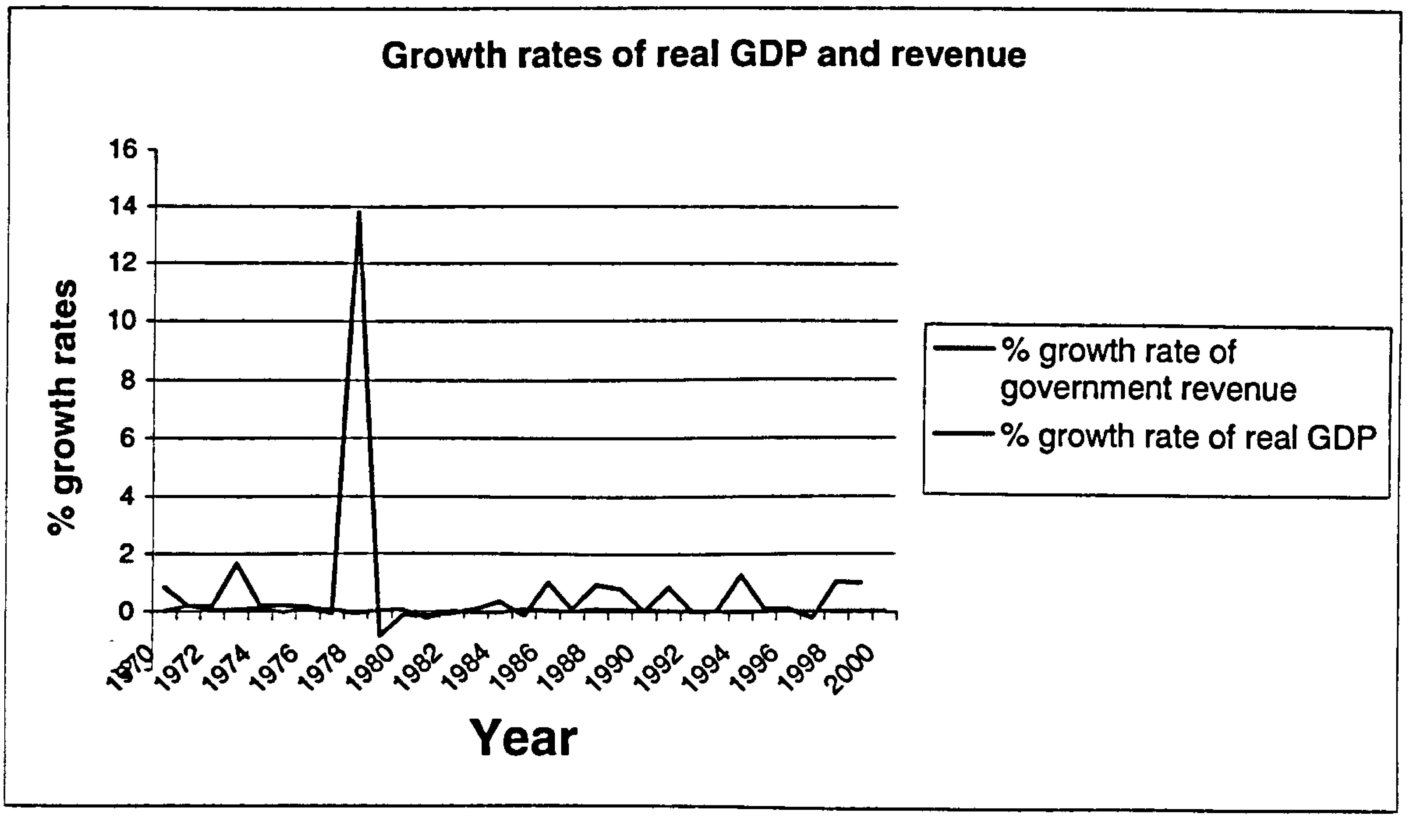


Figure 8.2: Growth rates of Real GDP and Government Revenue



Chapter 9
DIAGNOSIS, SUMMARY AND CONCLUSION

9.1: DIAGNOSIS

9.1.1: Oil and Gas Industry Issues

From the discussion under 8.2, the essential and sufficient conditions for an oil and gas industry driven process of economic growth are hinged on robust value-adding activities in the oil and gas industry which ascribes to regeneration mechanisms that are embedded in the regulatory policies as well as the structure and operations of the industry. It can be specified that the essential condition revolves around incentives for large scale investments in the sector to match the growing demands (domestically and globally) for the products of the industry while the sufficient condition requires that the activities in the industry propels other sectors to efficiently utilise available resources towards the attainment of favourable macroeconomic performance of the economy. Both the essential and sufficient conditions are contingent on a sound regulatory and operational framework. It is therefore pertinent to evaluate the existing regulatory policies of the Nigerian oil and gas industry and the operational issues arising there from.

- The main thrust of regulations of the industry has revolved around ownership structure and the distribution of benefits of exploration activities while insufficient considerations have been given to linkage relevance of the industry to other sectors of the economy. Consequently, the nature of concessions and contract agreements (JVCs and PSCs agreements) entered into between the government and the oil companies placed more emphasis on the revenue gains of the government without adequate recourse to domestic processes that could generate positive externalities and growth of the economy.

- Land, as crucial a factor and input in the production process it is, has not been given any value by the regulatory policies. This misconception of land as a free commodity, coupled with the absence of or the non enforcement of any law to prevent or minimise the adverse effects of environmental degradation and other negative externalities have encouraged the holders of oil operation licences to refuse to adopt rational land-space and environmentally clean techniques. The resultant negative social and economic impact has generated grievances among the people of the oil producing area. The absence of a decent means of pursuing their grievances has precipitated violent attacks against personnel and equipments of oil companies operating in the area culminating into operational risks that tends to increases the cost of production and adversely affecting the efficiency of factors of production and by extension leading to lower level of output.

- The Nigerian tax system provides incentive for investment in the upstream activities in oil and gas sector. The tax rate of 50 per cent for Petroleum Profit Tax (PPT) is considered to be among the lowest at the international level (similar to in Venezuela) compared to other countries especially those in the Middle East where petroleum profit tax rate ranges between 65 to 80 percent The inclusive and exclusive list of items allowed to be charged is additional yardstick for determining the investment attractiveness of the tax policy. For instance, the exclusion of depreciation from the account (as stated in section 11, 1(g) of the Petroleum Profits Tax Ordinance of 1959 (Amended in 1979) can induce book-keeping malpractice since provision will always be made for this item by operators in the industry even though it is a precautionary measure. Thus investors in the sector could use the exclusive list to reduce the taxable profit. Given the heavy capital intensity of the industry, the value of depreciation could be high enough to drastically reduce the profit, sometimes to negative leading to loss of revenue to the government. The lack of in-depth knowledge of the operations of the industry by government supervisory agencies such as the NNPC and its subsidiaries which has led to asymmetrical engagements could lead to further losses of revenue as a result of the exclusions.

- Considering that the value of land is not given any cost entry, the values of profits are usually to be exaggerated with the components of rents unchargeable, which should have accrued to the land owner. In addition the possible resort to cost-minimising production methods by operators in the industry could result into deleterious environmental consequences and other adverse economic effects on the oil producing areas in particular, and the economy in general. This could have disruptive effects on the process of economic growth. The Oil Terminal Dues Decree No 9 of 1969 has been used to parcelled land for oil exploratory activities such as; 1354 acres of Bonny land in Rivers State to Bonny offshore oil terminal; 810.04 acres of land in Ibeno in Akwa Ibom State as Qua Iboe Oil Terminal owned and managed by Mobil Oil Company whose operations were mostly offshore; the Ughelli/Forcados Oil Terminal uses 61.96 acres in Delta State. The practice of zero cost of land tends to encourage inefficiency in the utilisation of land as a factor of production and efficiency is a crucial element in the production function and in economic growth process.

