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UNIVERSITY OF NIGERIA

TO RESTORE THE DIGNITY OF MAN

GAS INDUSTRY IN NIGERIA: PRODUCTION, UTILIZATION AND THE IMPACT ON THE ECONOMY

BY

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TITLE PAGE

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Being a Project Submitted to the Department of Economics,
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CERTIFICATION

This research work has been approved by the Department of Economics, University of Nigeria, Nsukka

By

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DEDICATION

To my caring Daddy and Mummy;
And to everyone who believes that there is a great future for Nigerian economy.

PREFACE

This research work which is on the economic impact of gas utilization in Nigeria has been presented in such a way that makes the work easy to understand. Each of the three objectives pursued in this work is evaluated using a different model; and each step of the evaluation is well explained.

The work is laid out in five chapters. The first chapter gives the background of the study as well as the statement of problems, objectives and the hypotheses of the study. This is followed by the literature review which is sub-divided into theoretical literature review, empirical literature review, and limitations of previous studies. The theoretical literature review was further categorized into nine different sections. Chapter three and chapter four deal on the methodology and the evaluation of results respectively. The last chapter reveals the policy implications of the findings of this research work and also discusses the policy recommendations.

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I would not have pursued this second degree due to some many constraints. However, God gave me the inspiration, courage and determination. Therefore, I give him all the praise, glory and honour both now and forever.

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ABSTRACT

A key policy objective of sustainable economic development, especially in any developing country like Nigeria, is to establish energy development paths that are both economically efficient and sustainable. However, this depends significantly on full utilization of such resources. This research work adopts an econometric approach to evaluate both the impact and the sustainability of Gas utilization in the Nigerian economy. Also, it examines the structure of gas flaring in Nigeria in relationship to the imposition of fine on flared gas. The regression results and the co-integration tests show that utilization of Nigerian natural gas does not only impact positively on the economy; it is also sustainable. On the other hand, this research work equally reveals that the imposition of fine on flared gas since 1984 has not led to any structural change on the level of flared gas. Hence there is the need for government to always use analytical tools to evaluate its policy implementations. Finally, this research work offers some policy recommendations for effective planning, management and development of gas industry in Nigeria.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Energy is at the core of human existence. It is also the pillar of wealth creation. As such, modern society cannot seriously address issues of development if such consideration is not based on the foundation of effective energy planning and management that enhances optimal utilization, regular supply and availability of energy resources. Humans have been aware of the natural flammable gases from the earth for at least several thousand years. Gas was not used extensively as a fuel source until the nineteenth century. Although natural gas was used as early as 1821 to illuminate the town of Fredonia, New York; its widespread use in the United States awaited the rise of the petroleum industry. (NCEMA, 1999 and Barnes et al, 2005).

Nigeria is richly endowed with energy resources. These include coal, tar sand, oil, natural gas, hydroelectricity, solar and so on. The commercial energy sector is, however, dominated by oil and gas, both of which jointly account for 71 per cent of commercial domestic energy resources. (Iwayerm and Adenikinju,2001). Thus, oil and gas play significant role in the development of the Nigerian Economy.

Actually, the search for oil in Nigeria began in 1908 when a German company, Nigeria Bitumen corporation, drilled fourteen wells in what is today Lagos state before ceasing operations with the outbreak of World War I. Interest in the possibility of discovering oil in Nigeria revived in 1937 with the establishment of Shell / D' Arcy

Exploration parties, a consortium owned equally by Royal Dutch Shell and British Petroleum that later became the Shell-BP Petroleum Development company of Nigeria limited. In November 1938, this company received Oil Exploration License (OEL) covering all of Nigeria. However, by 1957, Shell–BP had reduced its acreage to 40,000 square miles of oil prospecting Licenses (OPL'S). Out of this acreage, Shell-BP converted nearly 15,000 square miles into Oil Mining Lease (OML'S) in 1960 and 1962. Then, Shell–BP returned the residual to the Nigerian government.

Between 1938 and 1941, Shell-BP undertook preliminary geological reconnaissance. After a five-year interruption caused by World War II, it intensified and followed up this activity with geopolitical surveys in the 1946–51 period. In 1951, Shell–BP drilled its first wildcat well. This drill came up dry. During the next four years, the company concentrated efforts in the cretaceous areas rimming the Niger Delta without discovering any oil-producing wells. After shifting focus to the Tertiary area of the Delta itself, Shell-BP made Nigeria's first commercial discovery in 1956 at Oloibiri now in Bayelsa state). This lunched off a period of extensive exploration activity in the tertiary, which is still continuing. Nigeria was, thus, ushered into the international oil stage.

However, even before Shell–BP started exporting oil from Port Harcourt in 1958, other companies began to show interest in Nigeria. Mobil carried out reconnaissance work in the north western corner of the country in the mid-1950's and then shifted to the coastal area in what is now Lagos State between 1958 and 1961, drilling four dry holes before abandoning the area. Following Shell-BP's release of acreage, Tenneco, Gulf, Agip, Satrap, and later Phillips obtained onshore OPL's. Additional onshore OEL's were later granted to ESSO, Satrap, and Great Basins. Furthermore, in 1960, Nigeria divided its offshore continental shelf into twelve blocks of about 1,000 square miles each. Ten of these blocks were taken up in 1961 – four by shell-BP, two by Gulf, two by Mobil, and two by Texas Overseas which made Nigeria's initial offshore oil strike in 1963. Out of the remaining two offshore blocks, Gulf took one in 1964 and Union obtained the other block in 1967. (Pearson, 1970).

Thus, oil production has been going on in Nigeria for about 48 years together with the production of natural gas. Associated gases are routinely flared in the course of producing and processing oil. Flaring is a means of safely disposing of waste gases through combustion. This is carried out with an elevated flare through the top of a pipe or stack where the burner and igniter are located. This is a common practice in the oil production process. Hence, it is not necessarily an ecological or social crime to flare gas. However, the Nigerian case attracts more attention given the volume of gas flared since the beginning of commercial oil production in the country (Evoh, 2002). Traditionally, oil companies do not like to find gas together with their oil fields – associated gas (AG). Rather, they prefer to find gas without it being mixed up with oil – so called non-associated gas (non-AG). Finding AG means they have to find ways to dispose of it in order to profit from the oil, the lucrative driver. But while AG flaring has been increasingly frowned at in most parts of the world, in Nigeria it has flourished. Hence, Nigeria is reputed to be the largest gas flaring country in the world.

Therefore, understanding the economic impact of gas utilization has become an area of critical studies.

1.2 STATEMENT OF THE PROBLEM

Although it is established that economic advancement and industrialization are contingent on continuous availability and prudent utilization of energy resources, still Nigeria's energy policy planning and management system leaves much to be desired. Nigeria, despite its widely acknowledged status as an energy-rich nation, is still saddled with the problem of inadequate and unreliable energy supply for domestic and industrial use. (NCEMA, 1999).

Natural gas is rapidly gaining importance both as a source of energy and as a feedstock for industry. This growth is being driven by a number of factors including:

- Growing energy demand from an expanding world economy;
- An abundant resource base;
- Environmental pressures for the use of gas which is a relative 'clean" fuel in comparison to oil or coal;
- Improving technologies for the production, transportation and conversion of natural gas.

Thus, currently, most economies of the world are diversifying away from oil to gas as energy source. (Barnes et al, 2005).

Nigeria is endowed with a huge gas reserve, which has remained largely untapped since the ascendancy of crude oil as the nation's major cash earner. In fact, petroleum experts regard Nigeria "as a gas province with little oil in it." (Gaius-Obaseki, 1996). Nigeria's proven reserve of natural gas was estimated at about 124 trillion cubic feet (TCF) of gas during an exploration in 1995. In energy terms, this is said to be twice as much as the nation's crude oil reserves. In Nigeria, natural gas is obtainable in two main forms, that is, as associated natural gas (AG) and as non-associated natural gas (Non-AG).

Despite the various ways in which natural gas can be used as well as the regulations introduced more than 20 years ago to outlaw gas flaring, approximately 75 percent (by 2000) of the total gas output are flared. This may be broken down into 80 percent of non-associated gas and 99 percent of the associated gas output. Gas flaring has, thus, become a dominant feature of upstream activity in the petroleum industry of the Nigerian economy. (Okoh, 2001).

Gas flaring in Nigeria could be blamed on the unsustainable exploration practices coupled with the lack of gas utilization infrastructure in the country. However, Ojinnaka (1998) believes that energy, such as gas, has a pervasive impact on the economy and environment such that the progress or development of any area in the world is measured by per capita energy consumption or the contribution of the energy sector to the gross domestic product of that area.

Therefore, this work shall be guided by the following research questions:

- What is the economic impact of gas utilization on the performance of Nigerian economy?
- Has the imposition of fine on flared gas affected the level of flares?
- Based on the current level of utilization, is gas sustainable vis-à-vis Nigerian economy?

Previous studies were more interested in the environmental impact of gas flaring. (Barnes et al, 2005; Climate Justice, 2005; Friends of the Earth, 2004; Pelagagge, et al, 1996, Deekor, 2002; Egbuna, 1987; Stiglitz, 2004 and NCEMA, 1999). However, Okoh (2004) carried out a cost-benefit analysis 'Gas Production in Nigeria' using NPV approach. Some others researchers who did work on economic impact of gas production and its flaring, rather, used the spot price of gas to calculate the values of these impacts. On the other hand, some others were more interested in the monetization of gas in Nigeria with special attention on the different gas-based projects. Iwayemi and Adenikinju (2001) employed the method of computable general equilibrium (CGE) model in their study of energy–environment–economy linkage in Nigeria. However, it is obvious that CGE approach which is employed in equilibrium analysis cannot offer a good estimate on impact study as it does not provide for the testing of the significance of the variables under review. Likewise, NPV which is used in cost-benefit analysis cannot be a good tool for impact study. These methods have, therefore, led to the lack of good estimate of the economic impact of gas utilization which is needed for proper policy planning and management. Thus, this study intends to fill this gap by applying an econometrics approach to this analysis, thereby providing an unbiased estimate for proper policy making.

1.3 OBJECTIVES OF THE STUDY

The overall objective of this study is to evaluate the economic implications of gas utilization in Nigeria. Specifically, the study intends to achieve the following objectives:

i. To ascertain the impact of gas utilization on the national income.

ii. To determine if the imposition of fine on flared gas has affected the level of flares.

iii. To investigate the sustainability of gas utilization.

1.4 HYPOTHESES

This study will investigate the following hypotheses:

i. H_0: Gas utilization in Nigeria has no impact on the national income.

ii. H_0: The imposition of fine on flared gas has no significant effect on the level of flares.

iii. H_0: Gas utilization in Nigerian economy is not sustainable.

1.5 SIGNIFICANCE OF THE STUDY

Nigeria has reacted in various ways to the energy crisis but the crisis persists in the domestic economy in the form of shortage of energy products in a country so richly endowed with energy resources. To adequately handle this energy crisis, policy planning and management based on facts and figures become a necessity.

Since this study promises robust estimates, unbiased inference and attainable policy recommendations, the federal government of Nigeria as well as most States and Local government authorities especially those in the Niger Delta region will find it very useful. Of course, both the foreign and indigenous companies which are in the upstream operations of the petroleum sector in Nigeria will benefit immensely from this study. Likewise, individuals and corporate bodies who are interested in the downstream operations of Nigerian oil sector, especially as it pertains to gas, will find this work very useful. Furthermore, this study will be of great benefit to students, researchers, community leaders, human right activists, and so on.

1.6 SCOPE OF THE STUDY

The study is limited to the Nigerian economy for the period between 1970 and 2005. That is, a period of 36 years. Choice of the period is due to data availability and its structural features.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL REVIEW

According Ojinnaka (1998), countries that have higher per energy consumption are, generally, more developed than those with lower level. The importance of the production of natural gas lies in other aspects of development which includes increase in foreign exchange earning when the products are exported, transfer of technology in employment in gas industries, improvement in workers' welfare through increase in salaries and wages, improvement in infrastructure and socio-economic activities in the process of natural gas exploitation. However, the importance of natural gas production should also be seen in the negative impacts gas could have on the economy and on the environment when its exploitation and utilization are irrational and uneconomic.

Generally, natural gas is a fossil fuel that contains a mix of hydrocarbon gases, mainly methane (CH_4), along with varying amounts of ethane (C_2H_6), propane (C_3 H_8), and butane (C_4H_{10}). Carbon dioxide, oxygen, nitrogen, and hydrogen sulphide are also often present. Natural gas is "dry" when it is almost pure methane, absence of the longer-chain hydrocarbons. It is considered "wet" when it contains other hydrocarbons in abundance. Those longer chain hydrocarbons can condense to form valuable light liquids (so-called natural gas liquids, or NGL_S). "Sweet" gas possesses low levels of hydrogen sulphide compared to "sour" gas. Natural gas found in oil reservoirs is called "associated" gas. When it occurs alone, it is called "non-associated" gas (Barnes et al, 2005).

2.1.1 NATURAL GAS RESERVE IN NIGERIA

Nigeria is endowed with massive reserves of associated and non-associated gas, estimated in excess of 160 trillion cubit feet. It is ranked amongst the 10th largest in terms of proven natural gas reserves in the world. Its natural gas reserves/production is estimated at 109 years. Geologists, however, insist that there is a lot more gas still to be found, if companies deliberately explore for gas, as opposed to finding it by chance whilst in search of oil. (Pelagagge et al, 1996).

