Economic and Financial Review

Volume 43 | Number 2 Article 2

6-1-2005

Pipeline transportation of petroleum products in Nigeria: threats, challenges and prospects.

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Pipeline Transportation of Petroleum Products in Nigeria: Threats, Challenges and Prospects

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Pipeline transportation as a mode is crucial for the distribution of petroleum products in Nigeria. The mode has contributed immensely to the movement of crude oil and refined products across the country and for export. The contribution of this mode is, however, under threat from natural ruptures, vandalization, and sub-optimal usage of pipelines. The constraints of other modes in the haulage of refined products over long distances provide a great challenge and opportunity for the pipeline mode to explore. For the pipeline mode to take full advantage of these opportunities, the government must expand the pipeline network, maintain properly the existing network, increase surveillance on pipeline systems, and evolve policies that will increase private sector participation in the pipeline sub sector of the oil industry.

Keywords: Pipeline Transportation, Petroleum Products, Vandalization, Unbundling, Private Involvement
JEL Classification Numbers: Q32, Q40, R40, R41, R49, L95

I. Introduction

Prior to the discovery and commercial exploration of crude oil in Nigeria, the Nigerian economy was highly dependent on the agricultural sector in terms of revenue and foreign exchange earning needed for development. The bulk of the agricultural freight meant for exchange was transported by road, rail and water, which constituted the major transport modes for the country during the period. The advent of crude oil in the commodity basket

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of Nigeria marked the beginning of another freight transport mode, which is Pipeline transportation. In 1937, the British Colonial administration granted Shell-D'arcy the operational licence to commence oil exploration in the coastal areas of Nigeria. Shell-D'arcy,which later became Shell-BP discovered oil in commercial quantity in 1956 [Mohammed, 1989:105]

In 1958, the oil tanker 'Hemifusus' lifted crude oil from Nigeria for export, which made Nigeria not only an oil producer but also an exporter of oil. The discovery of oil and subsequent exploration in commercial quantity, therefore, signalled the arrival of pipeline transportation in Nigeria's freight history, given the role of pipelines in oil exploration, export and, domestic utilization of crude oil and distribution of petroleum products. Petroleum pipeline in Nigeria is about fifty years old, given that the first crude oil pipeline was constructed in 1955. How has this freight mode fared in the transportation of petroleum products in Nigeria? This paper, therefore, examines the roles of pipeline in petroleum product distribution, the threats, challenges and prospects. The rest of this paper is structured into seven sections focusing on the following topics: oil and the Nigerian economy; pipeline transportation in Nigeria; pipeline transportation of petroleum product; threats; challenges and opportunities; strategies for improvement and; conclusion.

I. Oil and The Nigerian Economy

The discussion on pipeline transportation of petroleum products in Nigeria will not be complete without a discussion on the importance of the goods, which it carries, to Nigeria's economic development. These goods are crude oil and refined products. The role and relevance of pipeline transportation in crude oil exploration, refining and distribution in Nigeria is intricately linked to the dominance of the oil sector over the years. This is because

pipeline is the primary transport mode in the oil and gas industry from exploration to consumption. The dominance of the oil sector can be examined under three categories. These are revenue generation, export and foreign exchange earning and oil-Gross Domestic Product (oil GDP).

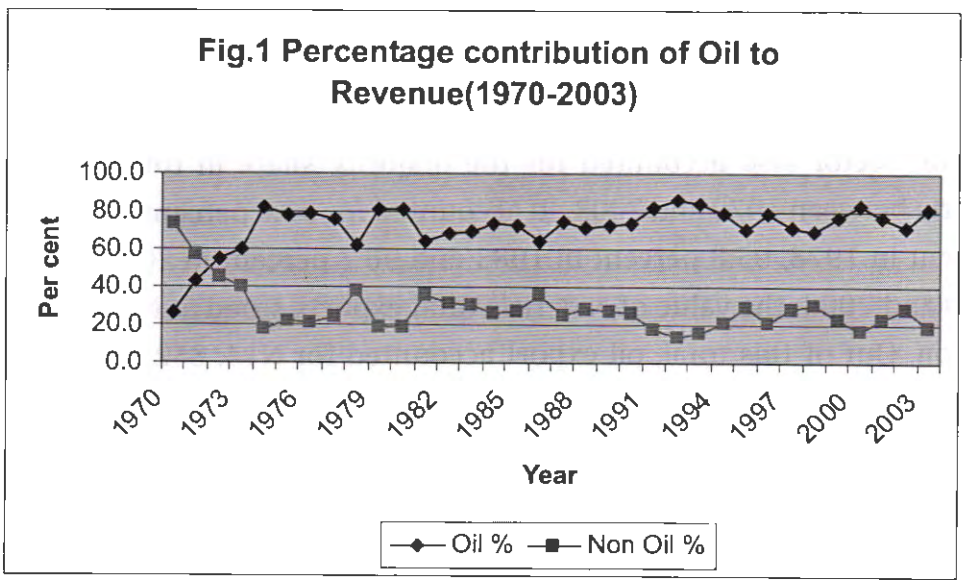
In terms of revenue accruing to the federation account, the oil sector contributed N166.6 million out of the N632.0 million collected in 1970, which represents 26.3 percent. The non- oil sector was responsible for 73.7 percent of the total federally collected revenue (TFCR) in 1970. In 1971 the percentage contribution of oil and non-oil sectors to TFCR was 43.6 and 56.4 percent, respectively. Between 1972 and 2003, the oil sector has consistently dominated the contribution to TFCR (Appendix Table 1). Between 1970 and 2003, the oil sector contributed 77.3 percent of the TFCR on the average. The trend in percentage contribution of the oil sector to TFCR between 1970 and 2003 is shown in Figure 1. It shows the overwhelming dominance of the oil sector in revenue generation.

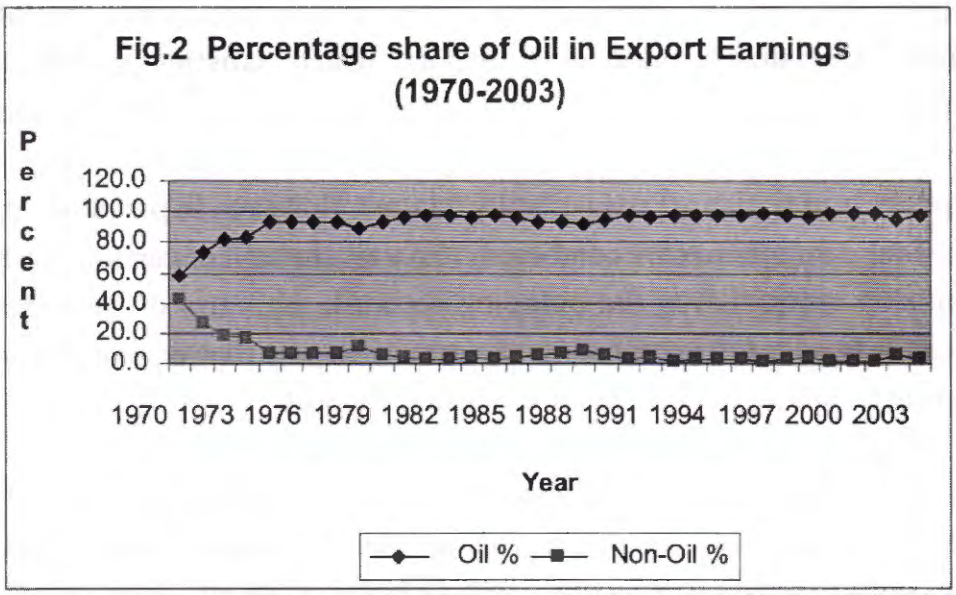
The oil sector also accounted for the majority share in total exports of Nigeria between 1970 and 2003. It accounted for 57.6 percent in 1970, 89.1 percent in 1978, 95.8 percent in 1985 and 96.7 percent in 2003. Between 1970 and 2003, the value of Nigeria's total exports stood at N15,262,093.1 million. Out of this total, oil export accounted for N14, 852,435.5 million representing 97.3 percent, while non-oil export accounted for N409, 657.6 million representing only 2.7 percent of the total for the period of analysis (Appendix Table 2). This trend in the share of oil in total exports is shown in Figure 2. The figure not only depicts a rising trend in oil contribution to Nigeria's total exports, but the dominance of oil export as Nigeria's main foreign exchange earner.