- The Nigerian National Petroleum Corporation (NNPC) is vested with excessive and encompassing regulatory and operational powers which have given rise to bogus functional responsibility of the corporation that has resulted into inefficiency. The corporate goals enshrined in the regulatory laws establishing the NNPC are overwhelming and can hardly be achieved by such a body that operates under the supervision of the Ministry of Petroleum Resources, which give rise to restricted autonomy of the NNPC and contributes to management instability. Ojo and Adebusiyi (1996) revealed that the average turnover of changes in NNPC Managing Director was one in every two years. This, coupled with the entrenched inefficiency in the Nigerian public sector constitutes a basic functional constraint on the NNPC. Besides, it is difficult if not impossible for the NNPC to effectively discharge its function of overseeing compliance with government's requirements of oil companies and such other functions such as inspections, supervision and overseeing the activities of the joint venture investments with the private oil companies simply because it lacks the strategic (technological) ability to enforce this crucial function ascribed to it. Invariably, direct government investment in the oil and gas industry in Nigeria involves losses in capital and low returns on investment. The inefficiency of the NNPC leads to high operating cost and vent for petroleum products' subsidies by domestic consumers. Thus the public ownership of the corporation constitutes a large fiscal burden on the government.

- Refining of petroleum products, the main value-adding and most profitable of the downstream sector activities is, by regulation, the exclusive right of the government. The entry and exit law preclude any firm from refining activities and grants the sole right to the Federal Government (Petroleum Refining Regulations of 1974). The Uniform Pricing Decree of 1973 also vests in the Federal government the power to fix the prices of petroleum products, which has most frequently been exercised, leading to persistent and wide ranging changes in domestic prices of petroleum products, especially from 1986. Thus the laws give the Federal government, through the NNPC, monopoly powers with respect to the supply of petroleum products and the uniform pricing decree makes petroleum products non-taxable. This supply and distribution monopoly, in addition to other pricing and tax concessions granted the NNPC is detrimental to domestic refining activities, domestic consumers of petroleum products and by extension, the health and safety of the Nigerian environment. The persistent increase in prices of petroleum products, arising mainly from the over bloated overhead cost of NNPC management as a derived effect of public sector inefficiency, has ensured that consumers are penalised and made to reward inefficiencies at all points on the production and distribution chain of petroleum products. Garba (2000) reflected that:

  > *"The Uniform Pricing Decree caused an unprecedented shortage of petroleum products in 1973-74 not only because of the fixing of prices below market levels but also, because distribution was centralised at the NNPC and organised through a collusive monopoly of the NNPC and major marketers. Yet another decree, The Petroleum Production and Distribution (Anti-Sabotage) Act of 1975 addressed the persistence of shortages caused by un-competitive structures erected by the decrees. The formation of tax forces of various fancy names was its equivalent in 1986-99. However, none of the fancy named Task Forces could forcefully make regular or efficient supply of petroleum products a reality".*

- Laws regulating the health and safety of the work places and products in both the upstream and downstream are either non-existent or weakly enforced. Garba (2000) recounted incidences of deliberate contamination of petroleum products by producers (suppliers) and the importation of toxic petroleum products that have subjected Nigerians to untold health hazards and explosions and have claimed several lives, yet no law(s) have either being enacted or enforced to reprimand those responsible. In addition, environmental degradation has continued to be a national calamity despite all the laws that seeks to protect the environment.

- Adequate information dissemination on activities of the oil operators did not receive any regulatory and legal consideration. As a result there has been little or no access to basic information about the operations of the petroleum sector. This give rise to anti-competition conducts by advantageous oil firms at the detriment of other firms leading to different strands of monopolistic behaviours with associated distortions on the economy. For instance, basic information on joint venture budgets, cost of crude extraction, quality of pipelines, costs of crude transportation, daily incomes from crude oil sales, cost of refining, cost of transportation of refined products, operating cost of the NNPC and its subsidiaries and all other related activities of the sector are kept confidential by oil firms and government agencies.

- Apart from apparent regulatory weaknesses, some of the prevailing regulatory policies are outdated and fall below global standards. Even though, the Federal Government controls majority equity holdings in all joint venture contracts and agreements in the industry, its knowledge of the mechanics and dynamics of the industry has remained shabby and shallow, which tends to cripple its control of the industry. The increased level of involvement of government in the industry over the years has not resulted in a proportionate increase in its knowledge of the industry simply because it has chosen to be a passive partner in all its operational involvement concentrating on revenue accruable from its ownership status. This is detrimental to the economy in that it undermines a mutually optimising partnership between the owners (The Federal Government) and operators (The Oil Companies), who keep relevant information (such as technology options, input-output plans and input prices) secrete or incomplete. This has given rise to asymmetry contractual engagements that creates distortions in the activities of the industry thereby increasing the strain of macroeconomic policies and management of the economy.

Thus, the regulations in the industry are inadequate, fall below international standard and are weakly enforced, which provide opportunities for operators to maximise their profit objectives at the detriment of macroeconomic achievements. According to Abdullahi (2002), the regulatory environment of the Nigerian oil and gas industry has been enmeshed by a systemic failure as a result of regulatory capture as such Multinational Oil companies easily slip through the regulatory net, leaving the government to account for crisis of regulatory management. Garba (2000) averred that beside the deficiencies of regulatory policies, the existing ones are not adequately enforced and that "if you have rules that are not enforced, it is as if you have no rules at all".

In economic growth perspectives, the regulatory and operational features of the Nigerian oil and gas industry do not provide the appropriate conditions for efficient utilisation of oil and gas resources that could stimulate robust inter-industry linkages within the economy towards inclusive economic growth process. The large scale distortion evident in the operational features of the industry, coupled with restriction of entry into the downstream sector prevents viable investments in the downstream sector that could generate healthy competition and enhance the efficiency of factors of production, which tends to stultify domestic production both within the oil and gas industry and across other sectors of the economy. This implies that the value-adding potentials of factors of production are inadvertently supplanted, positive externalities such as learning-by-doing and the endogenous technological change to be derived are emasculated and inherent underutilisation of resources permeates, which has implications for macroeconomic policy and management.

9.1.2: Macroeconomic Issues

Industrialisation has been a key component of Nigeria's economic planning and a major component of its economic growth strategy since political independence in 1960. However, the pursuance of industrialisation policies over the years has focused on capital intensive manufacturing projects such as Steel and Aluminum, Vehicle assembly plants, Fertilizer factory projects etc., which are unrealisable because of lack of effective chain of domestic value-adding capabilities of factors of production, manifesting in low capacity utilisation rates and deteriorating financial and commercial performance. The capital and intermediate goods sub-sectors of manufacturing are very small and dominated by high cost import-dependent industries. More fundamentally, the lack of indigenous technological wherewithal to sustain these capital intensive industrial projects implies that the success of the projects depends on foreign investors and expertise that may find the investment climate incompatible. These policy oversights have culminated into superlative industrial edifices that are incapable of effective operations. For instance, the Ajaokuta Steel Rolling Mill, the pioneer and the largest to be constructed, could have been a vital project for a viable industrial take-off, especially due to the potential demand for steel the country could have created by coordinating the activities of the vehicle assembly plants with other steel related industries which could have engendered inter-industry linkages has basically turned into a white elephant project.