Ojinnaka (1998), however, opines that Nigeria gas reserves have been estimated at 24.0 billion barrels of oil equivalent. That means that the country has more gas than oil. That is, for every barrel of crude oil in associated well, there is average of 1100 standard cubic feet of gas. Thus, Nigeria's natural gas reserves are well over 100 trillion cubic feet (2,800kms). The gas reserves are three times as substantial as the crude oil reserves. Okoh (2001), quoting Gaius-Obaseki (1996) states that Nigeria's proven reserve of natural gas was estimated at 124 trillion cubic feet (tcf) of gas during an exploration in 1995. In energy terms, this is said to be twice as much as the nation's crude oil reserves. According to her, with this proven natural gas reserves, Nigeria ranks ninth in the world and second in Africa in terms of gas reserves. In affirmation to the fact that Nigeria ranks the ninth largest concentration in the world, Evoh (2002) asserts that the country has an estimated 180 billion cubic feet of proven natural gas.

2.1.2 NATURAL GAS PRODUCTION IN NIGERIA

According to friends of the Earth (2004), there is confusion over how much natural gas is produced in Nigeria. The most recent and independent information source suggests that over 3.5 billion standard cubic feet (scf) of associated gas was produced in 2000.

Gas production in the country is undertaken by the major oil companies (Shell, Chevron, Agip, Texaco, Mobil, Elf, Ashland and Pan Ocean). Natural gas production has increased enormously from 125.55 million tones (MT) (310 million cubic metres) 1961 to 14472. 11 MT (36,036.6 million cubic metres) in 1998. It further increased to 101,976 million cubic metres in 2002. However, it is important to note that there is virtually no exploration for gas in Nigeria. Most gas reserves were discovered while exploring for oil. Therefore, high oil production implies that additional high volumes of associated gas will be produced. (CEE, 2006; CBN, 2004; and Okoh, 2001).

2.1.3 NATURAL GAS UTILIZATION

The clamour for sustainable development and improved quality of life for people has given more prominence to striking a balance between energy demand and economic growth. A commodity's value basically depends on its contributions to the achievement of some level of satisfaction. The role of natural gas resource in generating some level of satisfaction to improve the quality of life of a people is not debatable. (NCEMA, 1999).

The main driver of gas utilization projects in Nigeria had been the government's desire to create more wealth and diversify the economy of the country. Since the 1980s, there has been increasing utilization of gas in Nigeria for power generation, industrial heating, fertilizer and petrochemical manufacturing and as feedstock for direct steel reduction. But the largest gas users are the liquefied Natural (gas (LNG) project and the Aluminum smelting industry. Nigerian's LNG project had been on the drawing board since the 1960s. It was not until 1990 that the NNPC concluded financial arrangements for the project. Established in 1992, the Nigerian Liquefied Natural Gas Company commenced execution of the project in 1993. The shipment of gas from the Bonny Plant to overseas buyers in Europe commenced late in 1999.

The Nigerian Gas Company, the gas marketing subsidiary of the NNPC, has signed a 10 billion Naira gas sale agreement with Shell, involving the marketing of gas from its Utorogu gas plant. To augment government's gas commercialization effort, Chevron has embarked upon the Escravos Gas utilization project in which it will process about 160 billion standard cubic feet of gas daily from the company's Meta and Okan fields. The National Gas Company (NGC) currently supplies gas for power generation, as source of fuel or as feedstock to current industries, etc and the demand is increasing. A large potential market exists for investors in this area. Domestic gas demand is about 400 million cubic feet a day (MMcf/d), which is very low compared to the size of Nigeria's population and its gas resources. The domestic market is limited by the low level of industrialization and the inadequacy of the gas transmission and distribution infrastructure. The power sector currently accounts for almost 90% of gas sales. (CEE, 2006).

Unlike what obtains in Nigeria, where power sector consumes about 90% of the total gas supply, industrial 4% and the chemical feedstock about 3%, the pattern of gas consumption in advanced economies such as the United States of America is entirely a different scenario. The consumption pattern for residential, industry, power plants and others includes chemical feedstock stands at 45%, 25%, 17%, and 13% of the total gas supply respectively. In the Eastern Europe, the situation is quit closer to what is obtainable in the USA. Consumption for residential stands at 45%, industry 30%, power sector 13% while others take 12% of the total gas supply. (Douglas, 1996).

Thus, besides being abundant in Nigeria, natural gas has numerous potentials which if properly tapped, would help alleviate the energy crisis in the country. Gas is a close substitute for other fuels in electricity generation, a complement to crude oil in revenue earning, a feedstock for fertilizer and petrochemical industries, and environmentally more friendly, being cleaner than crude oil or coal. But natural gas in Nigeria has a problem, and that is, most of it is flared. (Ojinnaka, 1998). This leads to a high level of underutilization of capacity which Chiang (1984) calls a slack in capacity utilization.

2.1.4 WHY GAS FLARING IN NIGERIA?

Historically, gas flaring in Nigeria began simultaneously with oil extraction in the 1960s by Shell-BP. Although, the British government subsequently acknowledged that the flaring was unacceptable, it was allowed to continue without any real efforts to change infrastructure and prevent the waste of the gas. This is in contrast to Britain's policies on gas flaring in their own territory where gas flaring has been reduced to a minimum. In fact, in Western Europe 99% of associated gas is used or re-injected into the ground. Gas flaring is generally discouraged and condemned by the international community, as it contributes greatly to climate change.

Nigeria's natural gas, which occurs in association with crude oil and on its own, is estimated (reserves) at 3 trillion standard cubit metres, the bulk of its output realized during crude oil extraction, and about 75% of the product flared. The remaining 25% is either re-injected or treated and sold to relevant industries. In an effort to encourage better use of natural gas and minimize adverse environmental impact of its flaring, government has periodically adjusted upwards fines and penalties for non-adherence to official flaring-reduction guidelines. Government has, however, not sufficiently followed through with its decision to have more industries convert to the use of natural gas as a way of increasing demand for the product and making flaring less desirable. (Ukpang, 1998).

Thus, the neglect of Nigerian natural gas was due to institutional and policy lapses. The joint venture comprises' primary preference was to extract crude oil and make their profit. Consequently the gas associated with crude oil was seen as a nuisance and had to be flared. Even when government imposed penalty of 2 kobo, and later 50 kobo on any 1000 cubic feet of gas flared, the companies found it more cost effective to pay the penalty than to invest in gas re-injection or gas using projects. Government did not help matters by not approving a natural gas policy that was produced in 1992 or by delaying in providing the appropriate environment in the exploitation of the enormous gas reserved of the country. The augment that there was no market for selling Nigeria's gas or the technology for developing the gas turned out to be baseless as a number of projects later put in place to develop gas resources indicate. (Ojinmake, 1998).

Friends of the Earth (2004) states that several other reasons that have been put forward for continuing to flare, could be categorized into economic, commercial and technological issues. On the other hand, Evoh (2002) emphasized that the entire issues of gas flaring in Nigeria boils down to one question; who manages natural resources exploitation in Nigeria – the government or multinational corporations?

It is quite astonishing that gas flaring has continued in the country despite the fact that flaring has been in general, illegal since 1984 pursuant to section 3 of the Associated Gas Re-injection Act, 1979. This section only allows companies to flare if they have field(s) – specific, lawfully-issued, ministerial certificates. Despite requests, none of these certificates have been made public. Moreover, the toxic cocktail from flares violates the Delta residents' rights guaranteed under Nigerian law, such as to live in dignity, and to enjoy health and a satisfactory environment.

Nigeria extended the zero flaring deadline to 2008 from 2004 after the operators (the major transnational oil companies) argued that the earlier deadline was not feasible. In May 2000, representatives of these operators in Nigeria announced that they would be able to meet the required phase out by the following dates:

Chevron Texaco	-	2008
Total Fina Elf	-	2008
Shell	-	2008
Agip	-	2005
ExxonMobil	-	2004

At present, efforts to achieve the target have been, at best, tardy. More so, with crude oil production having risen to 2.5 million barrels per day in 2004, and with the projected increase to 4 million barrels per day by 2010, it is difficult to see how most of the resulting increased amounts of associated gas will not be flared. (Climate Justice, 2006 and CEE, 2006).

The technology or argument made by these companies is quite paradoxical. The argument comes at time when technological innovations in the oil industry are rapidly increasing. The oil industry in Europe and America had already invested a reasonable amount of money in Research and Development of technologies over the years. This had resulted to an increase in deep-water drilling and enhanced recovery of more oil from formally depleted wells. The companies undertaking these technological innovations to enhance oil recovery are also the very ones operating in Nigeria. What these companies want the Nigerian public to believe is that, while technological advances have been made to enhance oil recovery in Nigeria, nothing has been done technologically to curb gas flaring after decodes of oil exploration in the country. One cannot help but ask if this is intentional neglect or a technological oversight on the part of the companies? (Evoh, 2002).

Quoting UNDP/Word Bank (2004), climate Justice (2003) asserts that the SPDC's (Shell) strategic plan states that it seems that the industry is seeking clearer guidance from the Federal Government of Nigeria (FGN) in meeting the 2008 zero flaring deadline and it is trying to "guess-out" true FGN intentions as meaning business this time or just another down the road deadline that this government would not live to see.

2.1.5 GOVERNMENT AND GAS FLARING IN NIGERIA

Marxist political economy provides a broader view of economic development. Like classical and neo-classical economists, political economists are concerned with the efficient and cost effective allocation of scarce resources. They, however, bring a new coefficient – politics – into its development equation. When addressing why some groups or countries are better off than others, political economists do not look solely at market forces for an explanation. They focus on the social and political mechanisms that economic groups have created in order to control the allocation and utilization of scarce resources. (Contreras, 1996).

Therefore, it has been argued in some quarters that the participating of federal government in oil and gas production and exploration activities under the joint programme with multinational oil firms has incapacitated oil companies to stop gas flaring in the course of oil production. According to this view, the failure of the federal government to effect cash payment for its obligations in the operations of the joint venture partnership constitutes major obstacle for the oil firms to focus their attention on curbing gas flaring. Hence the argument goes that the government could not credibly enforce gas flaring laws or penalize oil companies, since it has failed to redeem its own obligation. This argument is right to some extent. However, it exaggerates the effect of the government's insolvency to the gas flaring phenomenon. It must be emphasized that the joint venture partnership in question is relatively recent. Hence, it will be a misjudgment to blame the prolonged flaring of gas in Nigeria on such failure on the past of the Nigerian government present or past.

For whatever reason, it is hard to justify the rate at which oil companies have continuously flared natural gas in the course of oil production in Nigeria through the decades. However, it is not only the responsibility of the oil companies to end this unhealthy practice. Rather, the government bears a great responsibility in this regard as well. If the Nigerian government can provide the will to mitigate gas flaring to its barest minimum, the oil companies will certainly provide the way to do it in terms of technological applications. However, none of these companies will end gas flaring at their own behest. Stopping gas flaring will involve financial investments, which oil companies would like to avoid. Nigeria is not an isolated case; rather, it is a clear depiction of the modus operandi of multinational corporations in the less developed parts of the world. In the industrial countries, this level of environmental abuse caused by energy production is rare. (Evoh, 2002).

Furthermore, it is believed in some quarters that the policy of the previous military regimes in making it cheap for the oil companies to flare gas into the atmosphere and pay a fine of about 10 American cents per 1,000 standard cubic has contributed significantly to the continuous flaring of gas in Nigeria. This is against the 10 dollar penalty required in developed countries, which has discouraged the companies from flaring gas in such developed regions of the world. For instance, the military administration of General Ibrahim Barbangida has been blamed for this problem; especially for the fact that it did not approve a natural gas policy that was produced in 1992. In general, the military administrations have been blamed for delaying the provision of the appropriate environment in the exploitation of the enormous gas reserves of the country. (Ojimaka, 1998 and Evoh, 2002).

From 1966 to 1979 and again from 1984 to 1999, military was the dominant actor in the governance of the Nigerian state. Accordingly, over this period, the military also occupied a pre-eminent position in the management of the Nigerian economy. Citing Horowitz's (1966) thesis, retired Major General Charles Ndiomu (2000) opines that given its centralized, hierarchical and disciplined nature, and particularly its coercive attribute, the military should be in a better position to mobilize all sectors and resources into a coherent 'national' cause, aimed at quickening production, limiting consumption and sustaining the savings and investments necessary for the take-off of sustainable development. He cited a member of the school of thought, Odetola (1985), who states that he had found strong support for Horowitz's position with respect to Nigeria. According to Odetola, between 1964 and 1966, (the civilian regime), the GNP level was 4.2; from 1969 to 1971 (the military regime), it jumped to 9.1, and in 1972 to 12.1.

However, Ndiomu believes that while the figures in the data of both Horowitz and his supporters appeared convincing at first glance, they were deficient in the sense that no variables were controlled for, to demonstrate that the relationship remained unchanged after the control. In the Nigerian case, for instance, such a variable as the increasing contribution of petroleum exports to GNP between 1964 and 1972, may have explained, at least in part, the significant growth that was recorded during the early years of military government in the country.

To explain the Horowitz's thesis with respect to Nigeria, Ndiomu carried out a critical study on the different military government regimes and the Nigerian economy. The examined regimes include:

i.	The Aguiyi – Ironsi administration:	January – July, 1966
ii	The Gowon administration:	1967 – 1975
iii	The Mohammed/ Obasanjo administration:	July 1975 – September, 1979
ii.	The Buhari Administration:	January 1984 – August, 1985

iii. The Babangida administration: 1985 – 1993

iv. The Abacha administration: 1993 – 1998

v. The Abubaka administration: June 1998 – May 1999

Therefore, in this discussion on the problems of military governments and the Nigeria economy, Ndiomu asserts that the military failed, when it was most expedient, to establish a solid iron and steel industry or develop a petrochemical complex that would have facilitated the liquefied natural gas project and thus enable the nation to convert the vast quantities of gas flared annually into hard currency.