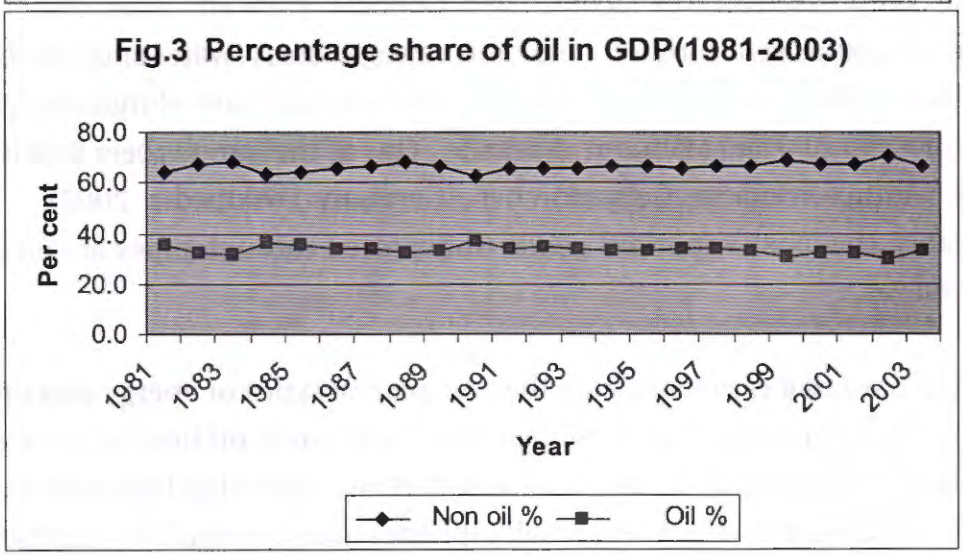
The oil sector's dominance in the Nigerian economy is also evident in its share of the Gross Domestic Product (GDP), that is oil-GDP. Between 1981

and 2003, oil GDP accounted for between 29.8 percent and 35.7 percent (Appendix Table 3). The trend in the percentage share of oil in total GDP is shown in Figure 3, which depicts a fairly stable contribution, within the range defined above. The contribution of oil to the GDP is better appreciated when its share is compared with the share of the rest sector of the economy that is non-oil GDP, which comprises agriculture, manufacturing, etc.

The above summary of the dominance of the oil sector in Nigeria in terms of contributions to GDP, export earnings and total federally collected revenue (TFCR) was made possible through various mix of technology, policy, management and above all pipelines, which form the primary mode of transportation in the oil sector.







III. Conceptual Issues

A good conceptual understanding of pipeline transportation and the freight goods it carries, particularly oil, is crucial in understanding the role of pipelines in the transportation of petroleum products.

For details of the way, the terminal, the unit of carriage and unit of propulsion in pipeline transportation, see Benson and Whitehead, 1976: 17-97.

Pipeline transport is the transportation of goods through a tube. Pipeline is a highly specialized mode of transport, which satisfies the physical components of any transport system namely the way, terminal, unit of carriage and unit of propulsion. In other modes of transport, these four components of transport are generally distinct. However, in pipelines, three of the four components are combined. The way, the unit of carriage and the propulsion units, that is the pumping stations, are parts of the pipeline system. It is only the terminus (tank farm or depot) that is separate. This situation makes pipeline a unique mode of transport.

The most common goods transported in pipes are liquid and gases. However, there exists pneumatic tubes, which transport solid capsules using compressed air (see Jacobs, 1980, Gubbins, 1996 and Zhao, 2002). In terms of liquids sent through a pipeline, sewage, slurry, water and even beer pipelines exist. Among the famous water pipelines are Morgan-Whyalla (South Anstralia) and Mannum Adeliade. One of the famous beer pipelines is in Veltins-Arena in Gelsenkirchen, Germany (Wikipedia 2005). But arguably, the most important goods transported through pipes are oil and natural gas.

Oil and natural gas pipelines are the two general types of energy pipelines. Within the oil pipeline network, there are both crude oil lines and refined products lines. Crude oil line is subdivided into gathering lines and trunk lines. Gathering lines are very small pipelines usually from 2 to 8 inches in diameter in the areas of the country in which crude oil is found deep within the earth. These small lines gather the oil from many wells, both on shore and offshore, and connect the larger trunk line measuring from 8 to 24 inches in diameter. Trunk lines are the large lines that bring crude oil from producing areas to refineries or export loading farm or terminals. Refined product pipelines or distribution pipelines vary in size from relatively small 8 to 12 inch diameter lines up to 42 inches in diameter. These pipelines

supply petroleum products to large fuel terminals with storage tanks to be loaded into tanker trucks. Natural gas pipeline on the other hand convey natural gas which is found in many of the same areas of the country as crude oil. This gas is collected through small gathering pipeline system connected to large transmission pipelines and moved to gas processing plants, where impurities are removed. Large distribution pipelines called 'mains' move the gas close to cities, while local distribution pipelines deliver directly to homes and business [Pipeline 2005].

Since this paper deals with pipeline transportation of petroleum products, it is necessary to conceptualize oil. Crude oil often referred to, as petroleum is a resource that is drilled for throughout the world. Petroleum, from Latin *petra* rock and *oleum* oil, is colloquially called *black gold.* It is a thick, dark brown or greenish liquid. It consists of a complex mixture of various hydrocarbons, largely of the alkane series, but may vary much in appearance, composition, and purity. The origin of crude oil is explained by both the Biogenic and Abiogenic theories. The first oil wells were drilled in China in the 4th Century or earlier.

Since the first commercial exploitation in Pennsylvania in 1859, the importance of oil increased significantly in the global economy. The strategic importance of the commodity is seen in its use as a source of energy as well as a raw material in the manufacturing of plastics, fertilizer, etc (Rodrigue 2005).