This lack of proper planning, coupled with ineffective policy implementation has affected the functions and efficiency of public expenditure. The government expenditure version of endogenous economic growth analysis postulates that public expenditure that concentrates on essential non-excludable social and economic services tends to create favourable atmosphere for investments leading to economic growth. A review of the public expenditure trend in Nigeria indicates that the social and economic sectors have received relatively small attention for several years. For instance, according to statistics of the Central Bank of Nigeria (CBN) as illustrated in table 9.1, capital expenditure on social and community services was 0.7 percent of total in 1970 but have experience incidental increases in subsequent years but not in a definite pattern with the highest level being 29.3 percent in 1974 and further decreasing continuously to, in some years very low as 2.2 per cent in 1997 and 3.0 in 1999 and increasing again to 11.7 in 2000. In terms of recurrent expenditure, the percentage expenditure on economic services has been within the range of 4.0 percent and 7.2 percent for many of the years with only one exception, the highest percentage being 10.3 in 1981; that of social services increased gradually but not consistently over the years from 0.4 in 1970 to 12.7 percent in 2000 but much more higher in other years such as 16.6 percent in 1976, 16.8 in 1980, 17.1 in 1983 with highest being 17.7 in 1981. Considering the importance of social and economic services in creating a conducive climate for investment and the attainment of economic growth, it will be difficult for the investment climate in Nigeria to be attractive with these low levels of expenditure on social and economic services. Ekpo (1996) established, using a computed compound growth rate of selected components of public expenditure between 1960 and 1992, that the growth rate of GDP in Nigeria has not been commensurate with the growth in public expenditure. Thus the pattern of public expenditure in Nigeria is indicative of inefficiency of resource utilisation. Public expenditure does not stimulate growth through the chain of increase in productivity, demand and accessibility to basic needs by the populace.

The Hartwick (1976 and 1992) rule of investing the rents (from oil and gas) to ensure intergenerational equity has been overshadowed by the pursuit and mismanagement of *Hotelling rent.* Investment in education, health, housing, transportation and communication, which could have satisfied the requirements of the Hartwick's rule of intergenerational equity, got only 5.87 per cent of the total public expenditure in 1984. This increased to 11.56 in 1986, decreased to 2.78 in 1987, increased to 7.06 in 1988, thereafter declined continuously to 0.79 in 1997. Defence and the establishment and the replication of several administrative public institutions that drains resources without providing any concourse for social and economic activities that could enhance the value-adding capabilities of factors of production received very high public expenditure allocations at the expense of social and economic services This unproductive and consumerist pattern of public expenditure, driven by the flow of *Hotelling rent* (revenue from crude oil exports), has been the main feature of the economy for several years. The volatility of international oil markets as amplified by commodity concentration analysts emphasises the fact that *Hotteling rent* lacks inherent sustainability hence a steady state consumption is not possible from it.

The persistent urge for more *Hotelling rents* weakened the synergy for regeneration of resources and led to the suppressing of the expansionary multiplier effects that could have emerged from robust inter-industry linkages. Environmental degradation and other negative externalities such as soil infertility, erosion and ecological problems emanating from the extraction activities have deprived the oil producing areas sources of agricultural livelihood without a viable alternative source of livelihood that could have been obtained from a productive public expenditure disposition.

Huge increases in oil revenues have tended to increase the marginal propensity to spend on imported consumer goods to the detriment of real production and efficient utilisation of resources. The gross misallocation of capital and labour that is associated with most developing economies, combined with the prevalence of pervasive distortions in the operations of the oil and gas industry in particular and the economy in general, has given rise to *latent* demand for petroleum products and other basic consumer commodities. Furthermore skewed income distribution that is usually associated with rent seeking behaviour has been a creeping phenomenon in the Nigerian economy.

A World Bank (1996) report summarised the Nigerian economic situation as follows;

> *"Nigeria presents a paradox. The country is rich but the people are poor. Per capita income today is around the same level as in 1970. And in between, over $200 billion has been earned from the exploitation of the country's oil resources. This report examines what has happened to the poor during this period, in particular during the past decade. It is a complex story with a clear message: Nigeria is rich in land, people, and oil and natural gas resources. If more of this wealth had been channeled to the development of its people and to the productive use of its land and other resources—then Nigeria could have been poised for a promising future. How Nigeria now addresses its economic and social problems will not only determine its own fate but will also have a major impact on the success or failure of the region. Nigeria should take the lead in demonstrating how growth with poverty reduction can be achieved in Africa".*

Comparing Nigeria's aggregate economic performance, especially over the last three decades with other developing countries with similar economic, social and political conditions reveals that the Nigerian economic performance leaves much to be desired. For instance, GDP per capita for Nigeria was $260 in 1995, almost the same as it was in 1972, while that of South Korea and Indonesia in 1995 were $3890 and $980 respectively. In 1965, Nigeria's GDP was $5.8billion compared with $3.8 billion for Indonesia, $3.1 billion for Malaysia, and $9.8 for Venezuela. By 1998, Nigeria's GDP had increased to $28.8 billion (3.6 fold increase), Malaysia's to $84.5 billion (27 fold increase), Indonesia's to $198 billion (52 fold increase) and Venezuela to $75 billion (20 fold increase). It implies that Nigeria with all her resource endowments is among the least developed countries of the world. With per capita GDP and per capita income below the LDCs[62] average, Nigeria is at the bottom range of developing countries

Xavier and Subramanian (2003) found that the poverty level in Nigeria worsened between 1970 and 2000. The poverty rate increased from close to 36 per cent to just under 70 percent, translating into the number of poor from 19 million in 1970 to 90 million in 2000. In terms of income distribution, they reveal that the top 2 percent and the bottom 17 per cent of the population earned the same total income in 1970 but this deteriorated to 2 percent in 2000 with the same total income as the bottom 55 percent. They averred that waste and poor institutional quality stemming from oil rather than the "Dutch Disease" has been primarily responsible for the poor long-run economic performance of the Nigerian economy which has led to a very wide income disparity. They proposed that to address the problem, oil revenue should be distributed directly to the people, with each adult having right to equal share of the proceeds and then contributing part of it to financing public institutions. The logic of this prescription is hinged on the possibility that if people pay directly for the services of public institutions, they are more likely to hold them accountable in contrast to the prevailing lukewarm and at times docile culture that has further enhanced corruption and poor performance of such

[62] The per capita GDP, income and other economic indicators are measured for various countries periodically by the World Bank and published in its annual report. It has revealed consistently that Nigeria's has been less than the average for less developed countries (LDCs) for some years in recent times.

public institutions. The IMF, in its 2005 country report assessed the Nigerian economy thus:

> *"Despite Nigeria's recent progress in policy and reform implementation, the economy continue to feel the effects of more than two decades of economic mismanagement, neglect of infrastructure and social service provision and disregard for market-based institutions. Social indicators for Nigeria continue to compare unfavorably with those of even other sub-Saharan African countries; nearly 60 per cent of the population lives in poverty. Nigeria's infrastructure and public utilities rank among the worst in the world. Corruption, infrastructure and weak public institutions are the major obstacles to higher growth in the non-oil economy and to improvements in social welfare"*

Apparently, co-ordination failures arising from institutional weaknesses have cultivated a culture of rent seeking which has discouraged enterprise of real production that requires nurturing. This trend has given rise to skewed income distribution and considering that the household sector is critical to a formidable linkage effects upon which productive enterprises can thrive, it is logical that the inter-industry linkage level of the economy is as low as discovered. A much wider implication is that due to lack of opportunities from flourishing productive activities, agitations for increased revenue benefits by different segments of the country have intensified leading to additional strains on the challenges of macroeconomic management and by extension, the attainment of economic growth. The squabbles by different constituents in the sharing of oil revenues have culminated into the concept of "resource control". Jega (2002) averred that the complete reliance on oil revenues for all activities of government, the neglect of areas where oil extraction activities take place resulting into defoliation, environmental devastation and ecological degradation, coupled with lack of social responsibilities by the multinational oil firms with government support, all of which has crippled economic activities of the area with adverse consequences on their standard of living, are responsible for the grievances of the oil extraction communities and their agitation for "resource control".