2.1.6 GAS FLARING AND ENVIRONMENTAL ISSUES

Gas flares can have potentially harmful effects on the health and livelihood of the communities in their vicinity, as they release a variety of poisonous chemicals. Some of the combustion by-products include nitrogen dioxides, sulphur dioxide, volatile organic compounds like benzene, toluene, xylene and hydrogen sulphide, as well as carcinogens like benzapyrene and dioxin. Humans exposed to such substances can suffer from a variety respiratory problems, which have been reported amongst many children in the Delta but have apparently gone uninvestigated. These chemicals can aggravate asthma, cause breathing difficulties and pain, as well as chronic bronchitis.

Of particular note is that the chemical benzene, which is known to be emitted from gas flares in undocumented quantities, is widely recognized as being a causative agent for leukemia and other blood related diseases.

Often, gas flares are located close to local communities, and regularly lack adequate fencing or protection for villagers who may risk nearing the tremendous heat of the flare in order to carry out their daily activities. Many of these communities claim that nearby flares cause acid rain which corrodes their homes and other local structures, many of which have metal roofing. However, whether or not the flares contribute to acid rain is debatable, as some independent studies conducted have found that the sulphur dioxide and nitrons oxide content of most flares was insufficient to establish a link between flaring and acid rain. (Friend of the Earth, 2004).

Generally, flaring is a violation of human rights. The psychological and physical effects of roaring sound and intense heat are also significant, as well as property damage. Under the 1999 constitution of the Federal Republic of Nigeria, Article 20 provides that: "The State shall protect and improve the environment and safeguard the water, air and land, forest and wild life of Nigeria" an guarantees, for example, the fundamental rights to life (Article 33) and dignity (Article 34). It requires the state to take reasonable and other measures to prevent pollution and ecological degradation, to promote conservation, and to secure an ecologically sustainable development and use of natural resources. Article 12 of the International Covenant on Economic, Social and Cultural Rights (ICESCR), to which Nigeria is a party, requires governments to take necessary steps for the improvement of all aspects of environmental and industrial hygiene. (Climate Justice, 2006).

The problem of flaring gas is not debatable. Ojinnaka (1998) quoting Anyaigbo (1998) states categorically that this problem has to do, mainly, with its adverse environmental impact on immediate communities whose corps and poultry and fishing activities are damaged due to pollution. This is what Stiglitz (2000) calls negative externalities.

2.1.7 GAS FLARING AND NIGERIAN ECONOMY

Quoting Hartwick (1977), Iwayemi and Adenikinju (2001) identify the theoretical condition linking resource rents to economic sustainability. However, despite the various ways in which natural gas can be used in Nigeria, approximately 75 percent (by 1998) and 63 per cent (by 2000) of the total gas output were flared. For instance, if you take gas which is flared in Africa, which is around 40 billion cubic meters each year, with Nigeria contributing 46%, and if you used that to generate power in efficient modern power plants, you could actually double the power production in sub-Saharan African, excluding South Africa. (NLNG, 2006).

Ojinnaka (1998) describes flaring gas as enormous loss of revenue that could have been realized. Citing Adeyeye (1991), he states that it has been estimated that Nigeria flares the equivalent of 300,000 barrels of crude oil equivalent of gas every day, which is more than enough to supply the refineries to process petroleum products. However, he notes that some percentage of gas is sold in the domestic market to industries like cement, brewery, glass and aluminum as complement to the use of diesel and fuel oil to operate private generators. As liquefied natural gas, there is high demand for gas in the international petroleum market. Hence when Nigeria exports LNG, it will earn additional revenue to complement revenue from crude oil. Therefore, investors are showing more and more interest in gas production because of its high economic potential ad higher efficiency when compared with other fuels.

There has been a recent change in the energy policy of the United States to make Nigeria and West African the centerpiece of their energy policy. The only way that Nigeria can achieve the full benefit of this new US policy and to meet Nigeria's quality of life needs through hydrocarbon resource development, is to put in place the full scope of assets required to double Nigeria's oil and gas production and hence income levels. This scope includes plans to reduce gas flaring to near zero by year 2008 and the development and export of the significant gas reserves. (CEPMLP, 2003).

In his discussion on gas flaring as an economic loss, Ogbonna (1999) asserts that against the massive economic loss, natural gas should and can play some vital roles in the Nigerian economy. These roles include:

i. Stimulant for industrial development
ii. Foreign exchange earner
iii. Improved capacity utilization of Nigeria industries.
iv. Provision of employment opportunities.

2.1.8 ENDING GAS FLARING IN NIGERIA

The application of the existing technologies in oil production will go a long way in minimizing the potential for unconfined flaring of gas in the numerous oil fields in Nigeria. These technologies are not out of the reach of the various multinational oil companies operating in the country as they have presented it to the government. Curling flared gas could offer oil field operators significant safety and so many economic and environmental advantages to other stakeholders. It will substantially reduce atmospheric greenhouse (GHG) emissions thereby securing environmental stability in the region. Such reduction in emission in Nigeria can possibly attract companies in the advanced countries seeking carbon reduction credit under the Kyoto protocol programme of emission trading. This will definitely be an additional source of income to the country. (Friends of the Earth, 2004).

Recently, the government extended the zero flaring deadline to 2008, replacing the previous apparent date for ending the flaring of 2004. This was done after the major operators argued that the earlier deadline was not feasible. As noted earlier, in May 2000, representatives of the major oil companies operating in Nigeria announced that they would be able to meet the required phase-out by the following dates: Chevron Texaco – 2008; Total Final Elf – 2008; Shell – 2008; Agip – 2005; and ExxonMobil, 2004. (CEE, 2006).

However, according to Onwuka (2005), a major hiccup on government's effort to terminate gas flaring by 2008 has occurred as one of the key players in the oil sector, Shell Petroleum Development Company (SPDC) said that the official deadline will no longer be realistic to the firm. At the end of May 2005, SPDC announced in their 2004 Annual Report, citing mainly "past under-funding by partners" that they will miss the 2008 flares-out deadline. They said that "construction of ... {gas gathering facilities} ... will only be completed by the end of 2009, which means that gas flaring from the relevant forestations will not be eliminated until that time". This is a very serious development, especially, in the light of the fact that Shell is the biggest oil and gas producer in Nigeria, pumping over 50 per cent of the nation's crude oil, and condensate and gas as the operator of the NNPC/Shell/Agip joint venture. The company plays leading role in the policy implementation in the sector since its compliance accounts for 50 percent success in any official policy on the upstream petroleum industry. Although elimination of routine flaring of associated gas is an old national aspiration, it received a fillip in the economic reform agenda of the present administration in which government works to harness economic potentials of natural gas for revenue and sundry development goals. Therefore; it is tempting to believe that the flaring will end by 2008. Not only is that date too late, the history of Nigerian flaring suggests that such a belief would be naïve. However, SPDC and other oil multinational companies in the country have initiated gas-based projects in the race to end gas flaring (Onwuka, 2005 and Climate Justice, 2006).

2.1.9 GAS BASED PROJECT IN NIGERIA

The number of gas projects going on in the country underscores the importance of gas as a panacea to the energy crisis Nigeria has experienced over the years. Nigeria National Petroleum Corporation (NNPC) and other major oil and gas companies in the country are currently embarking on several gas utilization projects. The major existing and future projects are:

1. **LNG PROJECTS:**

The $3.8 – billion LNG (Lignified natural gas) facility on Bonny Island was completed in September 1999. The facility is expected to process 252.4 bcf of LNG annually. Initially, the facility is to be supplied from dedicated non-associated gas fields, but with a few years, it is anticipated that half of the input gas will consist of associated (currently flared) gas. Construction of third LNG production train, with an annual capacity of 130.6 bcf, was completed and operational in December of 2002. This third train increased NLNG's overall LNG processing capacity to 383 bcf per year. NLNG has work underway for train 4 and 5, or NLNG plus project", with Halliburton and KBR as joint venture partners. When NLNG project is completed, the plant will have an overall production capacity of 16.8 million tons per year (MMT/Y) of LNG, and 1 million tons of condensate it will also utilize about 2,8000 MMcf/d of gas. Additionally, a sixth train is currently being planned. Apart from the environmental benefits, the expansion is expected to generate large export earnings for Nigeria and establish NLNG as an increasingly significant player in the global natural gas industry:

2. OSO NGL PROJECT:

MOBIL JV NGL plant located at its OSO field in the Southeastern part of Nigeria started production for export during the third quarter of 1998. The OSO phase 2 project is to provide additional gas make-up for the OSO NGL as well as maintain condensate production at the expected plateau.

3. TRANS-SAHARAN PIPELINE

Nigeria underlines its determination to penetrate the European gas market when it signed preliminary agreements with Algeria in October 2001 on a planned Trans-Saharan Ripe line running through the North African country. The project would seek to connect the Nigerian gas field with that of Algeria, to the European market.

4. BELEMA GAS INJECTION PROJECT

SHELL JV Belema Gas injection project is aimed at reducing flares in five flow stations by re-injecting some of the gas, some for gas lifting, and some for use as fuel by local industries and excess for backing out NAG that is currently used to meet various existing contractual obligations. The contracts for the execution of the EPC and gathering pipelines are still in the early stages of executing. About 80 MMcf/d of gas is expected to be utilized.

5. INDEPENDENT POWER PLANTS (IPP)

Government is encouraging JV and PSC multinational oil companies operating in Nigeria to embark on IPPS as part of the power sector reform. The Reform that reviewed the generation, transmission and distribution of electricity in the country to improve its performance. The IPPs will not only boost electricity supply but also, provide necessary infrastructural support for economic growth, and also guarantee additional revenue to the participating JV/PSC companies. The IPPS will further strengthen the oil companies' social responsibility in the local economy as well as protect the environment through environmentally sustainable operations and industry best practices. The various IPPS are expected to contribute about 3000 MW to the national grid by 2007. This strategy will ensure the realization of government's intention to increase the national electricity generation from the current 4,000 MW to about 10,000 MW by 2010 to enhance economic activities.

6. THE WEST AFTRICAN HAS PIPELINE PROJECT (WAGP)

This project would transport gas from Nigeria to Ghana, Benin, and Togo. The $400 million WAGP will traverse 620 miles (1,033 kilometers) both on and off shore to its final planned terminus at Effasu in Ghana and will initially transport 120 MMcf/d of gas to Ghana, Benin and Toga. Gas deliveries are expected to increase to 210MMcf/d in 2010 and be 400 MMcf/d by the end of 2020. Among the key conditions are the following.

- The sale, transmission and purchase of natural gas must be performed on a commercial basis
- Third party access to WAGP must be granted on a non-discriminatory basis
- The pipeline company and the sellers of natural gas must be guaranteed settlement in hard currency.

It is also possible that the WAGP will be extended to markets in cote d'Ivoire. Negotiations are currently in progress with a number of prospective buyers in the sub region. However, though the transnational corporation claims that the project will contribute to flares reduction, there remains no clear programme for use of flared associated gas (AG) into the WAGP. In addition, the continued failure to require the use of AG, and to enforce regulatory and human rights obligations to end the flaring, will mean that the WAGP will become yet another non-AG project.

7. EXPANSION OF DOMESTIC GAS DISTRIBUTION NETWORK:

Several distribution schemes are planned to help promote Nigerian consumption of natural gas. The proposed $745 – million Ajaokuta – Abuja – Kaduna pipeline will deliver gas to central and northern Nigeria, while the proposed $552 million, Aba-Enugu-Gboko pipeline will deliver natural gas to portions of eastern Nigeria. The Lagos state government and Gas link Nigeria Limited (Gas link), a local gas distribution company, and developing a pilot program the deliver natural gas to nine residential neighbour hoods in the state. Gas link recently began supplying gas to nearly 30 industrial customers in Lagos Ikeja industrial district.

8. ESCRAVOS GAS PROJECT

The Escravos Gas project is a joint venture between NNPC and Chevron Oil Company. The project was designed to convert flared gas into propance, butane and natural gasoline. This project was the first major gas project to gather and process associated natural gas in Nigeria. It produced the first export of LPG to the world market in September 1997. The project's second phase – extending capacity to 285 MMcf/d began operations in 2000. A planned phase 3 will process up to 400 MMcf/d.

The completed project will export 40,000 barrels per day of liquefied petroleum gas and condensate. (CEE, 2003; MMPC, 2005, and Okoh 2001).

TABLE 2.1 SUMMARY OF GAS PROJECTS IN NIGERIA

Project	**Type**	**Company**	**Design Capacity MMcf/d**	**GasUtilized MMcf/d**	**Cost $Mm**
Oso Phase II	NGL & LPG	MPN	600	600	800
Gas To Liquids	Synthetic Fuel	Chevron Texaco	300	300	1,200
Escravos Gas Plant	NGL & LPG	Chevron Texaco	Phase 1-165 Phase 2-135 Phase 3-400	700	550-1000
Belema Project	Gas Injection	Shell	80	80	N/A
NLNG	LNG	SHELL (25.6)/ELF (15)/AGIP(10.4), NNPC (49)	Train 3,4 & 5	3000	N/A
Lagos-Ikeja Gas lines	Distribution & Marketing	UNIPETROL, Gas link	20	20	35
Ota,/Agbara & Aba Gas lines	Distribution & Marketing	Shell Nig Gas (SNG)		N/A	35
`West Africa Gas project (WAGP)	Distribution & Marketing	Chevron Texaco SHELL (SPDC), NNPC(NGC), TOGO(SoToGaz), GHANA (GNPC), BENIN(SoBeGaz)	180 620 miles of 18" diameter pipeline	180	400
Escravos-Lagos Gas pipeline phase 1,2 & 3	Distribution	NGC	Phase 1-80, Total phase3-160	160	N/A
TNEP Phase 1-3	Dist., ket'g & power	ChevronTexaco, ABB		N/A	2,500
Elf Gas Comp	Gas gathering	Elf		N/A	400
Lagos Emer. Power purchase	Power Generation	AES Corporation	Supply 270mw	N/A	800
ABB – IPP	Power Generation	ABB Group	Phase 1 2 & 3 300 mw	N/A	N/A

Source: Center for Energy (2006)

2.2 EMPIRICAL LITERATURE

Nigeria has an estimated 170 tcf of proven natural gas reserves, the 10th largest in the world. Abundant gas reserves exceed foreseeable needs of the domestic, regional and export markets. But Nigeria is experiencing power outages, low capacity utilization in the refineries and industries, high unemployment and a declining standard of living. Due to limited gas distribution infrastructure, Nigeria today flares about 2.6 bcf/d of gas, representing 12.5% of all globally flared gas, which is 68% of the associated gas produced or 51% of the total gas production in the country (CEE, 2003).