Oil is generally propelled through pipeline by centrifugal pumps. The pumps are sited at the originating station of the line and at 20 to 100 mile intervals along the length of the pipeline, depending on pipeline design, topography and capacity requirements. Most pumps are driven by electric motors, although diesel engines or gas turbines may also be used (Trench 2001:II). Pipelines are located in areas called a right-of-way (ROW). They are

marked above the ground by signs, to provide an indication of their presence, location, product carried and the name and contact information of the company that operates the pipeline. The signs are usually a combination of yellow, black and red colours. Some are above the surface, but in most environmentally sensitive regions, they are buried underground at a typed depth of one meter (about 3 feet).

The speed of products in the pipes varies. Pipeline transport speed is dependent upon the diameter of the pipe, the pressure under which the oil is being transported, and other factors such as the topography of the terrain and the viscosity of the oil being transported. The operator of the pipeline system can pump or ship different petroleum products or grades of the same product in sequence through the pipeline, with each product or batch distinct from the preceding or following. In this process, a batch is a quantity of one product or grade that will be transported before the injection of a second product or grade.

The United States is reputed to have the largest network of energy pipelines, both oil and natural gas in the world. The oil pipeline network of United States alone is estimated to be more than ten times larger than that in Europe (Pipeline 2005). Prominent among the world famous pipelines in this sector are; Baku-Tbilisi-Ceyham pipeline (BTC); Druzhba pipeline; Lakehead pipeline; Operation Pluto (World's first under sea oil pipeline); Trans-Afganistan pipeline (TAP); Trans-Alaska pipeline system (TAPS), etc (Wikipedia 2005).

The pipelines are cleansed through a process called pigging. In this process various instruments are used to flush the pipes in order to remove scale debris and other blockades that may impede the free flow of products.

Generally, oil pipelines provide transportation, temporary storage and

logistic services. The essence of investment in pipeline system is to operate it at the optimum to achieve maximum efficiency and profitability. Pipelines are at their optimum when used continuously at full capacity. This puts the operating costs at the minimum. It is crucial to note that the costs of operating pipeline transport rise per unit hauled as capacity utilization falls below the optimum level. This is principally due to the huge proportion of fixed costs in the total cost of operation.

In spite of the comparative edge of pipeline transport over other modes in the transportation of petroleum products, a serious damage to the pipelines leading to spillage of content could seriously undermine the benefit of the mode and its environment-friendliness. The development of advanced detection techniques has, however, helped in minimizing spillage volume and its consequences on the environment.

Pipeline Network Development in Nigeria

Prior to the Third National Development Plan (NDP) (1975-1980) in Nigeria, pipeline transport had been virtually ignored as a transport mode within the context of public ownership and control. The rapid development of the crude oil pipeline systems from producing areas to export terminals and domestic refineries, and the increased growth in domestic consumption of petroleum products led to the prospects for pipeline development in Nigeria (FRN, 1975:228). This is not to say that pipelines did not exist prior to this plan. However, in the Third Plan of 1975-1980, the pipeline system was largely that of "gathering pipelines" of private oil companies. These lines were used to connect the Eastern and Western Delta oil fields to each other and to evacuation ports. In Nigeria, the use of pipelines for the transportation of any product other than water dated only to 23rd December, 1955 when the first crude oil pipeline was constructed to connect Oloibiri Oil Field with Kugbo Bay over a distance of eleven kilometers. Thereafter,

the line was extended to Port Harcourt in 1958 with the construction of another 225 km (Onakomaiya 1983:336). As at 1964 Shell-BP had about 300km of pipelines. The three prominent pipeline systems before the 3rd NDP are the Central Swamp Pipeline System, the Trans-Niger Pipeline and the South Forcados Pipeline System (FRN, 1987). But an earlier prospect for pipeline transport was evident in the 1973 report of the Transport Planning unit of the Federal Ministry of Transport, which gave economic viability to petroleum products pipeline between Lagos and Ibadan and a crude oil pipeline from the oil fields of Southern Nigeria to Kaduna when Kaduna refinery would be built. The above, therefore, show that the genesis of pipeline transportation in Nigeria is intricately linked to the oil sector and the need to ensure effective and efficient distribution of petroleum products internally and for export.

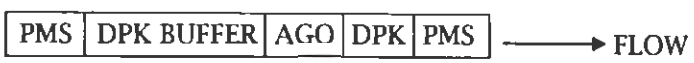
However, it is important to note that the foundation of pipeline transportation in Nigeria was laid by the Third National Development Plan (1975-1980), which recognised the need to improve the distribution of crude oil and refined products internally and for export, through expansion in the pipeline network. The plan asserts: "To obviate other difficulties, it is the intention of the Federal Government in the Third Plan period to improve the distribution network for petroleum products by constructing petroleum products pipeline..." (FRN,1975:139). Nigeria witnessed frequent widespread shortage of gasoline and kerosene in the pre-1975 era, a situation the government found difficult to explain given that Nigeria is one of the world largest producers of crude oil. These shortages brought to light the inefficiency and ineffectiveness of the distribution network, which was done mainly by the rail and the road mode. Evidences show that the road mode accounted for over 90 percent of the hauls of petroleum products between 1970 and 1976 except in 1974 when it accounted for about 73 percent (Osayimwese 1986:119). The need to cover the vast area of Nigeria, particularly long distance hauls at high speed made the distribution by rail

and road inefficient. Secondly, it was not economical to transport these products through the road mode because of high freight rate, accidents, etc. These shortcomings brought to the forefront the need for pipeline development and expansion in Nigeria.

The Third Plan accommodated the construction of pipelines across the country to alleviate this distribution deficiency. The pipeline programme includes: a crude pipeline from Warri to Kaduna; a product pipeline from Warri to Ibadan/Abeokuta area; and another product pipeline from Port-Harcourt to Enugu and Makurdi (FRN, 1975:142). The petroleum pipeline network of Nigeria is made up of gathering, trunk and distribution pipelines. A 3,001 kilometre crude oil/petroleum products pipeline was commenced, completed and commissioned during the Third Plan period (1975-1980). The pipeline network stretches from Port-Harcourt to Makurdi via Aba and Enugu, Zaria to Gusau and Kaduna to Maiduguri via Jos and Gombe (FRN, 1981:128).

At present Nigeria has about 5,001km of pipeline network managed by the Pipelines and Product Marketing Company (PPMC), a subsidiary of the Nigerian National Petroleum Corporation (NNPC) (Kalu 1999:5-6; FRN 2000:33). The size of pipelines in use in Nigeria varies depending on the purpose. They range from 6 to 24 inches in diameter and are usually buried three feet deep to avoid accidental contacts, on a Right-of-Way (ROW) of 3.5 metres. The petroleum pipeline network is made up of a number of systems namely 2A, 2B, 2C, 2D, 2E, 2CX, 2DX and 2EX (Appendix Table 4).

The above systems are used for moving crude to refineries and export terminals and products from the refineries/import receiving jetties to the 21 storage depots across the country. It is important to note that all the systems are multi-purpose pipelines except for Mosimi Satellite depots line. Products are moved in batches for ease of operation and avoidance of contamination. The sequence for product movement in the pipelines by PPMC is shown below.



Where PMS is premium motor spirit; DPK is dual purpose kerosene and; AGO is automotive gas oil.

The above pipeline networks are not used independently of other modes of transporting petroleum products. The general principle is that of "inter-modal complement" where pipelines are used for long distance hauls while rail, water and road cover short and medium distance hauls.