Table 9.1: PATTERNS OF GOVERNMENT EXPENDITURE: 1970-2001 (%)

	CAPITAL EXPENDITURE				RECURRENT EXPENDITURE			
Year	Administration	Economic Services	Social & Community Services	Transfers	Administration	Eonomic Services	Social & Community Services	Transfers
1970	37.40	8.30	0.70	53.60	19.60	4.30	0.40	75.70
1971	36.40	33.50	7.60	22.50	5.60	4.00	0.60	89.80
1972	24.10	29.40	9.30	37.10	49.20	4.60	2.90	43.30
1973	23.70	44.10	7.10	25.10	47.20	5.40	3.20	44.20
1974	21.90	38.10	29.30	10.70	36.60	4.90	6.30	52.20
1975	23.30	41.00	28.90	6.80	38.60	4.80	10.50	46.10
1976	19.70	55.20	22.30	2.80	26.50	3.70	16.60	53.20
1977	20.20	62.40	16.50	0.80	27.20	5.00	9.60	58.10
1978	21.40	58.00	16.70	3.90	47.50	8.00	14.50	29.90
1979	18.20	66.60	14.50	0.60	31.40	3.60	16.00	49.00
1980	14.80	58.80	24.20	2.20	39.90	9.80	16.80	33.50
1981	11.00	55.30	19.80	14.00	44.90	10.30	17.70	27.20
1982	6.00	39.60	15.10	39.30	42.60	7.10	14.80	35.50
1983	22.50	46.90	21.00	9.60	48.60	7.20	17.10	27.00
1984	6.40	16.00	5.80	71.80	45.90	5.60	13.20	35.30
1985	8.40	16.30	21.10	54.10	34.80	4.20	14.90	46.10
1986	3.10	12.90	7.70	76.30	34.80	6.70	11.20	47.40
1987	28.50	33.90	9.70	27.90	38.60	7.00	3.00	51.40
1988	22.80	25.50	20.70	31.00	29.80	6.30	10.90	53.00
1989	17.40	26.10	12.30	44.20	24.10	5.50	16.30	54.10
1990	12.10	14.50	8.70	64.60	18.10	4.50	9.40	68.10
1991	11.80	11.10	5.30	71.80	18.20	3.40	7.00	71.40
1992	12.90	5.90	5.40	75.90	16.40	5.80	2.50	75.30
1993	14.80	33.70	6.60	45.00	22.40	5.70	10.70	61.30
1994	12.40	38.20	7.00	42.40	23.90	4.60	11.70	59.80
1995	11.00	35.60	7.60	45.80	21.60	4.50	10.40	63.50
1996	9.40	40.10	5.50	45.10	37.90	4.70	10.40	43.20
1997	15.90	54.40	2.20	27.40	38.70	4.90	14.20	43.00
1998	9.70	55.50	6.50	28.30	30.70	6.70	13.50	49.90
1999	7.50	69.80	3.00	19.60	28.70	6.00	11.10	54.20
2000	22.20	46.60	11.70	19.50	26.30	6.50	12.70	54.50
2001	11.20	59.20	12.20	17.40	31.20	9.20	13.80	45.90

Source: *CBN Statistical Bulletin* Vol. 11, No 2 (Dec. 2000) & Vol. 14 (Dec. 2003)

9.2: SUMMARY AND CONCLUSION

9.2.1: Summary

This thesis comprise of a total of nine chapters; seven core chapters, an introductory chapter on the research issues and one chapter on the diagnosis, summary and conclusion of the research.

Chapter one introduced the research issues by providing a general overview of the nature and processes of economic growth and the significance of inter-industry linkages in generating sustainable growth of an economy. Indicators of economic growth were defined and the role of a dominant natural resource sector such as oil and gas was highlighted. Efficient utilisation of resources in the process of effective production that enhances the value-adding capabilities of factors of production is the bedrock of economic growth processes. This requires a multiple sector value-adding productive activities that can be spearheaded by a critical sector. The oil and gas industry in Nigeria has emerged as a dominant sector around which the Nigerian economy revolves; contributing over 70 per cent of total government revenue and an average of 28.2 per cent to real GDP annually. By the intuitions of the high linkage hypothesis advanced by Hirschman (1958) and further projected by Yotopoulos and Nugent (1973 and 1976); Laumas (1975 and 1976); Jones (1976) and Cella (1984), strategic consideration of a large activity sector identified as a key sector with high linkage relevance to other sectors can lead to gradual diffusion of value-adding activities across sectors of the economy to ensure efficient utilisation of resources and generate economic growth. Endogenous growth theory and the leading sector strategy of economic growth (Currie, 1974 and 1997) give additional credence to this conception of economic growth process.

This perspective provided the inspirational setting for the research which relied on the conceptual link between inter-industry linkages and economic growth to determine the levels of inter-industry linkages and the impact of the oil and gas industry as well as analysing the contribution of the industry to the growth of the Nigerian economy. Methodologically, a theoretical and analytical framework formed the basis of the use of secondary data obtained from the Federal Office of Statistics in Nigeria, the Central Bank of Nigeria and other sources.

A survey of the literature on economic growth theories is carried out in chapter 2. The neoclassical models comprise of the Solow model, the Ramsey-Cass-Koopmans (RCK) model and the Diamond (Overlapping Generation) model.

The Solow model is based on constant returns to scale production function of the form:

$$Y_{(t)} = F(K_{(t)}, A_{(t)}L_{(t)})$$

where; Y= Output, K= Capital, L= Labour and A= "Knowledge" or "effectiveness of labour. Using output per unit of effective labour and capital per unit of effective labour, the intensive form of the production function is determined to be:

$$y_{(t)} = f(k_{(t)})$$

expressed in Cobb-Douglass production function as;

$$f(k_{(t)}) = k_{(t)}^{\alpha}$$

implying that $f'(k) = \alpha k^{\alpha-1}$ (the marginal product of capital) is positive and $f''(k) = -(1-\alpha)\alpha k^{\alpha-2}$, is negative, which in turn means that the marginal product of capital is declining as capital per unit of effective labour increases.

The fundamental equation of the Solow model is derived as:

$$\dot{k}_{(t)} = sf(k_{(t)}) - (n + g + \delta)k_{(t)}$$

which says that the rate of change of the capital stock per unit of effective labour at any given period of time, $\dot{k}_{(t)}$, is the difference between actual investment per unit of effective labour, $sf(k_{(t)})$ and the break-even investment, $(n+g+\delta)k$.

In a Solow economy that is on a balanced growth path, an increase in the saving rate, s, will lead to an increase in the level of actual investment, $sf(k)$, above the break-even investment, resulting in an increase in k, capital per unit of effective labour, above k^*, the level of k that establishes the equilibrium between $sf(k)$ actual investment and $(n+g+\delta)k$, break-even investment. In the absence of technological progress, the growth rate of GDP is equal to the growth rate of population and therefore the growth rate of income per capita is zero.

The RCK model argues that the path of consumption and hence saving rate are determined by the intertemporal optimizing behaviour of firms and households, through competitive market interactions, rather than exogenous and constant saving rate espoused by the Solow model. Savings is thus endogenous and the dynamics of economic aggregates are determined at the microeconomic level. There are large numbers of identical firms that rent capital and hire labour in competitive factor market to produce and sell output in a competitive product market. Firms are owned by households, so profits earned by firms accrue to households. Depreciation rate of capital is set to zero (i.e. δ=0) and the household divides its labour income and capital income (profits it receives from firms) at each point in time between consumption and saving to maximise lifetime utility over an infinite horizon. Each of the firms has access to the production function,

$$Y_{(t)} = F(K_{(t)}, A_{(t)}L_{(t)})$$

The household maximises lifetime utility, subject to its budget constraints based on the Langrage:

$$\Omega = B\int_{t=0}^{\infty} e^{-\beta t}\frac{C_{(t)}^{1-\theta}}{1-\theta}dt + \lambda\left[K_{(0)} + \int_{t=0}^{\infty} e^{-R(t)}e^{(n+g)t}w_{(t)}dt - \int_{t=0}^{\infty} e^{-R(t)}e^{(n+g)t}C_{(t)}dt\right]$$

The solution gives the Euler equation:

$$\frac{\dot{c}_{(t)}}{c_{(t)}} = \frac{r_{(t)} - n - g - \beta}{\theta} \quad \text{or} \quad \frac{\dot{c}_t}{c_t} = \frac{r_t - \rho - \theta g}{\theta}$$

where $\beta = \rho - n - (1-\theta)g$

$\frac{\dot{c}_{(t)}}{c_{(t)}}$ is the growth rate of consumption per unit of effective labour and g is the growth rate of knowledge, A. Since consumption per worker, $C_{(t)}$ is $c_{(t)}A_{(t)}$, the growth of C is equal to the growth of consumption per unit of effective labour, c, plus the growth rate of A *(i.e.* g). So consumption per worker grows at the rate $\frac{[r_{(t)} - \rho]}{\theta}$. This means that consumption per worker is rising if the real return exceeds the rate at which the household discounts future consumption and falling if otherwise.