In his study on Gas Flares, Oil Companies and politics in Nigeria, Evoh (2002) opines that Nigeria has an estimated 180 billion cubic fact of proven natural gas, making it the ninth largest concentration in the world. However, he argues that due to unsustainable exploration practices coupled with lack of gas utilization infrastructure in Nigeria, the country flares 75 per cent of the gas it produces and re-injects only 12per cent to enhance oil recovery. According to him, it is estimated that about two billion standard cubic feet of gas is being flared in Nigeria. Hence making the country the highest vis-à-vis gas flaring in any member-nation of the organization of petroleum Exporting countries (OPEC). This is an enormous flare amount. Consequently, and going by the available statistics (2002), Nigeria accounts for about 19 per cent of the total amount of gas flared globally. He argued further that the policy of the previous military regimes in the country encourage gas flaring by making it cheap for the oil companies to flare gas into the atmosphere and pay a fine of about 10

American cent per 1,000 standard cubic. This is against 10 dollars penalty required in developed countries, which has discouraged the companies from flaring gas in such developed regions of the world. In emphasizing his point he compared Nigeria and Canada. Using the data collected by the Alberta Energy and utilities Board (EUB) in Canada, he shows that in 1996 about 92 per cent of gases were conserved or used in some manner. The remaining eight per cent was flared. This socially responsible attitude towards gas conservation, as demanded partly by environmental requirements in Canada and other advanced countries, does not apply in Nigeria.

Climate Justice (2005) carried out an extensive study on 'Gas flaring in Nigeria." According to that report, more gas is flared in Nigeria than anywhere else in the world. Again, they opine that estimates are notoriously unreliable, but roughly 2.5 billion cubic feet of gas associated with crude oil is wasted in this way everyday. This is equal to 40% of all Africa's natural gas consumption in 2001, while the annual financial loss to Nigeria is about US$2.5 billion. This is unlike the British attitude to flaring North sea gas where flaring of associated gas was over 90% at the start of crude oil production, but has decreased over the last 25 years to around 2%, with onshore flaring at between 6-14% since 1991.

Furthermore, they observed that despite its oil and gas, Nigeria is one of the poorest countries in the world. This is difficult to believe. Until it is recalled, for example, that 28 of the 45 years since independence have been under military rule, and that the

Economic and Financial crime commission estimates 45% of Nigeria's oil revenues are reported wasted, stolen or siphoned away by corrupt officials.

With reference to a speech by SPDC's Chief Executive (June, 2001), they stated that oil production levels determine the amount of associated gas (AG) produced and thus bear on the amount of flaring. Thus, on the average, about 1000 standard cubic feet (scf) of gas is produced in Nigeria with every barrel of oil. Therefore, with oil production of some 2.2 million barrels pre day, about 2.2 billion set of associated gas is produced everyday. For the first 20 years or so of the industry, almost all the AG was flared: 2.1 billion cubic feet per day (bcf/d) or 92% in 1981 for example. This percentage barely declined during the 1980s, standing at about 88% in 1980. It seems to have reached about 2.6 bcf/d in the late 1990s, though by then this was about 75% of all gas production. Whilst OPEC has suggested that flaring has since dropped below 2 bcf/d, and whilst both OPEC and the Nigerian Department of Petroleum Resources have suggested that gas flared as a percentage of all gas production has dropped below 50%, this is not universally accepted. For instance, in 2000, production of 4.6 bcf/d was largely wasted with nearly 55 percent or close to 2.5 bcf/d being flared. The gross monetary valve of this gas is in the order of US$2.5 billion per year to the economy, amounting to US$50 billion over 20years. The balance of this amount is split among re-injection, NLNG feedstock, internal fuel usage, and a small percentage marketed as LPG. Quoting, also, the World Bank (23rd November 2004), they state that Nigeria flares 75 percent of the gas it produces.

In addition, with reference to the OPEC figures for Nigeria for 2001 - 16.8 bcm/y - they assert that Nigeria comes out as the world's number one flare on both absolute and proportionate bases. Estimating the total world flaring volume in 2001 at 84.87 bcm, Cedigaz data indicates that Nigeria accounted for 19.79% of the global amount. The Nigerian amount is more than the second and third countries combined and four times higher than the nearest African country, Algeria, which is recorded as having flared and vented 4 bcm. European flaring is put at 2.54 bcm, or 0.76 % of gross production, US flaring at 2.92 bcm, or 0.43 % of gross production. According to them, a recent study carried out for the Bureau of public Enterprises of Nigeria estimate that each year the country losses between US$500 million and US$2.5 billion to gas flaring.

Iwayemi and Adenikinju (2001), applied the computable general equilibrium (CGE) model framework to evaluate Energy-Environment –Economy linkage in Nigeria. They observe that the share of petroleum products in energy consumption declined from 74.6 percent in 1970 to 46.5 percent in 1992 and further to 37.7 per cent in 1999. On the other hand, the share of natural gas increased from about 5 per cent to 29.3 per cent in 1992 and to 53.2 per cent gas flaring between 1965 and 1987 amounted to 3.15 $x10^{11}m^3$.

A cost-benefit analysis of gas production in Nigeria carried out by Okoh (2001) reveals that during the project horizon of 38 year (1961 to 1998), Nigeria lost a total of 234.02 billion tones of gas valued at N936.09 trillion (at N4000/tonne;1997 government price) to gas flaring. She employed the NPV technique specified as follows:

$$NPV= \sum^{K}_{t-n} (B_t-C_t) \ (I+r)^t$$

Where

B_t= revenue derived from gas usage plus fines on gas flaring in year t

C_t = sum of the value of gas flared, agricultural output lost to thermal pollution and cost of labour, land and fixed capital in year t.

t= time period, t=38, 37, …, 1

n= total number of years of gas production

k= period in years since gas production began.

r= rate of interest

NPV=net present value.

According to her findings, the NPV for gas production in Nigeria over a 38-year project horizon (1961-1998) at the interest rate of 7 per cent was -₦759.30 trillion in constant 1998 naira. The negative sign indicates that gas production in Nigeria at this current state is not economically or socially worthwhile. That is, it is not profitable to the society.

Ajie (2004) also carried out a study on the impact of natural resources on economic development of Nigeria. Her general objective was to examine the impact of solid mineral resources on the gross domestic production in Nigeria. Thus, she used the following model specification.

$SDP = a_0 + a_1 CASS + a_2 CL + a_3 CMB + a_4 LST + a_5 GD + a_6 MB + U_i$

Where:

CASS= Castrate,

CL =coal,

CMB= columbite,

LST=Limestone,

GD=Goal,

MB= Marble.

Deekor (2002), equally did a research on the impact of gas flaring. But he was rather interested in the impact of gas flaring on the wetland soils of the Nigeria Delta.

On the other hand, Egbuna (1987) studied the environmental hazards of the natural gas industry. He observed that in 1986, the total gas flared from over 300 fields in Nigeria yielded a wasted heat equivalent of about 60×10^9 kwh, which is approximately equal to all the total Electric Power PLC (NEPA) that year from all sources. Quoting Osakwe (1985), he states that the economic loss estimates puts the price of flared natural gas at about fifty million naira (or over 30 million dollars, indexed at 1985), per day.

2.3 LIMITATIONS OF PREVIOUS STUDIES

One of the simplest ways of economizing efforts in any research is to review and build upon the related work already done by others. (Oduah,1999). From the reviewed literature, it was observed that most researchers were rather interested in the environmental impact of gas flaring. (Barnes et al, 2005; Climate Justice, 2005; Friends of the Earth, 2004; Pelagagge, et al, 1996, Deekor, 2002; Egbuna, 1987). Stiglitz, 2004 and NCEMA, 1999). Okoh (2004), however, deviated from such interest. Thus, she instead, carried out a cost-benefit analysis using NPV approach. Other researchers who actually worked on the economic impact of gas production and its flaring, rather, used the current price of gas for a particular year to calculate the values of these impacts for such year. On the other hand, the monetization of gas production in Nigeria with special attention on the different gas-based projects was the focus of some others researchers. While, Iwayemi and Adenikinju (2001), studied the energy–environment–economy linkage in Nigeria. They did this by employing the method of computable general equilibrium (CGE) model.

However, it was observed that little or nothing has been done on the economic evaluation of gas flaring in Nigeria using an econometrics approach. Therefore, this work will employ an econometrics analysis in evaluating the impact of gas flaring in Nigerian economy. Hence, it promises a robust estimate of the economic impact of flared gas in Nigeria.

CHAPTER THREE

METHODOLOGY

As earlier indicated, this work has adopted an econometric approach. Given the nature of the objectives of this study, three different models will be used. In the first model, real Gross Domestic Product (GDP) is regressed against gas utilization. While in the second model, flared gas will be regressed against fine on flared gas in Nigeria. The third objective will be evaluated using a conditional model.

3.1 MODEL SPECIFICATION

A. MODEL I

This model which shall be used in investigating the first objective has its mathematical function as specified below.

$$RGDP = f(Gu)\ldots\ldots\ldots\ldots\ldots 1$$

Where:

RGDP = Real Gross Domestic Product

Gu = Gas utilization

To eliminate specification error, two impulse macroeconomic variables have been included in the model. These variables are Crude oil production (Co) and Electricity consumption (Ec). Thus, equation (1) translates to:

$$RGDP = f(Gu, Co, Ec,)\ldots\ldots\ldots\ldots\ldots 2$$

However, following Occam's razor, the regression model will be kept as simple as possible. This will ensure the application of a parsimonious model. (Gujarati, 1995).

Assuming a linear relationship between our endogenous variable and the explanatory variables, the mathematical equation of the above function becomes:

$$RGDP_t = \beta_o + \beta_1 Gu_t + \beta_2 Co_t + \beta_3 Ec_t \ldots\ldots. 3$$

To ensure numerical accuracy, equation (3) was rescaled to obtain a log model which was transformed into an econometric model as shown below:

$$\ln RGDP_t = \beta_o + \beta_1 \ln Gu_t + \beta_2 \ln Co_t +$$
$$\beta_3 \ln Ec_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. 4$$

where U_i = stochastic term.

Equation (4) is the general model specification for objective (i). This static model assumes that all the variables are well behaved. That is, each of the variables is stationary at order zero. Else, equation (4) translates to:

$$D^{ko} \ln RGDP_t = \beta_o + \beta_1 D^{k1} \ln Gu_t + \beta_2 D^{k2} \ln Co_t +$$
$$\beta_3 D^{k3} \ln Ec_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. 5$$

Where:

D = Difference

K_0, k_1..., k_4 = order of integration as indicated.

Equation (5) assumes that:

$K_0 \neq k_1, k_2, k_3, k_4$

Else, if k_0 is equal to any of $k_1, k_2, \ldots k_4$, then a test for co-integration will be carried out between the endogenous variable and as such explanatory variable(s). If the test (unit root test) shows evidence of co-integration, then, equation (5) translates to an Error correction model (ECM) as show below:

$$D^{ko}\ln RGDP_t = \beta_o + \beta_1 D^{k1}\ln Gu_t + \beta_2 D^{k2}\ln Co_t + \beta_3 D^{k3}\ln Ec_t + \beta ECM_{t-1} + \mu_t \ldots\ldots\ldots 6$$

Where:

ECM_{t-1} =Error correction Mechanism of the previous year.

To actually ensure that our model is parsimonious, equation (6) translates to an Autoregressive Distributed Lag (ARDL) model as stated below:

$$D^{ko}\ln RGDP_t = \beta_o + \beta_1 D^{k0}\ln RGDP_{t-1} + \beta_i \sum_{i=1}^{4} Z_{t-j} + \beta_7 ECM_{t-1} + \mu_t \ldots\ldots\ldots 7$$

Where: Z_{t-j} = summation of all the other explanatory variables as contained in equation (6) apart from ECM.

To avoid unnecessary lost of degree of freedom ARDL (2,3) shall be used. Also, to avoid specification error in our ARDL, model stimulation will be applied. This will ensure the marginalization of the entire irrelevant variables in the model. However, caution will be taken as not to totally marginalize of the core variable of this research as contained in the function depicted as equation (1). Else, the aim of this study will be defected. If, however, our autoregressive variable becomes marginalized in the cause of our model stimulation, than, equation (7) translates to only Distributed Lag (DL) model as show below:

$$D^{ko}\ln RGDP_t = \beta_i \sum_{i=1}^{4} Z_{t-j} + \beta_7 ECM_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots 7$$

B. MODEL II

This model which shall be used in investigating the second objective has its hypothesis and mathematical function as stated below.

H_0: The imposition of fine on flared gas has no significant effect on the level of flares.

$$Gf = f(GfF) \ldots\ldots\ldots\ldots\ldots 9$$

Where: Gf = Flared gas

$$GfF_i = \begin{cases} 1 \text{ for post fine era} \\ 0 \text{ otherwise} \end{cases}$$

Recall: From the reviewed literature, it was observed that fine on flared gas was introduced in 1984 in pursuant to section 3 of the Associated Gas Rejection Act, 1979. (Climate Justice, 2005).

Volume of gas produced (Gp) is included in the function since quantity of flared gas is also a function of the level of production. Thus, equation (9) becomes:

$$Gf = f(GfF, Gp)............10$$

The econometric equation is as specified below:

$$\ln Gf_t = \beta_o + \beta_1 GfF_t + \beta_2 \ln Gp_t + \mu_t....11$$

Note: GfF was not logged because as a dummy variable, it contains zeros which cannot be logged.