IV. Pipeline Transportation of Petroleum Products

The contribution of any transport system to economic development is usually assessed in terms of its contribution to the Gross National Product and its modal share of traffic (passenger and goods) internally and internationally (Arosanyin, 2001:69-72). In the case of pipeline transportation, which is heavily in favour of petroleum products, its contribution to the Gross National Product is not computed in Nigeria (Arosanyin, 2004:15). The attempt by the Federal Office of Statistic to close this data gap led to more confusion as both pipeline and railway contribution to Gross Domestic Products were lumped together (see CBN 2003: 240 244). Pipeline and railway transport modes could be seen as overland transport but they are not the same in terms of conventional transport features such as the way, the terminal, the unit of carriage and the unit of propulsion. Therefore, the estimates cannot be relied upon because they are conceptually and technically wrong. Given this data shortcoming, emphasis is, therefore, shifted to traffic. Since pipeline transport is for freight movement, its contribution to economic development is through the distribution of products within the nation and evacuation of oil for export through the seaports. The use of this proxy is hinged on the fact that petroleum production is not complete until the goods reach the final consumers. Pipeline is the primary transport mode for petroleum products from exploration to consumption (Trench 2001:I).

Distribution of Products Within The Economy

It is important to note that pipelines are crucial for oil production and transportation of crude oil to local refineries for processing into various products. This underscores the role of the mode in the oil industry. Apart from crude oil, refined products are also transported by various modes, of which, pipelines play both major and primary roles.

Inter-modal comparison of petroleum products transportation within the country is difficult because of the different roles of the various transport modes. The distribution chain of petroleum product in Nigeria is a combination of at least two modes at any given time. There is always an interchange. The pipeline systems supply the products from the refineries (locally produced products) to various depots; and from the import receiving jetties to the 21 petroleum products depots. These products are evacuated from the depots to final consumers via selling outlets through other modes particularly the road mode.

Loading of petroleum products at the depots rely on a network of pipelines. At the sales point to consumers, that is petrol stations or gas stations, service delivery is highly dependent on a network of pipes. The above shows that pipelines bridge the gap between production zone and consumption zone of petroleum products. This gap-bridging role of pipeline could be approximated by the volume of petroleum products consumed in the country in the absence of data on inter-modal freight movement at the national level. It is important to reiterate that a better analysis would have been a modal analysis of petroleum freight, but the fact

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[3] *The inter-link project was designed to link the three major refining centers, thereby expanding and integrating the existing pipeline system into a national grid of products pipelines. This was with a view to improve the pipeline network capacity, operational flexibility and reliability.*

that the freight modes are both in theory and practice complementary make strict modal analysis questionable. The exposition based on local consumption volume is, therefore, considered as a viable alternative. While accepting the complementary nature of modes, available statistics on products evacuation from the refineries shows that about 70 percent of refinery production were evacuated by pipelines before the completion of the inter-link project. The remaining 30 percent were evacuated by sea, road and rail (Kalu 1999:7). The implication of the above is that after the inter-link project, the combined percentage evacuated from the refineries through the sea, rail and road became very negligible. This further lend credence to the use of local consumption volume as a yardstick for measuring the volume of products pumped through the pipelines.

It is, therefore, proper to use petroleum products consumed in the country as a good measure of the contribution of pipeline transport to petroleum product distribution in Nigeria. The white products used in the country pumped through the pipes are Premium Motor Spirit (PMS) called petrol, Dual Purpose Kerosene (DPK) called kerosene and Automotive Gas Oil (AGO) called diesel. Between 1986 and 2002 a total of about 57.3 million metric tonnes of Premium Motor Spirit was consumed in the country. During this period about 22.8 million metric tonnes and 16.4 million metric tonnes of Dual Purpose Kerosene (DPK) and Automotive Gas Oil (AGO) were also consumed in the country, respectively. All these products were pumped through the pipeline mode at one point or the other. Given this scenario, the total product pumped through the pipeline mode during this period stood at about 96.5 million metric tonnes as shown in Table 1.

If this volume of products were to be moved by road solely from the refineries or import receiving jetties to final consumers across Nigeria, the crisis in the road transport sector would have reached a near-collapse situation, given that the rail is not functioning. Moreover, the increased

Table 1

Domestic Consumption of Petroleum Products; 1986-2002 (metric tonnes)

Year	Premium Motor Spirit (PMS)	Dual Purpose Kerosene (DPK)	Automotive Gas Oil (AGO)	Total
1986	3,597,356	1,928,190	626,271	6,151,817
1987	3,625,220	2,017,336	704,506	6,347,062
1988	3,103,079	1,554,391	867,235	5,524,705
1989	3,256,442	1,583,488	798,608	5,638,538
1990	3,302,808	1,546,848	808,725	5,658,381
1991	3,380,049	1,311,893	773,803	5,465,745
1992	3,969,276	1,612,075	750,787	6,332,138
1993	3,336,215	1,427,784	688,072	5,452,071
1994	3,015,634	1,131,057	670,846	4,817,537
1995	2,735,700	686,719	472,754	3,895,173
1996	3,454,327.5	916,206.1	715,386.8	5,085,920.4
1997	601,731.8	916,206.1	715,386.8	2,233,324.7
1998	459,234.0	204,602.0	101,147.0	764,983.0
1999	3,051,190.8	1,196,149.8	1,450,564.7	5,697,905.3
2000	4,752,897.5	1,508,064.7	1,877,467.8	8,138,430
2001	5,397,577.40	1,744,430.13	2,179,226.40	9.321,233.93
2002	6,290,652.55	1,501,458.08	2,203,804.25	9,995,914.88
TOTAL	**57,329,390.55**	**22,786,897.91**	**16,404,590.75**	**96,520,879.21**

Source: *Department of Petroleum Resources cited in CBN (2000, 2002)*

Pipelines as a Mode for Evacuating Oil to Seaports

The Nigerian economy is an oil export-driven economy. Oil for export must of necessity be transported to the seaports for onward delivery to buyers scattered across the globe. The bulk of Nigerian exports is oil as shown in section two of this paper. Pipeline as a mode has played a significant role in freighting these export goods to the seaports. Table 2 shows that in 1987 a total of 103,965 tonnes of goods were conveyed to Nigerian Seaports for export through the pipeline mode. It rose to 832,371 tonnes in 1992, 1,034,920 tonnes in 1995 and 8,637,000 tonnes by 2002.

This shows a rising trend and its growing importance. Between 1987 and 2002 a total of 42.8 million tonnes of goods were conveyed to Nigerian Seaports through the pipeline mode. The bulk of these goods were crude oil and allied products.

A comparative analysis of pipeline mode with other modes shows that the mode during the period of analysis did comparatively well as a mode for exportation of goods. Table 3 shows that in 1987, pipeline mode accounted for only 16.22 percent of the total goods evacuated to Nigerian Seaports. It rose to 29.58 percent in 1990, 73.98 percent in 1993 and 89.47 percent in 2002. The average percentage contribution of pipeline mode between 1987 and 2002 stood at 73.74 percent, which was over half of the total goods conveyed to Nigerian Seaports for exports. Other modes namely rail, road and water accounted for 0.23, 23.21 and 2.83 percent, respectively, on average during the period of analysis as shown in Table 3. It must be noted that over the years, the composition of exports changed from primary products to oil.