The RCK model economy, like in the Solow model, converges to a balanced growth path, where capital, output and consumption per unit of effective labour are constant. The saving rate $\frac{(y-c)}{y}$ will also be constant since y and c are constant. The total capital stock, total output and total consumption grow at the rate $n+g$, and capital per worker, output per worker and consumption per worker grow at the rate g. However the RCK model differs from the Solow model in the balanced growth path analysis of golden-rule behaviour, in that it is not possible for the capital stock to be above the golden-rule level in the RCK model.

The Diamond overlapping-generations model assumes a turnover in the population with new households being born while old ones die, rather than fixed number of infinitely lived households as implied by the RCK model. Each individual lives for two period, supplies one unit of labour. Population grows at a constant rate, n, with $L_t = (1+n)L_{t-1}$, and thus $L_{t-1} = \frac{L_{(t)}}{(1+n)}$. In the first period, the individual divides his resulting labour income between present consumption and savings, and in the second period, consumes what has been saved plus interest accrued. Denoting C_{1t} and C_{2t} as consumption in period 1 (for young) and period 2 (for old) respectively, the utility of an individual born at t, denoted U_t depends on C_{1t} and C_{2t+1}. The assumption of constant-relative-risk-aversion utility, leads to the utility function:

$$U_t = \frac{C_{1t}^{1-\theta}}{1-\theta} + \frac{1}{1+\rho}\frac{C_{2t+1}^{1-\theta}}{1-\theta}, \theta > 0, \rho > -1$$

All other assumptions are similar to the RCK model and the production function is similar to the Solow and RCK, so $A_t = [1+g]A_{t-1}$.The old consume both their capital income and their existing wealth while the young divide their labour income, $w_t A_t$, between consumption and saving, which they carry forward to the next period.

Even though they differ in their assumptions of the saving rate, the conclusions of all the three neoclassical models are similar; that is economic growth can be achieved only through technological progress that increases the effectiveness of labour. The models gravitate around the dynamics of consumption, savings, investments and labour input in their relationship to the technological progress. These are the ingredients of input-output that propels the absorptive capacity of different sectors of the economy.

Endogenous growth models seek mainly to fill the gap of the source of technological progress, which was left hanging by the neoclassical models. The basic principle of the endogenous growth analysis is that, technological progress evolves from the interplay of economic forces based on two way interaction between technology and economic life. Technology is a by product of innovation, which is nurtured by rational economic behaviour; but technology also transforms economic life in turn. Assuming the absence of diminishing returns to capital, per capita growth will occur in the long-run even without exogenous technological change.

Constant returns to scale implies one-to-one relationship between output and inputs as such one unit of either physical or human capital input leads to one unit of (additional) output giving rise to an "*AK*" production function;

$$Y_t = A_t K_t$$

where A is a positive constant reflecting the level of technology.

Per capita output growth is sustainable in the long-run even in the absence of technological progress simply because there is no diminishing return to capital accumulation and savings rate, s, positively affects long-run growth rate.

Learning-by-doing is a veritable source of technological progress. Investment and production makes use of ideas but new ideas are also generated in the process of production through the positive effect of production experience, thereby eliminating the tendency for diminishing returns. Technical knowledge is thus embodied in new capital goods. Each time a capital good is produced, the experience of producing it generates new insights to both the particular production sector and to the economy in general. The functional activities of government such as provision of infrastructures, the protection of property rights and taxation policies could affect the level of baseline technology, A, and thus affects the long-run per capita growth rate.

Technological progress can be attained through Research and Development (R&D). Firms, driven by profitability, invest their resources in R&D, which leads to either quality improvement or variety expansion. Innovation leads to new products either in quality or variety, so innovators exploit some form of monopoly power. By the neo-Schumpeterian approach, the amount of resources devoted to R&D is determined by private firms, motivated by profit incentives in conditions of monopolistic competition. The final output and the R&D sectors as well as the labour market are assumed to be competitive, but the intermediate goods sector that provides inputs to the final goods sector based on blueprints derived from R&D (knowledge) is monopolistic. The non-rivalry and non-excludability attributes of knowledge leads to knowledge spillover that amplifies the phenomenon of "*Creative Destruction*".

The emphasis on consumption, the productivity of the competitive firms and the continued recourse for innovation and technological improvement by firms, driven by the urge to gain from markets are intertwined with the increase in the absorptive capacity of industrial production processes and this is the cardinal of inter-industry linkage process. Endogenous technological change, expected to be the by-product of increasing absorptive capacity, culminates from increasing demand for goods and services produced by different sectors of the economy either by other industries as inputs or as final goods and services by consumers. Thus conceptually both the neoclassical and endogenous growth theories are hinged on inter-industry linkages.

The implication of natural resource utilization to economic growth processes and policy perspectives are examined in Chapter 3. Incorporating natural resources into the standard production function yields;

$$Y = F(K, L, R)$$

R is the rate of flow of natural resource extracted from an existing pool. The natural resource, R is said to be essential if output is nil without it. Thus if $Y=0$ when $R=0$, then R is essential, otherwise it is inessential. In Cobb-Douglas form,

$$Y = AK^{\alpha}R^{\beta}L^{1-\alpha-\beta} \qquad 0<\beta\geq 1, \alpha+\beta\leq -1$$

Long-run growth rate of the economy depends not just on the rate of technological change, but also on the significant role of natural resource, measured by β, and the rate of population growth in a relationship interpreted by Jones (2002) as a classic race between technological progress and the diminishing returns introduced by the finite natural resource, S_0. If $g=0$, meaning that there is no technological progress, the production function will exhibit diminishing returns to capital and labour since constant growth rate of population will lead to increasing pressure on the pool of resources, as a result of which marginal product of labour will fall to the extent that accumulation of capital cannot fully offset. Technological progress will make labour, capital and the resource utilization more productive and can possibly offset the population pressure to ensure sustained growth in per capita income. This implies that, technological progress can alleviate the depletion of natural resources. However the effect of exogenous technological progress on production will be diluted by the diminishing returns to capital and labour.

The linkage relevance of natural resources is essential in engendering the process of economic growth since it creates a basis for increasing the absorptive capacity of industries through interdependence for goods and services produced by the cluster of existing industries.

Chapter 4 is an overview of the Nigerian economy dwelling on its evolution from pre-colonial period, through different stages and policy prescriptions over the years after independence to date. The pre-colonial economy was a rudimentary and subsistent enclave economy imbued with various constraints associated with limited absorptive capacity with some elements of Trans-Saharan trade activities. The colonial economy policies transformed the economy through the introduction of marketing outlets and improved methods of production, which led to expansion in economic activities. Agricultural activities, the bedrock of the economy before the advent of colonialism, continued to be the dominant activity of the colonial economy without significant structural transformation to prop-up manufacturing activities, which engendered a lopsided international trading that revolves around the exportation of primary agricultural commodities and the importation of finished consumer goods. However, the colonial economy established a foundation for modern industrial economy that inspired economic policies and development planning after independence in 1960.