Equation (11) is the general model specification for objective (ii). This static model assumes that all the variables are well behaved. That is, each of the variables is stationary at order zero. Else, equation (11) translates to:

$$D^{ko} \ln Gf_t = \beta_o + \beta_1 D^{k1} \ln GfF_t + \beta_2 D^{k2} \ln Gp_t + \mu_t......12$$

Where:

D = Difference

K_0, k_1, k_2 = order of integration as indicated.

Equation (12) assumes that:

$K_0 \neq k_1, k_2$

Else, if k_0 is equal to both k_1 and k_2, or any of the two (and $k_1 = k_2$) then a test for co-integration will be carried out. If the test (unit root test) shows evidence of co-integration, then, equation (12) translates to an Error correction model (ECM) as show below:

$$D^{ko} \ln Gf_t = \beta_o + \beta_1 D^{k1} \ln GfF_t + \beta_2 D^{k2} \ln Gp_t + \beta ECM_{t-1} + \mu_t \ldots\ldots\ldots 13$$

Where:

ECM_{t-1} =Error correction Mechanism of the previous year.

C. MODEL III

This model which shall be used in investigating the third objective has the following hypothesis:

H_o: Gas utilization in Nigerian economy is not sustainable.

This analysis shall be carried out using the test for co-integration between Real GPD and Gas Utilization in Nigeria. As already indicated above, to enhance numerical accuracy, these variables shall be used in their logged form – that is, $D^{ko}\ln RGDP_t$ and $D^{k6}\ln Gu_t$.

Where D^{ko} and D^{k6} are the order of integration of $RGDP_t$ and $\ln Gu_t$ respectively.

3.2 METHOD FOR TESTING THE HYPOTHESES

i. HYPOTHESIS 1:

H_0: Gas flaring in Nigeria has no impact on the national income

Using equation (5), β_1 will be tested at 5 percent level of significance. If it is found to be significant at that level, we conclude that gas flaring has impact on the economic performance. Else, we conclude otherwise.

ii. HYPOTHESIS 2:

H_0: The imposition of fine on flared gas has no significant effect on the level of flares.

Also, using equation (12), β_2 will be tested at 5 percent level of significance. If it is found to be significant at that level, we conclude that the imposition of fine on flared gas has impact on the level of flared gas in Nigeria. Else, we conclude otherwise.

iii. HYPOTHESIS 3:

H_0: Gas utilization in Nigerian economy is not sustainable.

As stated above, we shall test if ko = k6. If they are found to be equal, then, we suspect the existence of co-integration between economic performance and gas utilization in Nigeria. Thus, to confirm if co-integration actually exists or not, we shall carry out unit root test on $D^{ko}lnRGDP_t$ and $D^{k6}lnGu_t$. If evidence of co-integration is established between the two variables, then, we conclude that there is a long run relationship between economic performance and gas utilization in Nigeria. In other words, we conclude that gas utilization in Nigeria is sustainable. Else, we conclude otherwise. (Gujarati, 1995: 728).

3.3 JUSTIFICATION OF THE MODEL

The analytical framework of the model specification is such that it incorporates the major features of an econometric analysis in a systematic manner. For instance, in the model, provisions were made to ensure numerical accuracy and the stationarity of all the data. Also, provision was made for the elimination of co-integration by the application of Error correction Mechanism (ECM) - that is if co-integration exists in the model – expect in the evaluation of the third hypothesis where it is needed to establish sustainability. In addition, to ensure adherence to the principle of parsimony, dynamism as well as model stimulation was provided for. Thus, the model promises robust estimates

3.4 ANALYTICAL TECHNIQUES

The model will be estimated using the ordinary least squares (OLS) method. An annual data shall be used for all the variables over the period: 1970 to 2005. The estimation shall be carried out using the PcGive Econometric software after the necessary data have been imported into it from Microsoft Excel.

3.5 DATA REQUIRED AND SOURCES

Virtually all data to be used will be drawn from Central Bank of Nigeria (CBN) Statistical Bulletin. The other dummy variables will be generated by the researcher given the theory underlying.

CHAPTER FOUR

PRESENTATION AND EVALUATION OF RESULTS

As indicated in the previous chapter, the results of these analyses were obtained using a computer software package called Pcgive 8. The data used and the comprehensive results are presented in appendix A and appendix B respectively. The results as well as the evaluation of the analyses are presented below under three different sub-sections (model 1, 2, and 3) with each capturing a particular objective of this study.

4.1 MODEL I

This model evaluates the following hypothesis:

Ho: Gas utilization has on impact on the national income.

4.1.1 Stationarity Test (Model I)

To ensure that our model is not affected by seasonal variation, stationarity test was conducted on the variables using unit root tests at 1% level of significance (α) – using lag 1. Thus, the variables in this model were found to be stationary at the order of integration indicated in table 4.1 below:

Table 4.1: Stationarity Test (Model I)

Variable	Order of Integration
LRGDP	2
LGu	2
LCo	1
LEc	1

(See section B in appendix B)

The above table 4.1 shows that the dependent variable (LRGDP) is integrated to the same order with LGu. Therefore, a co-integration test was carried which established the evidence of co-integration between the two variables. Thus, error correction mechanism (ECM) was applied in the model to correct such co-integration problem. (See section C and D in appendix B).

4.1.2 Regression Result (Model I)

The result of this model is presented in table 4.2 below:

Table 4.2 Modelling DDLRGDP by OLS

Variable	Coefficient	Std.Error	t-value
Constant	-0.0034571	0.052327	-0.066
DDLRGDP_2	-0.35123	0.14024	-2.504
DDLGU	0.30414	0.15116	2.012
DDLGU_3	0.61700	0.20569	2.997
DLCo_3	-1.1583	0.41579	-2.786
DLEc	1.2864	0.35896	3.584
DLEc_1	-0.78938	0.34997	-2.256
ECM2_1	-0.033079	0.20128	-0.164

(See eq(2), section G in appendix B)

R^2 = 0.636603

F(7, 23) = 5.7559

F-probability = 0.006

DW = 2.09

4.1.3 Evaluation of Result (Model I)

A. The Co-efficient of Multiple Determination (R^2)

The result shows that the co-efficient of multiple determination (R^2) of the model is:

$R^2 = 0.636603$

This implies that approximately 64 per cent of the variation in the dependent variable (LRGDP) is explained by the independent variables in the model. This can be seen in graph 1 in appendix B where the fitted trend is shown to be running very close to the trend of DDLRGDP. Thus, we conclude that the regression line in this model achieved high goodness of fit vis-à-vis the dependent variable (DDLRGDP).

B. F-Statistic Test

F-statistic test is applied to ascertain the overall significance of the model. That is, to determine if the estimates of the parameters are simultaneously significant or not. Thus, the null hypothesis is as stated below:

Ho: $\beta_1 = \beta_2 = \ldots = \beta_{12}$

Where $\alpha = 0.05$

$F_{cal} = F(7, 23) = 5.7559$

$F_{tab} = 2.44$

F-probability = 0.006

Decision Rule: Reject Ho if $F_{cal} > F_{tab}$; accept if otherwise. Alternatively, reject Ho if F-probability is less than α; accept if otherwise. (Gujarat, 1995).

Conclusion: Since the F_{cal} (5.7559) > F_{tab} (2.44), we reject our Ho and conclude that the estimates of the parameters are simultaneously significant. This is further confirmed by the F-probability (0.006) which is less than the level of significant (α = 0.05).

C. Autocorrelation Test

One of the major assumptions of Least Squares is that no autocorrelation between the disturbances. Thus, the null hypothesis states that there is evidence of autocorrelation. That is:

Ho: $Cov(\mu_i, \mu_j / x_i, x_j) \neq 0$

Where x_i, and x_j are any two independent variables.

The presence or absence of autocorrelation can be detected by the use of the Durbin-Waston (Dw) statistic. According to Gujarat (1995), given

N = number of observations, and

K^1 = number of explanatory variable.

If Dw < d_l: there is evidence of positive first-order serial correlation.

If Dw > d_u: there is no evidence of positive first-order serial correlation.

But if d_l < Dw < d_u: there is inconclusive evidence regarding the presence or absence of positive first-order.

Where: d_l and d_u are lower and upper limits of Durbin-watson.

From the model (I)

Dw = 2.09

N = 36

K^1 = 7

Thus,

d_l = 1.053

d_u = 1.957

Conclusion: Since the Dw (2.09) of the model above d_u (1.957), we infer that there is no evidence of positive first-order serial correlation. This evidence of no evidence of positive autocorrelation between the disturbances was obtain by ensuring that seasonal variation was eliminated from each of our variables by using them at their different levels of stationarity. In addition, after the evidence of co-integration was established, error correction mechanism (ECM) was applied to correct that co-integration problem. Hence, the achievement of no autocorrelation between the disturbances.

D. Multicollinearity Test

Using the pair-wise correlation co-efficient between two regressors, we conclude that correlation is serious if the co-efficient is in excess of 0.8. Else, we conclude otherwise. These results can be seen in section F in appendix B. From the results, it is observed that no pair-wise correlation occurred between any two regressors in the model – excluding the major diagonal. This implies that each parameter estimate shows an independent and unbiased impact on the dependent variable.

E. t – Statistic Test (Evaluation of hypothesis I)

This test is employed to ascertain the significance of each of the independent variables. Thus, the null hypothesis is as stated below:

H o: $\beta_i = 0$

Where i = 1,2,…7

Let $\alpha = 0.025$

Decision Rule: Reject Ho if $/t_{cal}/ > /t_{tab}/$; accept if otherwise.

From the statistical table,

$t_{cal} = t_{36}^{(0.025)} = 1.960$

The summary of this test is shown in table 4.3 below:

Table 4.3: t – statistic test (Model I)

Variable	t_{cal}	T_{tab}	Conclusion
$DDLRGDP_{-1}$	-2.504	1.960	S
DDLGu	2.012	1.960	S
$DDLGu_{-3}$	2.997	1.960	S
$DLCo_{-3}$	-2.786	1.960	S
DLEc	3.584	1.960	S
$DLEc_{-1}$	-2.256	1.960	S
$DLEc_{-3}$	-0.164	1.960	NS

(See Eq(2), section G in appendix B)

Where: S = Significance

NS = Not Significance

Table 4.3 above shows that the two variables used in capturing gas utilization (ie, DDLGU and $DDLGu_{-3}$) are statistically significant in the model. In other words, gas utilization at current year and lag 3 have significant impact on the Nigerian economy. Therefore, we reject the null hypothesis (I) and conclude that gas utilization has significant impact on the national income.

4.2 MODEL II

This model evaluates the following hypothesis:

H_o: The imposition of fine on flared gas has no significant effect on the level of flares.

4.2.1 Stationarity Test (Model II)

As noted in section 4.1.1 above, to ensure that our model is not affected by seasonal variation, stationarity test was conducted on the variables using unit root tests at 1% level of significance. Thus, the variables in this model were found to be stationary at the order of integration indicated in table 4.4 below:

Table 4.4: Stationarity Test (Model II)

Variable	Order of Integration
LGu	1
GfF	1
LGp	1

(See section B in appendix B)

Since the dependent variable LGf and the two independent variables (GfF and LGp) are integrated to the same order, a co-integration test was conducted between the dependent variable and the two independent variables. From the result of the test, it was observed that the joint effect of the two independent variables on the dependent variable (LGf) did not establish any evidence of co-integration. (See section H under model II in appendix B). Thus, ECM is not required in this model.

4.2.2 Regression Result (Model II)

The result of this model is presented in table 4.5 below:

Table 4.5: Modelling DLGf by OLS

Variable	Co-efficient	Std. Error	t-va[illegible]e
Constant	**-0.029545**	**0.011376**	-2.5[illegible]
DGfF	**0.029638**	**0.063684**	0.46[illegible]
DLGp	1.0359	0.64934	15.9[illegible]

(See Eq(4), section J in appendix B)

R^2= 0.888464

F(2,32) = 127.45

F-probability = 0.0000

Dw = 2.40

4.2.3 Evaluation of Result (Model II)

A. The co-efficient of multiple determination (R^2):

The result shows that the co-efficient of multiple determination (R^2) of the mo[illegible]

R^2 = 0.888464

This implies that approximately 89% of the variation in the dependent va[illegible] (DLGf) is explained by the independent variables in the model. This can be se[illegible] graph 8 in appendix B where the fitted trend is shown to be running almost on[illegible] same trend with the dependent variable (DLGf). Thus, we conclude that the regress[illegible] line in this model achieved high goodness of fit vis-à-vis the dependent variab[illegible] (DLGf).

B. F – Statistic Test

F – Statistic test is applied to ascertain the overall significance of the model. That is, to determine if the estimate of the parameters are simultaneously significant or not. Thus, the null hypothesis is as stated below:

Ho: $\beta_1 = \beta_2 = 0$

With $\alpha = 0.05$

$F_{cal} = F(2,32) = 127.45$

F-probability = 0.0000

$F_{tab} = 3.32$

Decision Rule: Reject Ho if $F_{cal} > F_{tab}$; accept if otherwise. Alternatively, reject Ho if F-probability is less than α; accept if otherwise. (Gujarat, 1995).

Conclusion: Since the F_{cal} (127.45) > F_{tab} (3.32), we reject our Ho and conclude that the estimates of the parameters are simultaneously significant. This is further confirmed by the F-probability (0.0000) which is less than the level of significant (α = 0.05).

C. Autocorrelation Test

The null hypothesis states that there is evidence of autocorrelation. That is:

Ho: $Cov(\mu_i, \mu_j / x_i, x_j) \neq 0$

Where x_i, and x_j are any two independent variables.