Table 2
Tonnage of Goods Conveyed to Nigerian Seaports by Mode of Transportation (1987-2000)

Year	Rail	Road	Water	Pipeline[1]	Total
1987	19,997	387,435	129,447	103,965	640,844
1988	40,212	599,411	61,255	406,606	1,107,484
1989	22,634	499,416	139,128	220,667	881,845
1990	-	597,319	85,685	286,857	969,861
1991	5,400	833,640	103,652	2,298,298	3,240,990
1992	10,176	295,411	38,915	832,371	1,176,873
1993	-	524,469	99,690	1,774,729	2,398,888
1994	19,099	582,032	99,552	878,654	1,579,337
1995	504	541,032	98,400	1,034,920	1,674,856
1996	16	826,121	160,623	934,501	1,921,261
1997	0	656,000	218,000	1,624,000	2,498,000
1998	7,000	593,000	218,000	1,984,000	2,802,000
1999	0	3,753,000	101,000	4,350,000	8,204,000
2000	7,000	958,000	19,000	7,779,000	8,763,000
2001	0.00	844,000	45,000	9,697,000	10,586,000
2002	0.00	993,000	24,000	8,637,000	9,654,000
Total	132,038	13,483,286	1,641,347	42,842,568	58,099,239

Note: *1/ It include pipelines, conveyor belts and suction pipes. Its official documentation as a separate mode started in 1987.*

Source: *CBN (2003:343)*

Table 3
Percentage Tonnage of Goods Conveyed to Nigerian Seaports by Mode of Transportation (1987-2000)

Year	Rail	Road	Water	Pipeline
1987	3.12	60.46	20.20	16.22
1988	3.63	54.12	5.53	36.71
1989	2.57	56.63	15.78	25.02
1990	-	61.59	8.83	29.58
1991	0.17	25.72	3.20	70.91
1992	0.86	25.10	3.31	70.73
1993	-	21.86	4.16	73.98
1994	1.21	36.85	6.30	55.63
1995	0.03	32.30	5.88	61.79
1996	(Negligible)	43.0	8.36	48.64
1997	0	26.26	8.73	65.01
1998	0.25	21.16	7.78	70.81
1999	0	45.75	1.23	53.02
2000	0.08	10.93	0.22	88.77
2001	Nil	7.97	0.43	91.60
2002	Nil	10.29	0.25	89.47
Period average	0.23	23.21	2.83	73.74

Note: The effect of rounding is acknowledged in the percentage data in this Table.

Source: Computed by the Author based on the Figures in Table 2.

The above contributions of the pipeline mode are evidences of the growing relevance of the mode to Nigeria's economic survival within the oil freight transport sub-sector. This relevance is underscored whenever there is a major failure in the pipeline system through natural ruptures or vandalization.

IV. Threats to Petroleum Pipeline Transport in Nigeria

In spite of the significant role of petroleum pipeline in local petroleum products distribution and export in Nigeria, the mode over time has been faced with a lot of problems, which threaten the maximization of its benefits.

The major threat to pipeline transportation of petroleum products in Nigeria is the issue of pipeline rupture and vandalization, which ultimately affect the safety of pipeline products; and the impact of product spillage on the environment.. These threats were aptly acknowledged in the Fourth plan (1981-1985) under the problems of the mining and quarrying sector which states;

> *"Events of the past years both at the domestic and international levels have demonstrated the extent to which mining activities, particularly in the area of petroleum production, processing and transportation could be susceptible to such dangers as accidental spillage, pollution and wilful damage to installations" (FRN 1981:130).*

Once the concept of 'safe arrival' is broken in pipeline transport due to rupture or vandalization of pipelines, the contents are spilled, which have serious consequences on the environment, utilization rate of the system, product loss leading to scarcity, increased maintenance costs, delayed turn around of vessels as loading is hampered, high cost of distributing the products through the road mode as a result of 'bridging', etc. Table 4 shows that the number of ruptures has been on the increase. It rose from 10 in 1993 to 24 in 1998 and 36 in the first half of 2000. This trend was not unconnected with the poor maintenance culture in the pipeline sector over the years.

Table 4
Pipeline Rupture/Vandalization from January 1993 to June 2000

Cases	1993	1994	1995	1996	1997	1998	1999	Jan-June 2000	Total
Rupture	10	10	9	16	11	24	27	36	143
Vandalization	7	8	7	33	34	57	497	764	1,407
Total	17	18	16	49	45	81	524	800	1,550

Source: Pipelines and Products Marketing Company cited in FRN (2000:34)

The pipeline systems in Nigeria are deteriorating and are prone to natural ruptures due to lack of proper maintenance schedule. Also worrisome is the increasing cases of wilful destruction or blowing out of pipelines with the aim of sabotaging supply or stealing of products. This is called vandalization. Table 4 shows the cases have been increasing over the years. Only seven cases were recorded in 1993, it rose to 33 in 1996, 497 in 1999 and 764 in the first half of 2000. Between 1993 and the first half of 2000, 1550 cases of ruptures and vandalizations were recorded. The rising cases of pipeline vandalization pose a national security problem given the length of the network itself and the adverse consequences of vandalization on the economy. The areas mostly prone to vandalization are;

(1) Port-Harcourt Enugu via Aba line and Okrika Jetty line
(2) Enugu Auchi line
(3) Escravos Warri line
(4) Warri Benin line and Warri Jetty line
(5) Atlas Cove Mosimi line
(6) Mosimi Ore line, Satellite line and Ibadan line

As long as there are ready markets for stolen crude oil and petroleum products, vandalization will not cease. The presence of black marketing of

petroleum products in Nigeria encourages the vandalization of pipelines. The siphoned products are sold at black markets locally and beyond the shores of Nigeria. Apart from the black market factor (local and foreign), the restiveness in the Niger Delta is a contributory factor in the wilful vandalization of not only pipelines but oil installations. The cost of vandalization is enormous on the economy. The loss of revenue for the first half of 2000 is estimated to be over N4 billion (FRN, 2000). A study of the cost of marine pollution in Nigeria puts the estimate at a minimum of N105 billion (US$1.2 billion) between 1980 and 1997 (Arosanyin and Aderamo, 2001). Given that the bulk of serious marine pollution is caused by the oil sector, the share of spillage is likely to be high.

While pipeline accidents are the major and visible threats to the pipeline mode in Nigeria, other threats also exist. Among these threats are illegal occupations of the Right-of-Way (ROW) through farming activities, building and construction activities, etc. Encroachment on pipeline right-of-way is common in Nigeria probably due to the fact that pipeline marks to show their presence in most areas are missing. This portends a great danger in case of natural rupture and ability to control and manage the spillage. Another threat to pipeline transportation in Nigeria is low utilization rate. The advantage of pipeline transport is the mass movement of products at very high speed irrespective of terrain and weather conditions because pipeline systems are 'closed' and automated. This puts the cost per unit hauled to be very low compared with other modes. This advantage of low cost per unit hauled is, however, undermined once the capacity utilization of the pipelines falls below the optimum level. The pipelines in Nigeria are operated below optimum level due to low capacity utilization of the few existing refineries, seizure of flow stations in Niger Delta, vandalization, etc. This low capacity utilization of the pipeline systems in Nigeria is, therefore, a serious threat to this mode, as resources lie idle with serious losses to the economy.