The discovery of oil in commercial quantity, coupled with the significance of oil in the international market provided a source of foreign exchange earnings which spurred an upsurge in public expenditure pattern that undermined the process of industrialization. The economy transformed from a net exporter of agricultural products in the 1960s and 1970s into a net importer of agricultural commodities in the 1980s. In the 1980s, the Structural Adjustment Programme (SAP) was introduced to tackle the structural distortions of the economy. The impact of SAP policies were mixed but the structural weaknesses of the economy did not improve. Economic growth was not generated through effective utilisation of resources. From the early 1990s, various reform programmes were implemented to reverse the SAP policies. Most of these reform policies were anchored on diversification of foreign exchange earnings from non-oil exports.

As an evolving economy, transforming the structure of production and the pattern of consumption to ensure mutually self-reinforcing processes based on value-adding chain of activities driven by the mechanism of inter-industry linkages ought to be the strategic policy route towards attaining sustainable economic growth. This will ensure the diversification of the economy; reduce the dependence on oil exports for revenue earnings and imports for consumption so as to put the economy on a path of self-sustaining, inclusive and non-inflationary growth. This requires establishing the machineries for structural transformation that adapts to technological change.

An anatomy of the Nigerian oil and gas industry is presented in Chapter 5. The entire operation of the industry begins with Seismic Activities, which spirals into phases of activities such as exploratory drilling, production and decommissioning. The chain of downstream activities involves the production, transportation and marketing of end petroleum products. It begins with the supply of crude oil to refineries for refining and ends with the marketing of final (refined) petroleum products (such as gasoline, kerosene, heating oil, lubricants and waxes) and intermediate products (such as aviation fuel, industrial fuel, bitumen, asphalt and petrochemicals). Similarly, the gas chain begins with the processing of natural gas into final products such as cooking gas or intermediate products such as Liquefied Natural Gas and liquid gas. Over the years, four different types (models) of international (petroleum) contracts agreement (ICA) have evolved. These are *the concession agreements; the production sharing agreements; the joint venture agreements* and most recently, *the hybrid contracts*. The essence of these agreements is to establish the basis for partnership between multinational oil companies, who posses the requisite technology and countries endowed with (owners of) oil and gas resources.

Nigeria has used a mixer of the ICA at different stages of its development. Shell D'Arcy started exploration activities through a *traditional concession agreement* licence granted to the company by the colonial government in 1937 to prospect for oil and after the discovery of oil in commercial quantity in 1957, oil prospecting licences were granted to other companies to carry out oil prospecting, which culminated into the existence of several operators even though Shell remains the dominant company. Over the years several regulatory laws have been enacted to ensure adequate grip of the activities in the oil and gas industry by the government. These regulations focused mainly on extraction, transportation and revenue accruable to the government. The Nigerian National Petroleum Corporation (NNPC), the main strategic policy organ, lacks in-depth knowledge, techniques and general patterns of petroleum operation. Refining activities, which are capable of triggering a chain of inter-industry linkages, have been made exclusive to government operating with enormous monopolistic powers but without requisite technology for effective and efficient operations. This has the tendency of crippling the opportunities for inter-industry linkages that could form the basis of endogenous technological change for generating sustainable growth of the economy.

Thus, a high linkage sector ramification can emerge from the activities of the oil and gas industry to enable it to emerge as a key sector for growth of the economy as prescribed by Hirschman's (158) linkage hypothesis. However, high linkage performance of a sector is hinged more on the effectiveness and efficiency of its operations rather than the essentialness of products. Therefore efficacy of the regulatory framework, the structural and operational attributes of the oil and gas industry as well as the general macroeconomic disposition of the Nigerian economy are crucial determinants of the extent of linkage and economic growth relevance of the oil gas industry to the Nigerian economy. Appropriate investment climate that creates favourable markets, cost-effectiveness and returns on investment are important factors for effective operations and efficiency of the activities in the industry. Thus the expansion in different aspects of upstream and downstream activities does not necessarily lead to automatic high linkage and economic growth contribution of the oil and gas industry. Rather the processes of mutation of endogenous stimuli are the key determinants of linkage effects and the impacts of the industry on the overall economy. Restrictive regulations, nationalisation, and exclusive government participation in downstream activities albeit weak domestic technological capability, which are key features of the Nigerian oil and gas industry, have implications for the extent of linkage and economic growth relevance of the oil and gas industry.

A review of methodological developments of inter-industry linkages is carried out in Chapter 6. Traditional linkage measures are based on the computation of *backward* and *forward linkage* coefficients by a formal production system of Leontief technology with competitive imports, using the balance condition between supply and demand of the total output described in matrix form as:

$$X + M = V + F + E$$

where:

X= vector of sectoral output;

V= intermediate input demand matrix consisting of domestic and imported intermediate commodities;

F=domestic final demand vector consisting of domestic output and imported final demand;

M= imports vector; and

E=exports vector exclusively consisting of domestic output.

The Leontief inverse matrix can be derived as; $\left\{I-(I-\hat{\mu})A\right\}^{-1}$, the elements of which are described as the coefficients reflecting an increase in output of industry *i*, for per unit increase in the final demand for the product of industry *j*. Denoting R_{ij} as the element of the Leontief inverse, the backward linkage is defined as:

$$U_j = \frac{\frac{1}{n}\sum_i R_{ij}}{\frac{1}{n^2}\sum_i\sum_j R_{ij}}$$

where $\sum_i R_{ij}$ is the sum of column elements and is to be interpreted as the total increase in the output (direct and indirect) from the whole system that is required to cope with an increase in the final demand for the product of industry j by one unit. Similarly, an index of forward linkage is defined as:

$$U_i = \frac{\frac{1}{n}\sum_j R_{ij}}{\frac{1}{n^2}\sum_i\sum_j R_{ij}}$$

where $\sum_j R_{ij}$ is the increase in output of industry i, needed to match a unit increase in the final demand of all industries.

By the Hirschman-Compliance Index *(HCI)*, an effective strategy for generating economic growth should be based on identifying and emphasising on high the linkage industries. This strategy will lead to the attainment of higher overall rate of economic growth.

The second generation approaches of the linkage analysis comprise mainly of the Hypothetical Extraction and the Hypothetical Addition methods, which are based on the definition of total linkages. These approaches tend to identify key sectors of the economy without the use of backward and forward linkages. To measure the linkage significance of a particular industry, say j, it is removed so that it would not have any backward and forward linkages with other sectors. This will lead to a diminishing linkage effect of the remaining sectors due to reduced level of domestic input being bought and sold as a result of the removal of sector j, which will also affect employments that are related to the activities of sector j. The multiplier effects of the economy will also reduce. The total reduction in output due to the removal of the sector provides the linkage measures for analysing the impact of the identified sector.

The Hypothetical Addition method decomposes the total linkage into four additive components; internal linkage; the backward linkage; the forward linkage; and the closed-loop linkage. By adding, rather than extracting flows, decomposition can be obtained in which internal feedback, backward and forward linkages are identified in a natural way.

Empirical discussions of inter-industry linkages in the Nigerian economy and the impact of the oil and gas industry are carried out in Chapter 7. The output *(Types 1 and 2)* multipliers, backward and forward linkages income, employment and value-added effects and multipliers for sectors of the Nigerian economy are computed to illustrate the levels of inter-industry linkages in the economy for five years (1997-2001) for which data availability permitted. The Hypothetical Extraction method is used to analyse the linkage relevance and impacts of the oil and gas industry. A 25 percent increase in refining activities is imposed to simulate import substitution policy.

It reveals that the inter-industry linkage process of the economy is characterised by large number of sectors with less than one multipliers, very few sectors with multipliers value of above 1.5, a general low levels of employment, income and value-added effects. It is also apparent that the household sector does not have significant linkage relevance in the process except in the forward linkage. The very high forward linkage indicators of the household sector throughout the period points to the potential of the sector as a catalyst for the inter-industry linkage process of the economy. This is a reflection of the enormous human resource availability that can form the basis for a formidable inter-industry linkage process. The inability of the formal sectors of the economy to effectively use the available human resources has led to the resort to the informal sector, which explains the high employment and value-added significance of the Private Non Profit Organisation sector as reflected in high values for employment and value added effects but very low multiplier effects on the economy. The manufacturing activity sectors (Oil Refining, Cement and Other manufacturing) do not have significant linkage relevance. Only the Oil Refining sector has high *Type 1* output multipliers to be among the top six. Cement and Other manufacturing sectors performed very low in the rankings. Similarly the performance of these sectors in terms of *Type 2* multiplier is not better and even worse in terms of employment, income and value-added effects, though better in terms of employment, income and value-added multipliers with the Oil Refining and Other Manufacturing exhibiting high forward linkage significance.