The presence or absence of autocorrelation can be detected by the use of the Durbin-Waston (Dw) statistic. As stated above in 4.1.2 (C), given:

N = number of observations, and

K^1 = number of explanatory variable excluding the constant term.

If Dw < d_l: there is evidence of positive first-order serial correlation.

If Dw > d_u: there is no evidence of positive first-order serial correlation.

But if d_l < Dw < d_u: there is inconclusive evidence regarding the presence or absence of positive first-order.

Where: d_l and d_u are lower and upper limits of Durbin-Watson.

From the model (II)

Dw = 2.40

N = 36

$K^1 = 2$

Thus,

$d_l = 1.354$

$d_u = 1.587$

Conclusion: Since the Dw (2.40) of the model lies above d_u (1.587), we infer that there is no evidence of positive first-order serial correlation. This implied that the dependent variable has not affected the estimates of the independent variables.

D. Multicollinearity Test

Using the pair-wise correlation co-efficient between two regressors, we conclude that correlation is serious if the co-efficient is in excess of 0.8. Else, we conclude otherwise. These results can be seen in section I in appendix B. From the results, it is observed that no pair-wise correlation occurred between the two regressors (DGfF and

DLGp) in the model – excluding the major diagonal. This implies that each parameter estimate shows an independent and unbiased impact on the dependent variable.

E. t – Statistic Test (Evaluation of hypothesis II)

This test is employed to ascertain the significance of each of the independent variables. Thus, the null hypothesis is as stated below:

H o: $\beta_i = 0$

Where i = 1,2

Let $\alpha = 0.025$

Decision Rule: Reject Ho if $/t_{cal}/ > /t_{tab}/$; accept if otherwise.

From the statistical table,

$t_{cal} = t_{36}^{(0.025)} = 2.02$

The summary of this test is shown in table 4.6 below:

Table 4.6: t – statistic test (Model II)

Variable	t_{cal}	t_{tab}	Conclusion
DGfF	0.465	2.02	NS
DLGp	15.953	2.02	S

(See Eq(4), section J in appendix B)

Where: S = Significance

NS = Not Significance

Table 4.6 above shows that the imposition of fine has on significant impact on the level of flared gas. Rather, the total volume of produced gas has remained the significant determinant of the level of flares. Therefore, we accept the null hypothesis

(II) and affirm that the imposition of fine on flared gas has not significantly affected the level of flares.

F. Sustainability of Fine on Flared Gas

According to Gujarat (1995), co-integration implies the existence of long-run relationship – that is, sustainability. The fact that the imposition of fine on flared gas (DGfF) and the quantity of gas flared (DLGf) have the same order of integration gives evidence to suspect the existence of co-integration between the two variables. (see table 4.4 above). Thus, co-integration test was conducted between DLGf and DGfF. The result established the evidence of co-integration between the two variables. (See section K appendix B).

Therefore, we conclude that although the imposition of fine since 1984 has not led to any structural change in the level of flares, such imposition of fine has a long-run relationship with the level of flares. That is, if the imposition of this fine is well managed, in future, it will really cause a significant structurally change in the level of flares.

4.3 MODEL III

This model evaluates the following hypothesis:

H_o: Gas utilization in Nigerian economy is not sustainable.

As stated in chapter 3 (section 3.1 (C)) with reference to the assertion of Gujarat (1995), the existence of co-integration implies sustainability. Thus, co-integration test is applied in the evaluation of this hypothesis.

Of course, the existence of the same order of integration is a necessary but not sufficient evidence of co-integration. From table 1 above, it is observed that both LRGDP and LGu have the same order of integration (ie, each is integrated to order 2). Thus, a co-integration test was conducted between the two variables (LRGDP and LGu) as can be seen in section C and D in appendix B. This test established the existence of co-integration between LRGDP and LGu. Therefore, we reject the null hypothesis and conclude that gas utilization is sustainable in Nigerian economy.

CHAPTER FIVE

POLICY IMPLICATION, RECOMMENDATIONS AND CONCLUSION

5.1 Policy Implication

The policy implications of the findings are discussed in turn below:

5.1.1 Gas Utilization and Nigerian Economy

The first model shows that the two variables (lag 1 and 3) used in capturing gas utilization were found to have positive impact on the economy. For instance, the result shows that a percentage increase in gas utilization in the current year will increase the national income by approximately 0.30 per cent. Likewise, a percentage increase in utilization at lag 3 will increase national income by approximately 0.62 per cent. Thus, the results confirm the hypothesis that gas utilization has positive significant impact on Nigerian economy.

5.1.2 Fine on Flared Gas and the Level of Flares

The second model reveals that since the imposition of fine on flared gas in 1984 in pursuant to section 3 of the Associated Gas Rejection Act, 1979, the level of flares has never experienced any structural change. Thus, the results confirm the hypothesis that fine on flared gas has no significant impact on the level of flares. However, a further investigation reveals that there is a long-run relationship between the imposition of fine and the level of flares. In other words, adequate and effective management of this imposed fine in combination with other policy measures will, in the future, become an effective instrument towards curbing or totally ending gas flaring in Nigeria.

5.1.3 Sustainability of gas Utilization in Nigerian Economy

The third model shows that gas utilization is sustainable in Nigerian economy. This implies that in the light of economic diversification, natural gas can be considered as one of the major sources of national income even in the long-run. Thus, any investment towards the development of gas industry in Nigeria will be worthwhile since it will continue to impact positively on the economy – even in the long-run.

5.2 Recommendations

Based on our results and their policy implications, the researcher makes the following recommendations:

1. Gas flaring should stop immediately since its continuation is not only humanly and environmentally harmful, but also constitutes a huge source of revenue loss to the people and government of Nigeria. Thus, the current trend where greater proportion of produced gas is flared must be revised. (See graphs 15, 16 and 17).
2. Approval for exploration and new oil field development must be at the conditionality of providing facilities for the utilization of associated gas.
3. Effective legal obligations must be imposed to require associated gas to be used at Bonny LNG plant and in the West African Gas Pipeline before any non-associated gas is used.
4. All ministerial certificates, if any, that have purported to allow flaring must be disclosed by the major oil companies and NNPC.

5. Ministers issuing flaring certificates, if any, must disclose how they considered the human rights of hosting communities before they issued such certificates.
6. Government should promote private investment and ownership as well as stability and cost recovery for those firms that invest in major gas facilities.
7. It should also encourage multi-buyer and multi-seller gas marketing.
8. Incentive for domestic gas usage should be established.
9. Nigerian government should adopt a pricing regime more conducive to providing companies with an incentive to find and produce gas. If gas is able to compete on price with alternative energy forms in the market, the full value and potentials of Nigerian gas reserves will be realized.
10. Government should reduce its share in natural gas contracts to promote the development of the country's natural gas fields and the domestic use of natural gas. In return, producers should sell gas to consumers at lower price.
11. The on-going improvement on international market access for gas should be pursued vigorously.
12. Government and other related agencies should provide technical assistance to develop domestic market for natural gas as well as financing mechanisms for gas utilization projects.
13. Government as well as other related agencies should disseminate information on natural gas, including international 'best practices.'
14. Effort should be made towards promoting the elimination of barriers to the import of Nigerian Liquefied Natural Gas (NLNG) in major markets, by means of pubic-private consultation process.

15. Government should investigate any possible need for subsidies for flaring reduction projects at remote fields.
16. Gas re-injection or effective capping of reservoirs found to have mush high ratio of gas to crude oil should be encouraged rather than flare the gas.
17. Ojinnaka (1996) citing Sutalaksana (1996) opine that the progress which Indonesia and Malaysia (two countries that were on the same level of economic development as Nigeria in early 1960s) have made in recent times is attributable mainly to political and economic stability brought about by credible, consistent and visionary leadership. Government should, therefore, provide investment-friendly environment as investors will naturally like to go to areas where their assets are safe and profits can be easy to repatriate.
18. Government should always endeavor to fulfill its obligations, such as cash payment and so on, in the operations of the joint venture partnership. Else, it cannot credibly enforce gas flaring laws or penalize any defaulting oil company.
19. The participation of local communities, especially those from the oil and gas producing areas, in energy policy making should be encouraged.

5.3 Conclusion

This research work has examined the implications of the availability and utilization of gas resource in Nigeria by using econometric models. The results reveal that gas utilization has significant impact on the economy and it is also sustainable. On the other hand, it reveals that since the imposition of fine on flared gas in 1984, no structural change has been observed on the level of flares.

Therefore, there is an urgent need for the government to provide environment that is conducive for investment in the gas industry as this will lead to additional income to both the people and government of Nigeria. These results also show that the imposition of fine on flared gas may not be a better policy option than the need to provide the facilities that will enhance further utilization of Nigerian natural gas.

APPENDIX A

Year	RGDP (₦ M)	Electricity consumption (MKH)	Crude oil production	Gas produced (MCM)	Gas utilized (MCM)	Gas flared (MCM)	Flared gas era
1970	5870.643	1272.8	395689	8068	111	7957	0
1971	8262.655	1586.0	558689	12996	206	12790	0
1972	9016.154	1848.9	665295	17122	274	16848	0
1973	10037.93	2038.4	719379	21882	395	21487	0
1974	12734.63	2331.1	823320	27170	394	26776	0
1975	16550.95	2791.6	660148	18656	323	18333	0
1976	37585.37	3239.3	758058	21274	657	20617	0
1977	49202.43	3816.9	766055	21815	863	20952	0
1978	49050.52	4419.1	696324	20486	1046	19440	0
1979	61918.49	4030.3	845463	27451	1378	26073	0
1980	91184.9	4703.1	760117	24551	2337	22214	0
1981	70395.9	3503.7	525291	17113	3643	13470	0
1982	74036.23	5969.9	470638	15382	3442	11940	0
1983	76577.24	6103.1	450961	15192	3244	11948	0
1984	113203.3	5478.5	507487	16251	3438	12813	1
1985	186216.5	6285.0	547088	18569	4647	13922	1
1986	207604.4	7374.7	535929	18738	4821	13917	1
1987	235583.9	7471.4	483269	17170	4976	12194	1
1988	371875.6	7476.7	529602	20250	5510	14740	1
1989	625422.9	8556.3	625908	25087	6303	18784	1
1990	1089060	7870.5	660559	28430	6020	22410	1
1991	1922777	8292.0	689850	31460	6800	24660	1
1992	2559482	8698.9	711340	32083	7508	24575	1
1993	2851967	9998.3	691400	33680	7910	25770	1
1994	3178699	9593.9	696190	33680	6770	26910	1
1995	3460967	9435.9	715400	35100	8114	26986	1
1996	3827495	9051.7	740190	35450	8860	26590	1
1997	4693626	8843.7	759710	34617	10383	24234	1
1998	5558536	8521.2	776010	37039	13407	23632	1
1999	7018112	8576.3	778900	43636	21274	22362	1
2000	8043592	8688.9	797880	42732	18477	24255	1
2001	8972274	9034.6	817150	52461	25702	26759	1
2002	25339662	12842.4	685773	48193	23357	24836	1
2003	29984583	12866.6	655060	51766	27823	23943	1
2004	32461028	12887.9	900600	58973	33882	25091	1
2005	41904951	13557.8	998030	59285	36282	23003	1

Note: *RGDP = Real Gross Domestic Product (₦M: Million Naira)*
MCM = Million Cubit Metres
MKH = Million Kilowatt Hours
GfF = Fine on Flared Gas – computed by the researcher based on when fine was introduced (Where pre fine era = 0 and post fine era = 1)

Sources: (1) NNPC (2006): Annual Statistical Bulletin (www.nnpc.com)
(2) CBN (2006): Statistical Bulletin (www.cenbank.org)

APPENDIX B

---- PcGive 8.00, copy for meuller ----
---- session started at 22:09:42 on 13th August 2007 ----

A. Data loaded from: ojide.wks

DLRGDP = diff(LRGDP, 1);
DDLRGDP = diff(DLRGDP, 1);
DLEc = diff(LEc, 1);
DDLEc = diff(DLEc, 1);
DLCo = diff(LCo, 1);
DDLCo = diff(DLCo, 1);
DDGU = diff(DGU, 1);
LGU = log(GU);
DLGU = diff(LGU, 1);
DDLGU = diff(DLGU, 1);
DLGf = diff(LGf, 1);
DDLGf = diff(DLGf, 1);
DGDP = diff(GDP, 1);
DDGDP = diff(DGDP, 1);