IV. Challenges and Opportunities

The challenges facing the pipeline mode in the Nigeria's oil industry are woven around its competitiveness with other freight modes namely, rail, water and road in its specialized product delivery. The shortcomings of these main 'rival, yet complementary' modes provide the opportunities for pipeline transport in Nigeria for specialized goods such as petroleum products. The railway is a good long distance hauler of products, but it is virtually out of contention in freight transport in Nigeria. A look at Table 2 shows that there were years in which the rail did not convey any good to the Nigerian Seaports for exports (1990, 1993, 1997 1999, 2001 and 2002). Even the years the rail conveyed goods to the Seaports, the tonnage was small. Between 1987 and 2002, only 132,038 tonnes of goods were transported to the Seaports representing only 0.23 per cent of total goods hauled to Nigerian Seaports. Although the nature of goods conveyed to the Seaports were not spelt out, the general composition of goods hauled by the rail usually include petroleum products. It, therefore, serves as an inference on the declining role of the rail, and a challenge to the pipeline mode over certain products. A better picture of the challenge of the demise of the rail for pipeline transport is evident in the transportation of petroleum products by rail. Statistics show that the rail hauled 105,071 metric tonnes of petroleum products in 1976; it rose to 430,100 in 1978, but declined to 78,287 metric tonnes by 1985 (FRN, 1986). It hauled about 2.1 million metric tonnes in 1987. Thereafter, it started declining. It fell to 79,987 metric tonnes by 1990, 5,244 metric tonnes by 1992 and 3,486 metric tonnes by 1995 (FRN, 1999). This declining haul by rail provides a good 'traffic-divert' in favour of competing modes namely, water, pipeline and the road. Also, the technical configuration of the rail in Nigeria in terms of the gauge of track, which is 1067 mm or 3'6", sharp gradient, etc, made the speed to be

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[4] *The railway serves only two out of the seven Seaports in Nigeria*

very slow at 36 kilometres per hour. This slow speed is not economical for any investor in the distribution business as delays are costly. The limitations of the rail pose a great challenge for pipeline. It is worth noting, however, that the benefits of the challenges are cornered by the road mode.

In spite of the diverted traffic in favour of the road mode, the constraints of the Nigerian road transport system namely, poor road condition, tankers that are not road worthy, accidents, congestion and delays, etc, made the cost of transporting petroleum products by road very expensive. Water transportation in Nigeria is not well utilized for inland transport. Nigeria has twenty-four rivers (FRN, 1999), but the seasonal nature of these rivers in terms of navigation constrained the use of the waterways for inland petroleum products' distribution. This constraint further provides an opportunity for the use of pipeline mode as a better mode, which is not at the mercy of rainfall (water level), and siltation.

The slow speed of the rail, high cost of road haulage, seasonal nature of inland water transport and the low tonnage carriage of the water, road and the rail mode bring out the opportunities for the pipeline mode to exploit. These opportunities for pipeline mode are the issues that mark it out for preference in freight transportation of petroleum products. The issues of speed, safety, cost and volume are crucial in petroleum products distribution. The pipeline mode has a high comparative advantage on these issues over other modes, *ceteris paribus*.

Apart from the opportunities created for the pipeline mode by the inadequacies and ineffectiveness of other modes, there is a rising demand for petroleum products in the country, which will continue into the future. This rise in demand is as a result of a growing population, increased vehicle acquisition and kilometre-travelled, increased usage of generators due to the inefficiency in electricity generation and distribution, etc. The pipeline

mode can play a prominent role in the distribution, because of this anticipated increase in the consumption of petroleum products. It is, however, important to note that in spite of these opportunities, the pipeline mode has not utilized these advantages fully. The pipeline mode may not likely take advantage of these opportunities in future too, if certain measures are not taken to improve pipeline transportation of petroleum products in Nigeria.

IV. Strategies for Improving Pipeline Transportation

The strategies for improving petroleum pipeline transportation in Nigeria can be examined under two categories. The first category includes strategies within the pipeline sub-sector. The second category encompasses strategies that are outside the pipeline sub-sector, but which have profound impacts on the pipeline mode.

Strategies within the Pipeline Sub-sector

Extension of the Pipeline Network: The existing pipeline network in Nigeria is inadequate given the population and land size of Nigeria with its effects on aggregate and spatial demand for petroleum products. The existing network is just 54.1 kilometre per 10,000 square kilometres. The existing network needs expansion to cover critical areas in order to reduce the length of kilometres usually covered by road haulers. The expansion should be to states with international borders to serve as export points to neighbouring countries. This will reduce the cost of haulage and pressure on roads, and its attendant effects on accidents, pollution and congestion. Secondly, it will reduce smuggling of petroleum products across the borders once the government sells finished products to neighbouring countries through bilateral agreements scheme. Although investment in new network is capital intensive, it is worthwhile given the comparative benefits inherent in

an efficient pipeline system, the expected establishment of privately owned new refineries and the potential for exportation of refined products to landlocked countries of Africa.

In meeting the huge capital required for pipeline investment, the private sector should be involved. Private sector involvement could be through the instruments of Build-Operate-Transfer (BOT) or Build-Own-Operate-Transfer (BOOT), or other variants such as Build-Own-Operate (BOO), Build-Lease-Transfer (BLT), Rehabilitate-Lease-Transfer (RLT), Rehabilitate-Operate-Transfer (ROT) and Build-Rent-Transfer (BRT). The choice of private sector involvement should be in accordance with the oil and gas sector reform agenda. It is important for the government to provide the enabling political and legal framework for private sector investment in the pipeline sub-sector.

The country should have a proper maintenance and replacement schedule for the pipeline systems in Nigeria. This will enhance the life span of the pipes and reduce the propensity of natural ruptures. Pigging, that is pipe flushing should be done as scheduled. Scheduled maintenance is adhered to under a private entity than under a public entity. The present situation where NNPC/PPMC serves as both transporter and marketer should be unbundled. The initial conception of public investment in the pipeline system for meeting social need is no longer relevance. This initial conception is inimical to revenue generation, cost recovery and long term sustainability as unit costs of pipeline movement for crude oil and refined products are difficult to determine. Deregulation and unbundling will, therefore, ensure not only cost-recovery but profit margin for an efficient and properly maintained petroleum pipeline system

The surveillance system for pipeline network should be improved upon. The security outfits should be adequately equipped to monitor the network. Secondly, the PPMC should adopt the community policing system by

committing the communities where pipeline Right-of-Way (ROW) transverse to show interest in the protection of public property in their domain. Related to this is the issue of public enlightenment, which is paramount within these communities. These communities must also savor from the dividends of democracy and good governance. This can be done by employing local guards within the communities to watch pipelines in their domain. This will hasten the reporting of leakages, and suspected movements along pipelines and other oil installations.

Enhanced capacity utilization of pipelines: Investment in pipelines would be a waste of resources if they are not used optimally. The Nigerian pipelines are not utilized optimally. A better way of making optimal use of it, apart from the already mentioned strategies is to rehabilitate the existing refineries, which have been working below capacity before privatizing them and, allow the private sector to be involved in building new and modern refineries to meet local demands and export of refined products. Once there are products to pump from the refineries, investors will definitely prefer a transport mode such as pipeline that is cost-effective where feasible.