With relatively high rankings for *Type 1* output multipliers, employment multipliers, value-added multipliers and forward linkage indicators, the Oil Refining sector appears to have reasonable influence on the inter-industry linkage process. However, the undulation in the pattern of linkage significance of the sector especially its sharp decline in 2001, coupled with its associated low values and rankings of other linkage measures illustrates a lack of cohesive integration of the sector with other sectors of the economy. The other oil and gas sector and Crude Petroleum, have significant linkage relevance in employment and value-added multipliers as well as forward linkage indicators but very low and insignificant relevance in other linkage measures. Considering the nature of oil and gas activities and the dominance of the sector in the economy, the coefficients and spread of linkage relevance of the two oil and gas sectors is inadequate and could be the reason for the overall low level of inter-industry linkage process of the economy.

A discernible analysis of the impact of the oil and gas industry in generating linkage stimuli to other sectors for enhancing the inter-industry linkage processes was carried out using the hypothetical extraction method. A Substantial number of sectors derive different levels of multiplier and forward linkage stimuli from the oil and gas industry but most of these derive very low stimuli while very few do not completely derive any stimulus from the oil and gas industry. The preponderance of low linkage stimuli sectors could be a reflection of the fact that the linkage stimulus from the oil and gas industry to other sectors of the economy does not involve core activities of the oil and gas industry. This adds to the argument that the level of inter-industry linkages is not inspiring enough and the oil and gas industry, a veritable source of linkage stimulus tends to be inadequately integrated with other sectors of the economy.

Results of policy simulation of 25 percent increase in refining activities indicate that inter-industry linkages and output performance did not significantly improve. This implies that the low level of integration of the oil and gas industry and low level of inter-industry linkages of sectors of the economy are not merely because of lack of adequate refining activities but rather and more fundamentally, stemming from incapability of existing productive structures to absorb linkage and productive stimulus. In essence, much as refining activities are crucial in generating stimuli for value-adding activities that can spearhead effective inter-industry linkages and efficient productive activities, the structures for making use of linkage and productive opportunities are necessary preconditions for benefiting from the linkage and productive opportunities.

Overall, the empirical expositions of inter-industry linkages in the Nigerian economy and the impacts of the oil and gas industry are not robust enough to generate and absorb productive incentives. Thus the analysis of traditional linkage measures, the hypothetical extraction scenario and the import substitution simulation all tend to converge on the conclusion that a formidable inter-industry linkage process is not evolving, which have implications for effectiveness of factors of production and by extension economic growth.

Chapter 8 dwelled on qualitative analysis of the contribution of the oil and gas industry to economic growth using data on the performance of the industry over the years in juxtaposition with economic growth trends of the Nigerian economy. It affirms that the industry has been the main determinant of the overall performance of the economy due to high demand for oil and gas resources in contemporary world economies, which translates into high revenue-yielding of the industry. There is a mismatch in the impact of the oil and gas industry on revenue earnings as compared to GDP, indicating that the quantum of revenue generated by the oil and gas industry and contributed to the national income did not reflect the real economic activities of the sector but rather represents a high level of revenues (rents derived from) crude oil extraction and exports due to rising international demand and prices of crude oil.

Economic growth can be achieved only if a regeneration mechanism is established to benefit from the advantages of the available oil and gas resources that could lead to persistent increase in not only the level of output of crude oil, but also effectiveness of the factors of production as a reflection of positive technological change. This will not only be exhibited by the oil and gas industry but also by the entire economy through the effective use of resources from other sectors of the economy. The main derivative of such a regeneration mechanism is technological progress, the catalyst for persistent increase in output in all the sectors of the economy that leads to economic growth.

Despite the numerous diversification policies implemented for several years, the economy remain undiversified and income remained dominated by operating surplus while the productive base of the economy remain weak. The economy does not exhibit the attributes of inclusive growth process. Increase in aggregate demand is not reflected in a corresponding manufacturing output but rather flourishing of commerce as a result of persistent unproductive trend and distortions that characterize the Nigerian economy.

Chapter 9 diagnosed and summarised the issues of the research and provided a conclusion in form of perspectives, findings and policy recommendations. The diagnosis focused separately on the oil and gas industry and macroeconomic policy issues. It argues that the regulations in the industry are inadequate, fall below international standard and are weakly enforced, which provide opportunities for operators to maximise their profit objectives at the detriment of macroeconomic achievements. In economic growth perspectives, the regulatory and operational features of the Nigerian oil and gas industry do not provide the appropriate conditions for efficient utilisation of oil and gas resources that could stimulate robust inter-industry linkages within the economy towards inclusive economic growth process. The large scale distortion evident in the operational features of the industry, coupled with restriction of entry into the downstream sector prevents viable investments in the downstream sector that could generate healthy competition and enhance the efficiency factors of production, which tends to stultify domestic production both within the oil and gas industry that spills over to other sectors of the economy. This implies that the value-adding capabilities of factors of production are inadvertently supplanted, positive externalities such as learning-by-doing and the endogenous technological change to be derived are emasculated and inherent underutilisation of resources permeates, which has implications for macroeconomic policy management and the attainment of economic growth.

In terms of macroeconomic policy issues, huge increases in oil revenues have tended to increase the marginal propensity to spend on imported consumer goods to the detriment of real production and efficient utilisation of resources. The gross misallocation of capital and labour that is associated with most developing economies, combined with the prevalence of pervasive distortions in the operations of the oil and gas industry in particular and the economy in general, has given rise to *latent* demand for petroleum products and other basic consumer commodities. Furthermore skewed income distribution that is usually associated with rent seeking behaviour has been a creeping phenomenon in the Nigerian economy. Investment in education, health, housing, transportation and communication, which could have satisfied the requirements of the Hartwick's rule of intergenerational equity, got only 5.87 per cent of the total public expenditure in 1984. This increased to 11.56 in 1986, decreased to 2.78 in 1987, increased to 7.06 in 1988, thereafter declined continuously to 0.79 in 1997. Defence and the establishment and the replication of several administrative public institutions that drains resources without providing any concourse for social and economic activities that could enhance the value-adding capabilities of factors of production received very high public expenditure allocations at the expense of social and economic services. This unproductive and consumerist pattern of public expenditure, driven by the flow of *Hotelling rent* (revenue from crude oil exports), has been the main feature of the economy for several years. The volatility of international oil markets as amplified by commodity concentration analysts emphasises the fact that *Hotteling rent* lacks inherent sustainability hence a steady state consumption is not possible from it.

9.2.2: Conclusion

In general, the study generated the following theoretical and analytical perspectives:

- Effectiveness of factors of production is the veritable mechanism for attaining economic growth. Labour, capital and the "effectiveness of labour" (technology) are critical combination for efficient production processes. Economic growth theories recognise the imperative of consumption as the main activity of households and a source of demand that facilitates a production process, and the households are in turn, the source of labour input that is crucial in production activities that leads to economic growth.

- The role of natural resource in the process of economic growth involves the need for steady state consumption path based on intertemporal utility maximisation. Consumption is not monolithically determined by natural resource availability but the use of natural resources to generate a stream of economic activities that could lead to the production of various goods and services.

- Extraction processes of natural resources require inputs from other sectors of the economy, which can lead to chain of interdependence in input-output production activities of sectors of the economy that leads to the production of not only the natural resource but also different other goods and services with associated positive externalities that leads to technological change and improvements in the production processes as well as in quality and quantity of goods and services.