B. Unit root tests 6 to 36

Critical values: 5%=-1.952 1%=-2.639

	t-adf	å	lag	t-lag	t-prob
LRGDP	3.1289	0.26567	2	-0.86760	0.3930
LRGDP	3.1928	0.26453	1	0.77882	0.4424
LRGDP	5.3952	0.26279	0		
LCo	0.22924	0.12618	2	-1.7768	0.0865
LCo	0.22331	0.13079	1	0.33593	0.7393
LCo	0.24839	0.12884	0		
DGU	0.14856	2110.8	2	-2.4901	0.0190
DGU	-1.4617	2292.2	1	-3.3609	0.0022
DGU	-5.3153**	2656.6	0		
LGf	-0.12521	0.15865	2	-1.3573	0.1855
LGf	-0.22391	0.16094	1	0.22141	0.8263
LGf	-0.21878	0.15837	0		
DLRGDP	-1.4002	0.29434	2	-1.6694	0.1062
DLRGDP	-2.1022*	0.30327	1	-0.90598	0.3724
DLRGDP	-2.8475**	0.30236	0		
DDLRGDP	-4.8471**	0.29695	2	1.1978	0.2410
DDLRGDP	-6.6994**	0.29917	1	2.3110	0.0281
DDLRGDP	-7.8210**	0.32008	0		
DLCo	-5.1746**	0.12871	0		
DDGU	-3.8020**	2111.6	2	-0.022817	0.9820
DDGU	-8.5646**	2074.9	1	3.0003	0.0055
DDGU	-15.277**	2335.3	0		
LGU	2.5398	0.22141	2	-0.21331	0.8326
LGU	2.8507	0.21773	1	0.050251	0.9603
LGU	3.5385	0.21408	0		
DLGU	-1.8119	0.23688	2	-1.4478	0.1588
DLGU	-2.5996*	0.24132	1	-1.1064	0.2776
DLGU	-3.9630**	0.24222	0		
DDLGU	-6.2922**	0.23433	2	1.9923	0.0562
DDLGU	-7.1092**	0.24603	1	2.3240	0.0273
LEc	2.3679	0.14514	2	-0.19216	0.8490
LEc	2.6272	0.14271	1	-1.7779	0.0859
LEc	2.0415	0.14776	0		
DLEc	-2.3968*	0.15409	2	-1.3471	0.1888
DLEc	-3.5016**	0.15624	1	-0.97551	0.3374
DLEc	-6.3684**	0.15612	0		

	t-adf	å	lag	t-lag	t-prob
DDLGU	-9.2901**	0.26346	0		
DLGf	-4.0364**	0.15870	2	-0.015239	0.9879
DLGf	-5.0710**	0.15594	1	1.3943	0.1738
DLGf	-5.4121**	0.15837	0		
DDLGf	-3.8140**	0.19862	2	-0.52452	0.6040
DDLGf	-6.7006**	0.19613	1	2.3641	0.0250
DDLGf	-7.6361**	0.21059	0		
DInfl	-4.1606**	16.253	2	0.48941	0.6284
DInfl	-5.5344**	16.039	1	2.0120	0.0536
DInfl	-5.5547**	16.834	0		
DDInfl	-5.3045**	20.197	2	1.1586	0.2564
DDInfl	-7.3443**	20.316	1	2.8572	0.0078
DDInfl	-7.7428**	22.612	0		
GfF	0.00000	0.18257	2	0.00000	1.0000
GfF	0.00000	0.17961	1	0.00000	1.0000
GfF	0.00000	0.17678	0		
DGfF	-3.0000**	0.19245	2	0.00000	1.0000
DGfF	-3.7417**	0.18898	1	0.00000	1.0000
DGfF	-5.3852**	0.18570	0		
LGp	1.3126	0.14471	2	-1.0528	0.3014
LGp	1.0839	0.14498	1	-0.64479	0.5241
LGp	0.97188	0.14356	0		
DLGp	-4.0241**	0.14909	2	0.0060706	0.9952
DLGp	-4.8702**	0.14650	1	0.74220	0.4639
DLGp	-6.0979**	0.14540	0		

C. Co-integration test between DDLRGDP and DDLGu

EQ(1) Modelling DDLRGDP by OLS

The present sample is: 6 to 36

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE	PartRý
DDLGU	0.12233	0.20690	0.591	0.5588	0.26809	0.0115

R^2 = 0.0115183 å = 0.338812 DW = 2.73
* R^2 does NOT allow for the mean *
RSS = 3.443803476 for 1 variables and 31 observations

Residual added to database

Residual = Residual values of equation 14

D. Unit root tests 9 to 36

Critical values: 5%=-1.954 1%=-2.649

	t-adf	å	lag	t-lag	t-prob
Residual2	-4.4783**	0.29173	2	1.0688	0.2954
Residual2	-6.4023**	0.29253	1	2.1945	0.0373
Residual2	-7.6412**	0.31252	0		

Solved Static Long Run equation
DDLRGDP = +0.1223 DDLGU
(SE) (0.2069)

ECM added to database
WALD test $Chi^2(1)$ = 0.34958 [0.5544]

Analysis of lag structure

	Lag 0	1	2	3	4	5	ä
DDLRGDP	-1	0	0	0	0	0	-1
Std.Err	0	0	0	0	0	0	0
DDLGU	0.122	0	0	0	0	0	0.122
Std.Err	0.207	0	0	0	0	0	0.207

Tests on the significance of each variable

variable	F(num,denom)	Value	Probability	Unit Root t-test
DDLGU	F(1, 30) =	0.34958	[0.5588]	0.59125

MODEL I

E. Descriptive statistics

The present sample is: 6 to 36

Means

DDLRGDP	Constant	DDLRGDP_2	DDLGU	DDLGU_3	DLCo_3
0.0005616	1.000	0.002614	0.002289	-0.02303	0.006611

DLEc	DLEc_1	ECM_1
0.05679	0.05949	-0.0002372

Standard Deviations

DDLRGDP	Constant	DDLRGDP_2	DDLGU	DDLGU_3	DLCo_3
0.3408	0.0000	0.3397	0.2990	0.3070	0.1209

DLEc	DLEc_1	ECM_1
0.1467	0.1474	0.3385

F. Correlation matrix

Correlation matrix

	DDLRGDP_2	DDLGU	DDLGU_3	DLCo_3	DLEc	DLEc_1	ECM_1
DDLRGDP_2	1.000						
DDLGU	-0.01762	1.000					
DDLGU_3	-0.0006962	-0.02834	1.000				
DLCo_3	-0.09417	-0.06484	0.2510	1.000			
DLEc	0.03753	-0.2596	-0.1816	0.3318	1.000		
DLEc_1	-0.1520	0.07707	0.06175	-0.1513	-0.3250	1.000	
ECM_1	-0.3553	0.1956	-0.5317	-0.07210	-0.1603	0.3890	1.000

G. EQ(2) Modelling DDLRGDP by OLS

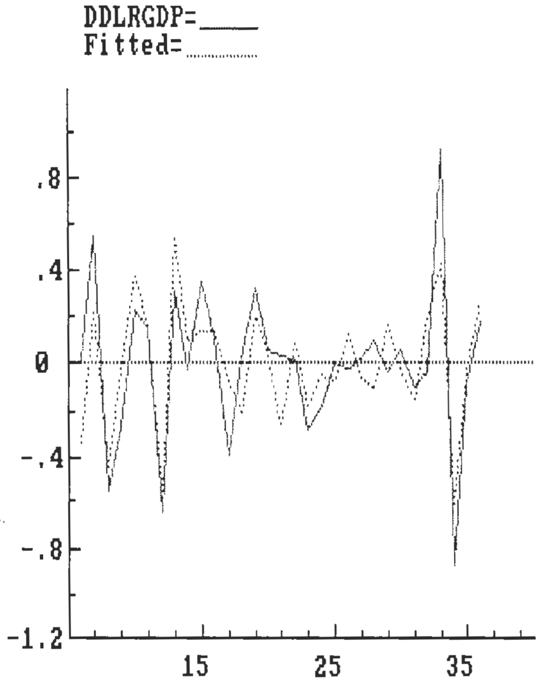
The present sample is: 6 to 36

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE	PartRý
Constant	-0.0034571	0.052327	-0.066	0.9479	0.038669	0.0002
DDLRGDP_2	-0.35123	0.14024	-2.504	0.0198	0.10596	0.2143
DDLGU	0.30414	0.15116	2.012	0.0561	0.18568	0.1497
DDLGU_3	0.61700	0.20589	2.997	0.0064	0.24702	0.2808
DLCo_3	-1.1583	0.41579	-2.786	0.0105	0.50501	0.2523
DLEc	1.2864	0.35896	3.584	0.0016	0.49217	0.3583
DLEc_1	-0.78938	0.34997	-2.256	0.0339	0.33433	0.1811
ECM_1	-0.033079	0.20128	-0.164	0.8709	0.20292	0.0012

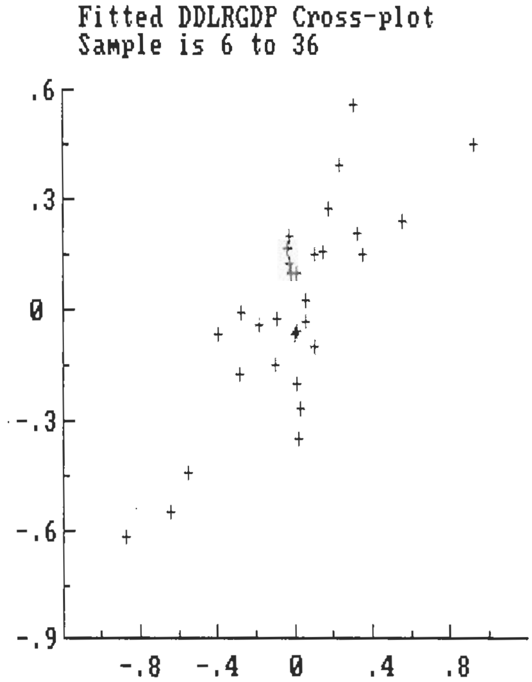
R^2 = 0.636603 F(7, 23) = 5.7559 [0.0006] å = 0.234618 DW = 2.09
RSS = 1.266048124 for 8 variables and 31 observations

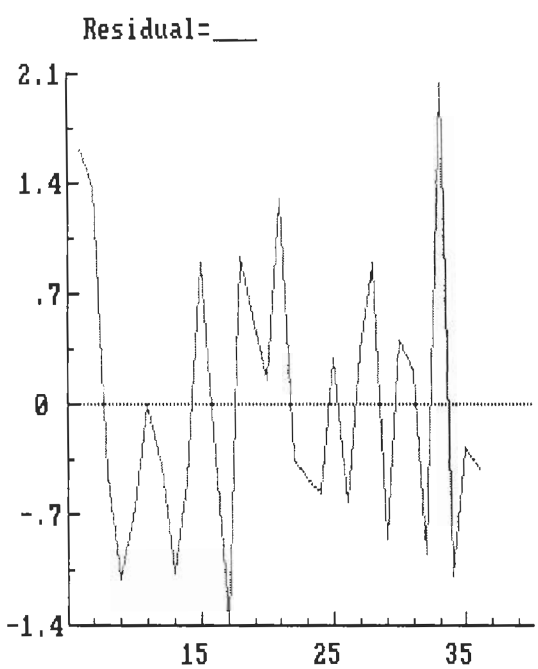
Seasonal means of differences are
0.00506
R^2 relative to difference+seasonals = 0.86428

Graph 1:

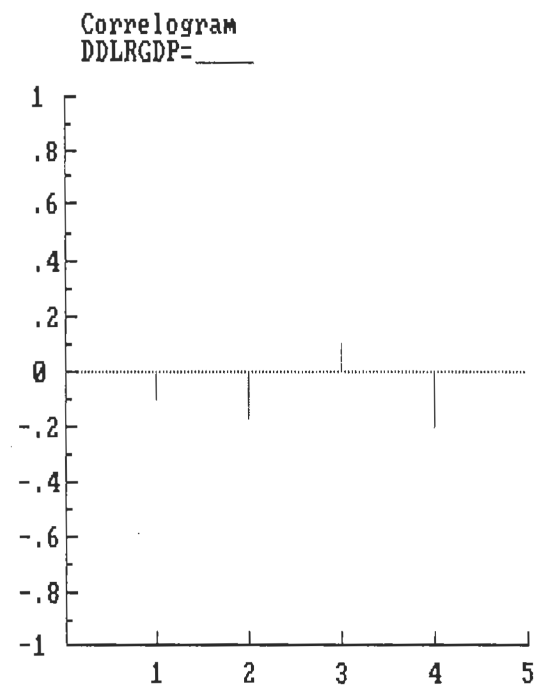


Graph 2:



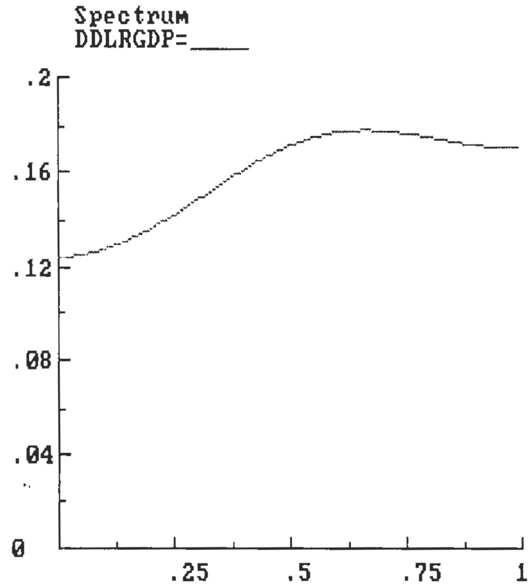


Graph 3

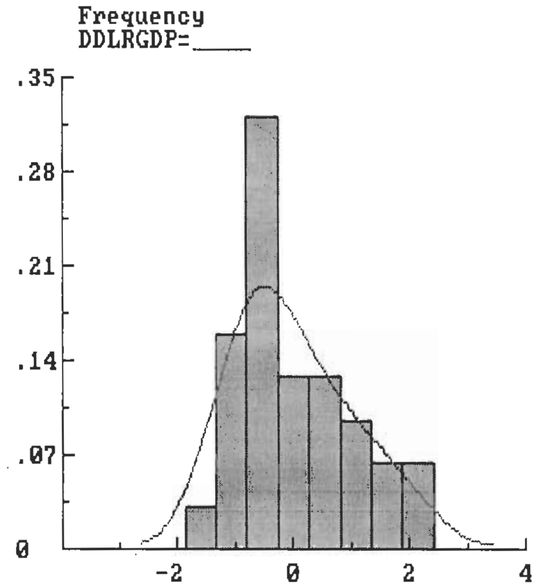


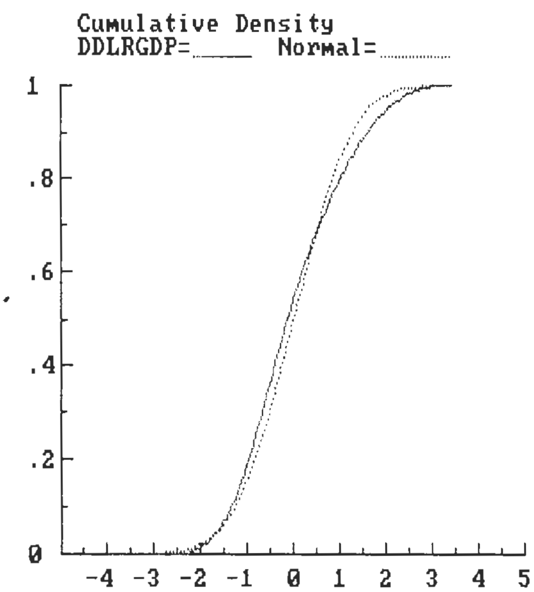
Graph 4

Graph 5:



Graph 6





Graph 7

Model II

H. Co-intregration test between DLGf and (DGfG and DLGp)

EQ(3) Modelling DLGf by OLS

The present sample is: 2 to 36

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE	PartRý
DGfF	0.0037698	0.068156	0.055	0.9562	0.0046733	0.0001
DLGp	0.98132	0.066576	14.740	0.0000	0.069352	0.8681

R^2 = 0.868694 à = 0.0680086 DW = 1.89

* Rý does NOT allow for the mean *

RSS = 0.1526304973 for 2 variables and 35 observations

Residual4 added to database

Residual4 = Residual values of equation 4

Unit root tests 5 to 36

Critical values: 5%=-1.952 1%=-2.637

	t-adf	à	lag	t-lag	t-prob
Residual4	-1.9506	0.061776	2	0.77587	0.4441
Residual4	-1.8091	0.061365	1	-3.2380	0.0029
Residual4	-5.2695**	0.070127	0		

I. Descriptive statistics

The present sample is: 2 to 36

Means

DLGf	Constant	DGfF	DLGp
0.03033	1.000	0.02857	0.05698

Standard Deviations

DLGf	Constant	DGfF	DLGp
0.1823	0.0000	0.1690	0.1658

Correlation matrix

	DLGf	Constant	DGfF	DLGp
DLGf	1.000			
Constant	0.0000	1.000		
DGfF	0.03776	0.0000	1.000	
DLGp	0.9422	0.0000	0.01092	1.000

J. EQ(4) Modelling DLGf by OLS

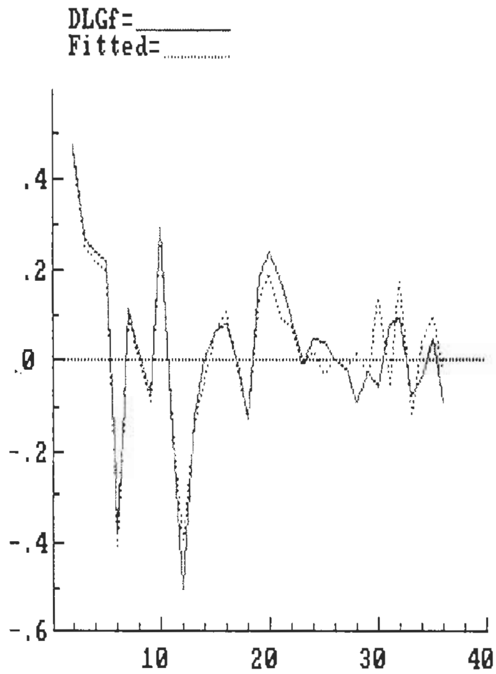
The present sample is: 2 to 36

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE	PartRý
Constant	-0.029545	0.011376	-2.597	0.0141	0.011488	0.1741
DGfF	0.029638	0.063684	0.465	0.6448	0.010934	0.0067
DLGp	1.0359	0.064934	15.953	0.0000	0.060984	0.8883

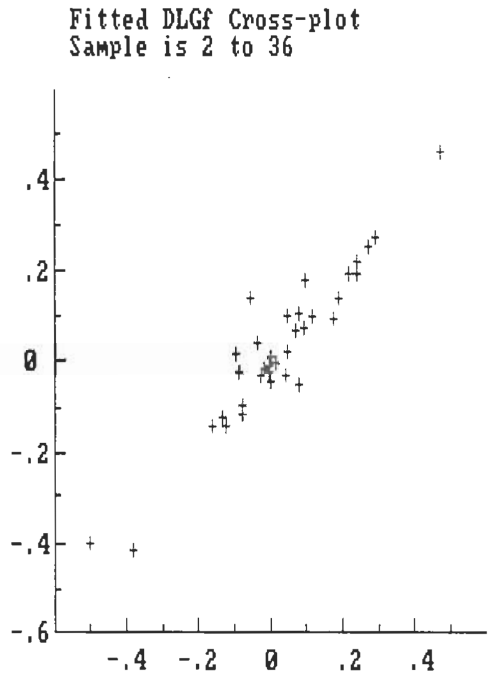
R^2 = 0.888464 F(2, 32) = 127.45 [0.0000] ä = 0.0627639 DW = 2.40
RSS = 0.1260579819 for 3 variables and 35 observations

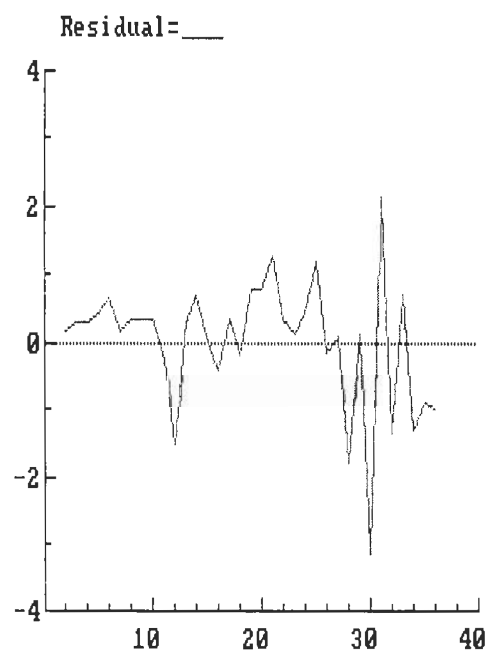
Seasonal means of differences are
-0.01651
R^2 relative to difference+seasonals = 0.91701

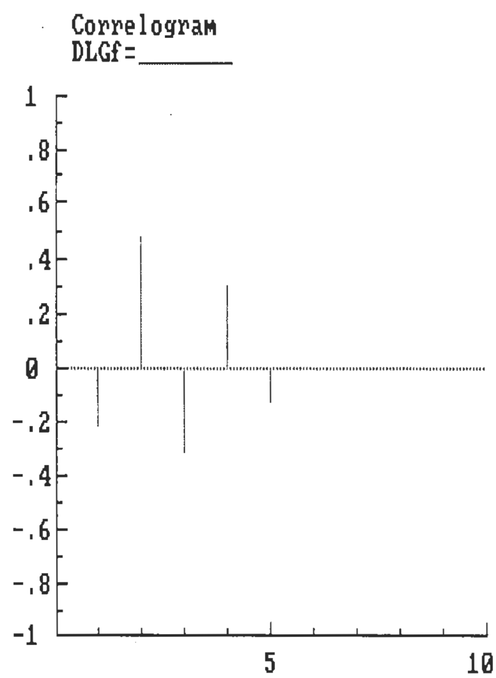
Graph 8



Graph 9



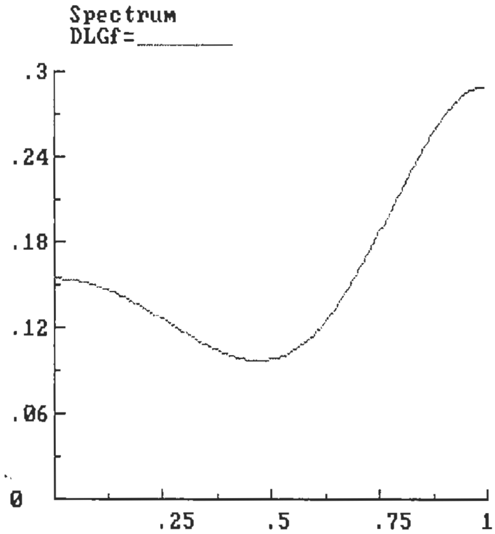




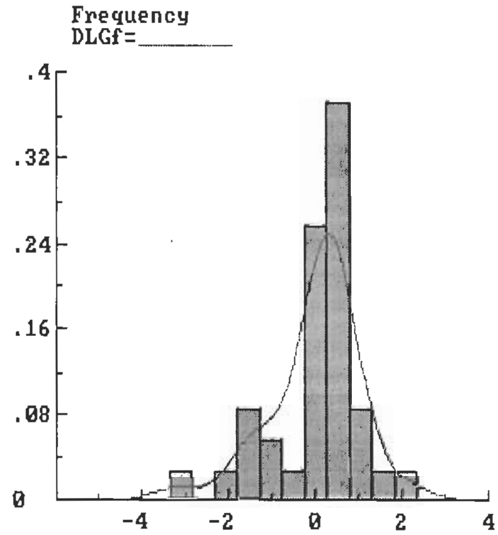
Graph 10

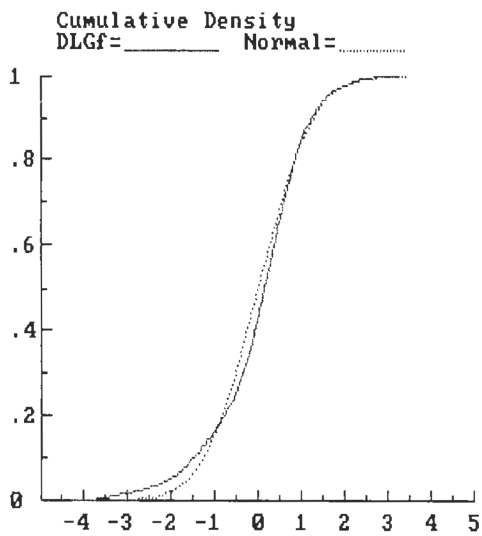
Graph 11

Graph 12



Graph 13





Graph 14

K. Co-intrgation test between DLGf and DGfF

EQ(5) Modelling DLGf by OLS
The present sample is: 2 to 36

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE	PartRý
DGfF	0.069896	0.18451	0.379	0.7072	---	0.0042

R^2 = 0.00420295 å = 0.184512 DW = 1.32
* R^2 does NOT allow for the mean *
RSS = 1.157514044 for 1 variables and 35 observations

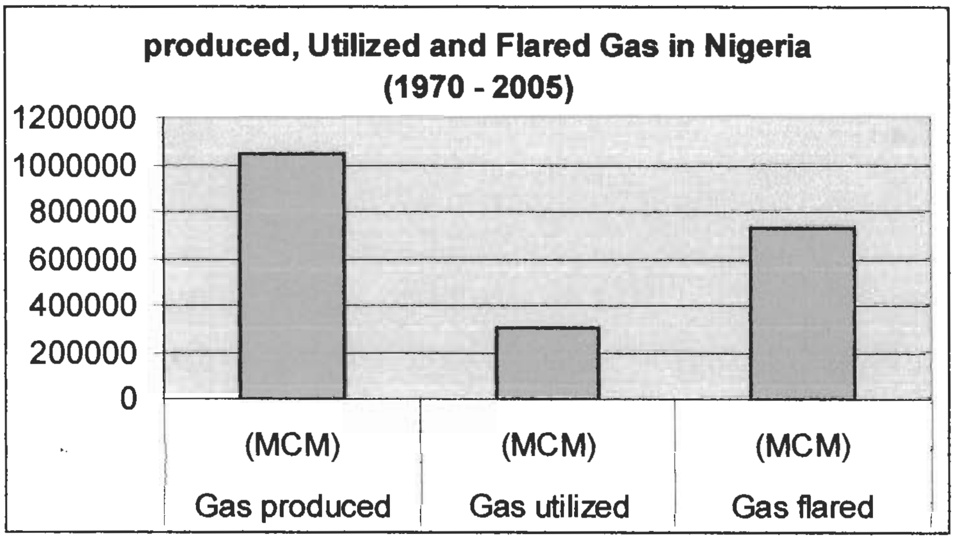
Residual3 added to database

Residual3 = Residual values of equation 3

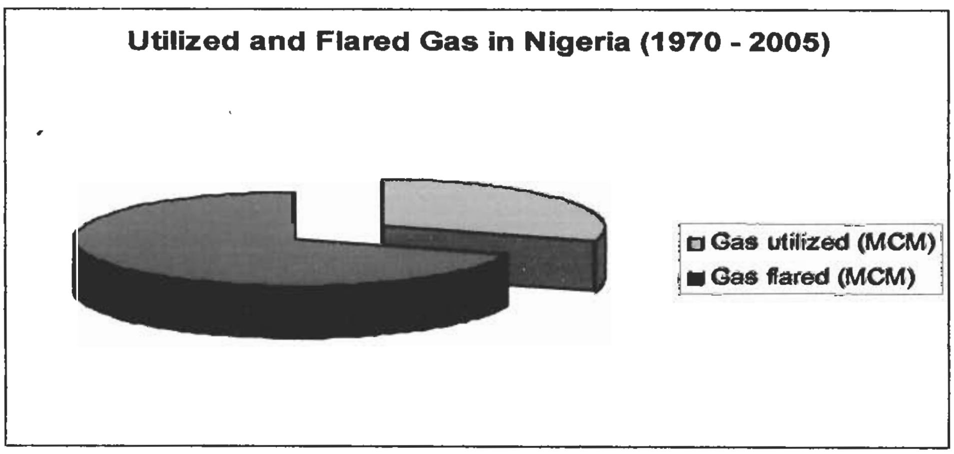
Unit root tests 5 to 36
Critical values: 5%=-1.952 1%=-2.637

	t-adf	å	lag	t-lag	t-prob
Residual3	-3.6809**	0.16042	2	-0.91463	0.3679
Residual3	-4.6599**	0.15999	1	0.92925	0.3602
Residual3	-5.2397**	0.15963	0		

Graph 16



Graph 17



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