Strategies outside the Pipeline Sub-Sector

Resolution of the Niger Delta Crisis: The incessant crisis in the Niger Delta on resource control, participation of oil companies in the development of host communities, inter-ethnic conflicts, etc, should be resolved as a matter of urgency. Increase in resource control through improved derivation percentage not only to the oil producing states, but to oil producing local government areas and communities within the Niger Delta will help calm tension. The Niger Delta harbours the source of Nigeria's oil and gas, therefore, crisis in the zone is not healthy for the nation. Crisis in the Niger

[5] *Nigeria imported about 82.46, 64.87 and 62.58 per cent of PMS, DPK and AGO, respectively, in the first half of 2000. This shows a gap between demand and local supply. See Appendix Table 5 for detail demand gap between 1990 and 2000.*

Delta always have negative impact on crude oil production, and distribution. It, therefore, means that peace in the Niger Delta will guarantee continuous production of crude oil and distribution of petroleum products through the pipeline mode. These are expected to increase the capacity utilization of the pipeline systems.

Speedy prosecution of pipeline vandals: The judicial process in Nigeria is not only slow, but also biased and corrupt. These loopholes are often exploited by pipeline vandals to escape justice. The deterrence factor is, therefore, not effective. Once pipeline vandals escape justice, it encourages others to join the act of vandalization. The judiciary should be strengthened to prosecute pipeline vandals irrespective of their status in the society. This will reduce the act of vandalization and, hence, promote the safety of pipelines.

IV. Conclusion

The place of pipeline transportation is crucial in any economy that is endowed with oil and gas reserves, not only for export but also for internal consumption at minimum transport cost. The pipeline mode in Nigeria should be made to play its desired role as the primary transport mode for petroleum products within the country while other modes such as rail, water and road should serve as the secondary transport modes both in theory and practice. The current situation where the road is the main mode for distributing petroleum products through the 'bridging policy' is not economical for the nation at large anddistribution stakeholders in particular. The government should accord the pipeline mode the right priority in terms of funding, maintenance, management and legal coat that

[6] *The closure of oil facilities at Makaraba, Abiteye, Opuekeba, Otumara, Dibi and Olero since March 2003 has led to the loss of 140,000 barrels of crude per day. The closure is costing Chevron Nigeria Limited about $1.3 billion. The closure was due to the ethnic feud between the Ijaw and Itsekiri in Warri (see The Punch, 2004: back page). For further reading on the Niger Delta crisis see Aghalino 2000, 2003.*

will make pipeline transportation effective and efficient. Also the private sector should be allowed to play an active role in the new investment drive in the pipeline sub-sector.

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Appendix

Table 1					
Total Federally Collected Revenue (TFCR) (1970-2003)					
Year	TFCR (NM)	Oil (NM)	Non Oil (NM)	Oil %	Non Oil %
1970	634	166.6	467.4	26.3	73.7
1971	1168.8	510.1	658.7	43.6	56.4
1972	1405.1	764.3	640.8	54.4	45.6
1973	1695.3	1016	679.3	59.9	40.1
1974	4537.4	3724	813.4	82.1	17.9
1975	5514.7	4271.5	1243.2	77.5	22.5
1976	6765.9	5365.2	1400.7	79.3	20.7
1977	8042.4	6080.6	1961.8	75.6	24.4
1978	7371	4555.8	2815.2	61.8	38.2
1979	10912.4	8880.8	2031.6	81.4	18.6
1980	15233.5	12353.3	2880.2	81.1	18.9
1981	13290.5	8564.4	4726.1	64.4	35.6
1982	11433.7	7814.9	3618.8	68.3	31.7
1983	10508.7	7253	3255.7	69.0	31.0
1984	11253.3	8269.2	2984.1	73.5	26.5
1985	15050.4	10923.7	4126.7	72.6	27.4
1986	12595.8	8107.3	4488.5	64.4	35.6
1987	25380.6	19027	6353.6	75.0	25.0
1988	27596.7	19831.7	7765	71.9	28.1
1989	53870.4	39130.5	14739.9	72.6	27.4
1990	98102.4	71887.1	26215.3	73.3	26.7
1991	100991.6	82666.4	18325.2	81.9	18.1
1992	190453.2	164078.1	26375.1	86.2	13.8
1993	192769.4	162102.4	30667	84.1	15.9
1994	201910.8	160192.4	41718.4	79.3	20.7
1995	459987.3	324547.6	135439.7	70.6	29.4
1996	520190	408783	111407	78.6	21.4
1997	582811.1	416811.1	166000	71.5	28.5
1998	463608.8	324311.2	139297.6	70.0	30.0
1999	949187.9	724422.5	224765.4	76.3	23.7
2000	1906159.7	1591675.8	314483.9	83.5	16.5
2001	2231532.9	1707562.8	523970.1	76.5	23.5
2002	1731837.5	1230851.2	500986.3	71.1	28.9
2003	2575095.9	2074280.6	500815.3	80.6	19.4
Total	12448899.1	9620782.1	2828117	77.3	22.7

Sources: CBN (2003:195-201).Percentages were computed by the Author.

Table 2

Nigeria's Total Export (1970-2003)					
Year	Oil (NM)	Non-Oil (NM)	Total (NM)	Oil %	Non-Oil %
1970	510	375.4	885.4	57.6	42.4
1971	953	340.4	1293.4	73.7	26.3
1972	1,176.20	258	1434.2	82.0	18.0
1973	1,893.50	384.9	2278.4	83.1	16.9
1974	5,365.70	429.1	5794.8	92.6	7.4
1975	4,563.10	362.4	4925.5	92.6	7.4
1976	6,321.60	429.5	6751.1	93.6	6.4
1977	7,072.80	557.9	7630.7	92.7	7.3
1978	5,401.60	662.8	6064.4	89.1	10.9
1979	10,166.80	670	10836.8	93.8	6.2
1980	13,632.30	554.4	14186.7	96.1	3.9
1981	10,680.50	342.8	11023.3	96.9	3.1
1982	8,003.20	203.2	8206.4	97.5	2.5
1983	7,201.20	301.3	7502.5	96.0	4.0
1984	8,840.60	247.4	9088	97.3	2.7
1985	11,223.70	497.1	11720.8	95.8	4.2
1986	8,368.50	552.1	8920.6	93.8	6.2
1987	28,208.60	2152	30360.6	92.9	7.1
1988	28,435.40	2757.4	31192.8	91.2	8.8
1989	55,016.80	2954.4	57971.2	94.9	5.1
1990	106,626.50	3259.6	109886.1	97.0	3.0
1991	116,858.10	4677.3	121535.4	96.2	3.8
1992	201,383.90	4227.8	205611.7	97.9	2.1
1993	213,778.80	4991.3	218770.1	97.7	2.3
1994	200,710.20	5349	206059.2	97.4	2.6
1995	927,565.30	23096.1	950661.4	97.6	2.4
1996	1,286,215.90	23327.5	1309543.4	98.2	1.8
1997	1,212,499.40	29163.3	1241662.7	97.7	2.3
1998	717,786.50	34070.2	751856.7	95.5	4.5
1999	1,169,476.90	19492.9	1188969.8	98.4	1.6
2000	1,920,900.40	24822.9	1945723.3	98.7	1.3
2001	1,973,222.20	28008.6	2001230.8	98.6	1.4
2002	1,787,622.10	95046.1	1882668.2	95.0	5.0
2003	2,794,754.20	95092.5	2889846.7	96.7	3.3
Total	14852435.5	409657.6	15262093.1	97.3	2.7