- To create a sufficient condition for steady state consumption and growth, the natural resource needs to be transformed by a process that generates multiplier effects into the economy. Sectoral interdependence based on input-output mechanism propels the productive fibre of each of the sectors, which leads to self-perpetuating inter-industry linkage process that generates externalities for sustainable economic growth.

- Production activities by all sectors of the economy is possible only if basic infrastructures and the rule of law that guarantees property rights (patents and copy right laws) are in existence. In addition, human capital formation, which is the bedrock upon which all aspects of economic growth processes are hinged, requires to be nurtured by services that are provided by non-profit making principles. These essential services (provision of infrastructure, the rule of law and human capital formation) are needed by both firms and households but their non-excludability character on one hand, and the competitive profit making objectives of firms on the other, prevent firms from engaging in the provision of these services as such can be more effectively provided by government. Beside, natural resource sectors which are the roots upon which economic growth processes germinates requires legal and institutional framework of operations and this can only be provided by government institutions. Thus effective governance, through the proper functioning of institutions and the implementation of robust policies, is a crucial prerequisite to the attainment of economic growth. Thus if the welfare and coordination functions are not properly performed, all the ingredients of economic growth ("effectiveness of labour", capital, technological change, R&D etc) will either be non-existent or dysfunctional.

- Inter-industry linkages has an essential role in engendering the process of economic growth since it creates a basis for increasing the absorptive capacity of industries through interdependence for goods and services produced by the cluster of existing industries. The increasing interdependence among sectors of the economy leads to expansion in production due to increasing demand. The intensity of this interdependence generates high level of learning-by-doing, prompts the need for innovation, which leads to R&D activities and positive technological change occurs to expedite the process of economic growth.

- Thus low level of value-adding activities tends to limit the absorptive capacity of the economy and strains balance of payment optimality. Incongruence between the interest of the nation state and that of oil companies arises when it is cheaper and more profitable to export crude oil and import refined petroleum products as such it is very critical for governments to create the requisite conditions for cost-effectiveness based on healthy competition for domestic investments.

Specific to the Nigerian economy, the study established the following analytical and empirical findings:

- Since pre-colonial, through colonial to its post-colonial trajectories, the Nigerian economy have been struggling to define a sense of direction without successfully evolving a cohesive economic structure and systems that can form the basis for periodic policy adjustments for effective macroeconomic management for attaining economic growth. The growth and development aspirations of the economy have all along being well defined in consonance with universal aspirations of contemporary modern economies but there has been persistent difficulties in matching these aspirations with the establishment of fundamental structures that can spearhead the process of attaining economic growth and development.

- A pattern emerged from the structures of the colonial economy but was not successfully transformed to withstand post independence challenges. Further disruption occurred as a result of discovery of oil and the resultant huge revenues earnings arising from the bourgeoning world economy which blurred the formulation and implementation of appropriate mix of policies and strategies for effective use of oil and gas resources to stimulate domestic productive activities towards sustainable growth of the economy.

- The weak and unsteady inter-industry linkages of the economy are attributed to lack of cohesive policy implementation strategy that can take advantage of the availability of oil and gas resources. This has inflicted a structural weakness on other sectors of the economy, resulting into low absorptive capacity and lack of endogenous technological change that can stimulate the economy towards sustainable growth path.

- The oil and gas industry has been a source of enormous revenue to the Nigerian government. The revenue contribution of the industry has grown from 27.8 per cent of total federally-collected revenue in 1970, to 78.4 per cent of total federally-collected revenue during the period 1991-1995. In terms of contribution to GDP however, the average contribution of the oil and gas the industry increased from 19.6 per cent during the period 1981 to 1990 to 36.8 per cent within the period of 1991 to 2000.

- Activities in the oil and gas industry are not embedded in value-adding processes that generate synergies for efficient utilisation of oil and gas resources. Real and value-adding productive activities in the sector are very low with little spillover effects on the sectors of the economy. This has stultified the impacts of the industry in stimulating inter-industry linkages and its contribution to economic growth, giving rise to deep-rooted distortions that prevent rational economic behaviours that could have facilitated the process of self-perpetuating process of economic growth.

- The economy is deeply entrenched in a sustainable non-inclusive non-growth process that has tended to undermine domestic production activities. Domestic expenditure remains consistently dominated by consumption expenditure leaving little for savings despite the fact that operating surplus dominate income of the economy. The capacity of the Nigerian economy to meet up the challenges of contemporary global realities is therefore very weak. A fundamental transformation of the economy requires a reversal of the deep rooted consumption pattern of the economy to be replaced by production process that ensures the effective utilisation of domestic resources.

- The trajectory and appalling growth performance of the Nigerian economy over the years is a logical outcome of the misplaced macroeconomic policies implemented and the mismanagement of public resources spanning several years. It has been difficult for the economy to transform from a major exporter of primary commodities and a large scale consumer of imported finished goods and services.

The following policy recommendations emerge from the study:

- A key strategy will require heavy investments that have expansionary effects on the economy with the complements of robust household sector that provides *effective market and supply* labour services. With a bourgeoning income earning household sector that seeks to *satisfy its* consumption needs, effective market with potential for expansion emerges to facilitate inter-industry linkage processes. These are the essential conditions for fostering a sustainable growth process that is internally generated even with declining public funds from sale (export) of crude oil. The manufacturing sector, due to its large scale value-adding attributes should be the route from which the spillover effects of a flourishing oil and gas industry is transmitted to other sectors of the economy.

- Efficacy of regulatory framework, the structure and operations in the oil and gas industry as well as the general macroeconomic disposition of the economy are crucial determinants of the extent of linkage and economic growth relevance of the oil gas industry to the economy.

- Appropriate measures for acquiring technological capabilities should be anchored on domestic value-adding activities in the oil and gas industry that ensures formidable linkages with other sectors of the economy driven by innovative transformation of sectors into dynamic systems through adaptation and interaction of factors of production based on co-ordinated (National) System of Innovation. The JVC model is a viable source of knowledge spillovers.

- To establish a balanced safeguard for inter-generational equity while pursuing sustainable growth, revenue from export of crude oil should be invested in social and economic services such as education, health and physical infrastructure, which can enhance the investment attractiveness of the economy that could form the basis for innovation, endogenous technology and sustainable economic growth, the benefits of which will encompass different generations of infinite-horizon

It needs to be stressed that, the nature and vagaries of the Nigerian economy have implications on the quality accuracy the input-output data generated and the input-out tables constructed for the Nigerian economy. The activities of some sectors of the economy tend to have been afflicted by the inherent distortions of the dispensation of the economy. As a result some of the computed results were very high and thus regarded as outliers. However, from a deeper understanding of the Nigerian economy, the pattern of inter-industry linkages obtained from the overall analysis is a reasonable reflection of the economy, more so that the incidences of extreme values are very few and are not given analytical emphasis. In context, the art of constructing input-output data in developing countries in general and Nigeria in particular is very nascent and not well established to attain a level of perfection that is comparable to high standards. The use of the input out-put tables for research and analysis could form a basis for periodic review of the methodologies for data generation and construction of input-output tables towards improvement in the quality and accuracy of the input-output tables.

In this regard, the renew efforts in constructing input-out tables for Nigeria by the Federal Office of Statistics in Nigeria (now National Bureau of Statistics) is encouraging. Institutionalisation of this effort is required in order to ensure sustainability and periodic improvements in the quality of input-output tables towards standard conformability.

Constructing input-output tables can be costly but considering its significance to the proper understanding of the nature and interaction of different activities of different sectors, which is useful for economic policy planning it should be given the priority it deserves. Published input-output tables should be made more accessible to research institutions and research outcomes should be made available to relevant policy making establishments including any data shortcomings identified so that policies and data generation processes can be enhanced. Further research on inter-industry linkages in the Nigerian economy using any of the existing and/or emerging approaches will be useful towards institutionalisation of the construction of input-output tables.

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