Sources: CBN (2003:391).Percentages were computed by the Author

Table 3

Nigeria's Gross Domestic Product (1981-2003)*

Year	Total GDP (NM)	Non Oil GDP (NM)	Oil GDP (NM)	Non oil %	Oil %
1981	205222.1	132202.4	73019.7	64.4	35.6
1982	199685.3	134357.5	65327.8	67.3	32.7
1983	185598.1	126140.2	59457.9	68.0	32.0
1984	183563	116678.7	66884.3	63.6	36.4
1985	201036.3	128884.3	72152	64.1	35.9
1986	205971.4	135180.5	70790.9	65.6	34.4
1987	204806.5	135791.7	69014.8	66.3	33.7
1988	219875.6	149037.9	70837.7	67.8	32.2
1989	236729.6	157407.7	79321.9	66.5	33.5
1990	267550	167326.6	100223.4	62.5	37.5
1991	265379.1	174065.2	91313.9	65.6	34.4
1992	271365.5	177751.2	93614.3	65.5	34.5
1993	274833.2	181023.1	93810.1	65.9	34.1
1994	275450.6	184063.2	91387.4	66.8	33.2
1995	281407.4	187870.7	93536.7	66.8	33.2
1996	293745.4	193506.3	100239.1	65.9	34.1
1997	302022.5	200305.5	101717	66.3	33.7
1998	310890.1	206966.6	103923.5	66.6	33.4
1999	312183.5	216054.3	96129.2	69.2	30.8
2000	329178.7	222351.2	106827.5	67.5	32.5
2001	344285.8	231868.4	112417.4	67.3	32.7
2002	356305.8	250303.7	106002.1	70.2	29.8
2003	392767	261430.4	131336.6	66.6	33.4

*Note:*GDP at 1990 constant basic prices*

Sources: CBN (2003:240-244).Percentages were computed by the Author.

Table 4
Characteristic of the Nigerian Products Pipeline Complex

System	Pipeline Segment	Lenght (Km)	Diameter Inch	Linefill (Capacity) M³	Flow rate M³/Hr
2A	Warri- Benin	90	16"	)	
	Benin - Ore	114	14"	) 32,300	300
	Ore- Mosimi	151	12"	)	
2AX	Auchi - Benin	107	12"	8,000	380
2b	Atlas Cove - Mosimi	49	16"	8,800	750
	Mosimi - Ibadan	79	12"	6,000	300
	Ibadan - Ilorin	170	6"	3,300	60
	Mosimi - Ikeja (ATK)		8"		75
	Mosimi - Lagos Satelite (PMS)		12"/10"	3,000	150
	Mosimi - Lagos Satelite (AGO)		10"/8"		
	Mosimi - Lagos Satelite (DPK)		8"/6"		
	Mosimi - Lagos Satelite (ATK)		6"		
	Mosimi - Lagos Satelite (PMS)		4"		
2C	Warri - Kaduna (Crude oil)	606	16"	72,910	650
2CX	Enugu - Auchi	169	12"	12,500	380
	Auchi - Suleja	250	12"	18,500	235
	Suleja - Minna	80	8"	2,515	80
	Suleja - Kaduna	150	12"	13,015	235
2D	Kaduna - Zaria - Kano	225	10"	11,860	160
	Zara -Gusau	177	6"	3,427	40
	Kaduna - Jos	167	10"	9,100	90
	Jos - Gombe	265	6"	)	
	Gombe - Maiduguri	297	6"	) 10,000	70
2DX	Jos - Gombe	265	8"	9,000	95
2E	PH - Aba Enugu	210	12"	16,000	280
	Enugu - Makurdi	180	6"	3,300	60
2EX	PH - Aba Enugu	210	12"	16,000	320
	Enugu - Makurdi	180	8"	6,000	155
	Markurdi - Yola	470	8"	15,500	70

Source: NNPC/PPMC

Table 5
Product Supplies from Domestic Refineries and Import

Year	Unit	PMS				DPK				AGO	
		Domestic production	Import	Total	% Import contribution	Domestic production	Import	Total	% Import contribution	Domestic production	
1990	MT	3,724.53	479.93	4,204.48	11.41	1,928.78	297.13	2,225.91	13.35	2,734.31	-
	M³	4,964.80	639.75	5,604.55		2,356.97	363.09	2,720.06		3,182.74	-
1991	MT	3,644.15	1,020.21	4,664.36	21.87	1,886.60	276.19	2,162.80	12.77	3,006.83	-
	M³	4,857.66	1,359.94	6,217.60		2,305.43	337.51	2,642.94		3,499.95	-
1992	MT	3,857.31	1,517.94	5,375.25	28.24	1,817.74	592.02	2,409.76	24.57	2,854.13	40.19
	M³	5,141.79	2,023.42	7,165.21		2,221.28	723.44	2,944.73		3,322.21	46.78
1993	MT	3,561.82	1,795.37	5,357.19	33.51	1,676.98	661.46	2,338.44	28.29	2,820.19	742.86
	M³	4,747.90	2,393.23	7,141.13		2,049.27	808.30	2,857.57		3,282.70	884.68
1994	MT	2,216.49	2,008.36	4,224.86	47.54	1,067.00	505.47	1,572.47	32.15	1,862.05	269.73
	M³	2,954.59	2,677.15	5,831.73		1,303.87	617.69	1,912.56		2,167.43	313.97
1995	MT	2,691.99	1,478.49	4,170.48	35.45	1,449.80	560.00	2,009.80	27.86	2,270.13	103.50
	M³	3,588.43	1,970.83	5,559.25		1,771.66	684.33	2,455.98		2,642.43	120.47
1996	MT	2,457.07	1,925.44	4,362.51	43.93	1,516.33	753.35	2,269.68	33.19	2,105.65	357.00
	M³	3,275.28	2,568.81	5,841.89		1,852.95	920.59	2,773.55		2,450.97	415.53
1997	MT	2,784.61	1,061.86	3,846.47	27.61	1,537.82	419.80	1,957.62	21.44	2,341.28	185.30
	M³	3,711.89	1,415.45	5,127.34		1,879.22	512.99	2,392.22		2,725.25	215.69
1998	MT	1,450.73	2,511.32	3,962.05	83.38	1,132.22	655.62	1,787.84	38.67	1,507.56	515.96
	M³	1,933.82	3,347.59	5,281.41		1,383.57	801.17	2,184.74		1,871.20	600.58
1999	MT	1,662.89	2,648.25	4,311.14	61.43	1,278.71	171.48	1,450.19	11.82	1,814.04	465.25
	M³	2,216.63	3,530.11	5,746.74		1,562.58	209.55	1,772.13		2,111.54	541.53
2000 1st half	MT	442.36	2,079.10	2,521.46	82.46	311.47	575.10	886.57	64.87	439.82	735.54
	M³	589.67	2,771.44	3,361.11		380.62	702.77	1,083.39		511.95	856.17

Source: *FRN (2000)*