Macroeconomic and distributional consequences of energy supply shocks in Nigeria

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Abstract

In spite of its vast oil endowments, Nigeria continues to experience sporadic domestic oil supply shortages. These oil shortages manifest in regular queues at fuel stations that are often empty and in thriving parallel markets that sprout all over the country. The shortages have resulted in huge economic and non-economic costs to the economy. This study investigates the causes of the shortages and provides quantitative estimates of the economic costs to the Nigerian economy using a survey and a computable general equilibrium (CGE) model. The findings from this study show very clearly that oil sector supply shocks are costly both directly and indirectly. Oil supply shocks result in lower real GDP, higher average prices and greater balance of payment deficits. Other macroeconomic variables such as private consumption, investment, government revenue and employment also decline. In addition, the distributional impact of the quantitative energy supply shocks is higher for poor households than rich households. We also find that the sectoral impacts are mixed, often depending on the oil intensity of the sector. Finally, our survey results show that many economic agents on the demand side are willing to pay higher prices if that will guarantee a stable oil supply. Few players in the market chain benefit from supply disruptions, while consumers and the poor bear the main burden of these shocks.

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1. Introduction

This study examines the impact of domestic oil supply shocks on the Nigerian economy. Nigeria is an oil-rich country with oil reserves estimated at over 31.5 billion barrels in 2001. The country's crude oil production in 2001 stood at 2.017 million barrels per day (bpd), out of which 2.089million bpd were exported. The same year, Nigeria was ranked the third largest oil exporter in the Organization of Petroleum Exporting Countries and the sixth in the world (OPEC, 2003). Domestic consumption of crude oil is estimated at about 350,000bpd. The refinery capacity of the country as at 2004 was 445,000bpd, making her theoretically self-sufficient in domestic oil consumption.

Since 1991, however, a combination of factors related to both demand and supply have led to intermittent oil supply shortages in Nigeria. The supply shortages, mostly unanticipated, occur on the average of three times a year, each shortage lasting weeks or months at a time. This has created a paradox. Why should a country with huge oil reserves and oil production that is several multiples of domestic consumption be faced with oil supply crises? The evidence of the oil shortages, whenever they occur, is seen in the long and regular queues at fuel stations that are often empty and in the thriving parallel markets – where fuels are sold above the official price – that develop very close to the fuel stations and at specific parts of the cities.

While our study provides some analyses of the causes of fuel shortages in Nigeria, more relevant to the study are questions relating to the distributional and macroeconomic consequences of oil supply shocks. The periodic fuel shortages have had major consequences for the economy – economic and non-economic. The economic costs can be divided into macroeconomic and microeconomics costs (Iwayemi, 1998). The macroeconomic costs include losses in national output and economic growth, increased unemployment, declining investment, greater inflationary pressures, and increased fiscal deficits resulting from subsidized imports of fuels. The microeconomic costs include losses suffered by agents in the economy such as higher production costs for manufacturers, work-hours lost during queues at fuel stations and bus stops, and forgone output and profit due to acute fuel shortages and product adulteration. All of these contribute to the erosion of the international competitiveness of the Nigerian economy (Adenikinju, Olofin and Iwayemi, forthcoming).

The non-economic costs include frustrations experienced at fuel stations, loss of lives from fuel explosions due to adulterations as well as explosions from fuel dumps at homes, loss of lives due to absence of fuel to transport patients to hospitals for treatment or referrals, long treks or long waiting time at bus stops, among others. This study abstracts from the non-economic costs to deal with quantitative, measurable economic costs of fuel shortages.

Rationale for the study

In spite of its significant economic implications, we are not aware of any study that has estimated the quantitative implications of the oil shortages. The only effort in this area is Iwayemi (1998). Iwayemi (1998) identifies the myriad of possible macro and micro economic consequences of fuel scarcity in Nigeria and attempts an interpretative analysis of the causes and possible solutions. He did not go beyond providing anecdotal evidence, however. Our study takes that next step by adopting relevant methodologies to estimate the efficiency and equity costs of fuel supply disruptions in Nigeria. Even at the international level, most studies on supply shocks are from the perspective of oil importing countries and have always examined the domestic disruptions that emanate from rising world oil prices. Nigeria's case is peculiar because the country is a net oil exporter.

The study adopts relevant methodologies, including a survey and a computable general equilibrium (CGE) model, to study the efficiency and equity costs of fuel supply disruptions in Nigeria. The use of CGE is appropriate given the focus on relative prices, efficiency and equity considerations as well as analysis of factors that affect the structure of an economy. A CGE also offers a useful laboratory to capture the total effects – direct and indirect – of the supply shocks. In addition, the survey method provides the framework for capturing microeconomic costs as well as perception of key players on the causes and impact of fuel shortages.

The rest of the study is organized as follow. Section 2 reviews the structure of the Nigerian petroleum product markets and identifies some causes of domestic oil supply shocks and reviews recent developments in the energy sector. An overview of the empirical literature is given in Section 3, followed by a presentation of the theoretical framework in Section 4. Section 5 discusses the modelling frameworks used in the study. The analyses of the results are presented in Sections 6 and 7, while the last section contains the conclusion and recommendations.

Study objectives

The central purpose of this study is to provide an analysis of the cost of oil supply shocks on the Nigerian economy. The specific objectives of the study are to:

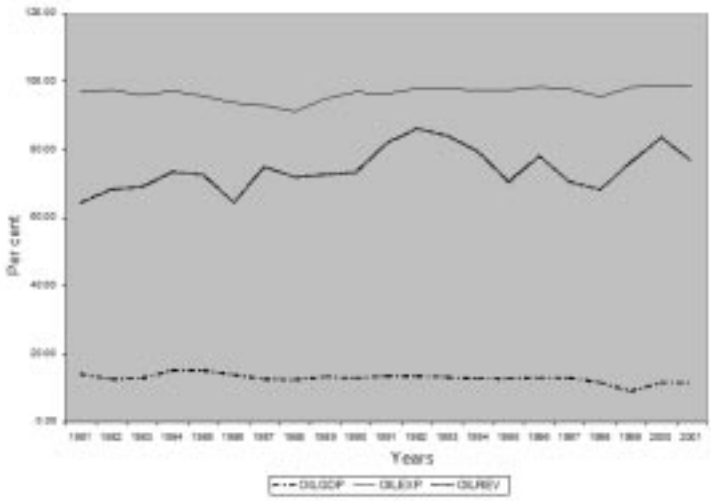
- Provide an overview of the structure of petroleum products' market in Nigeria.
- Examine the causes of oil supply shocks in Nigeria.
- Quantify the economic and distributional costs of the oil supply shocks on the economy.
- Proffer solutions on how to solve the problem.

2. The energy sector and Nigerian economy

The energy sector has played and continues to play a critical role in Nigeria's development process. It is not an exaggeration to opine that the growth path of the Nigerian economy, at least in the past three decades, has been closely linked with developments in the energy sector, particularly within the oil subsector (Adenikinju, 2003). This dependence is manifested in terms of the latter's contribution to exports, GDP, government revenue and foreign exchange earnings, among others. The share of the energy sector in the GDP rose from 1.60% in 1960 to 11% in 2001. It attained the highest share of 32% in 1975. In two of these years, 1975 and 1980, the energy sector actually displaced agriculture to become the largest sector of the Nigerian economy after services.

Perhaps more importantly is that the energy sector maintains a very strong fiscal linkage with the rest of the economy. Oil revenue as a percentage of total government revenue rose from 26.31% in 1970 to 77.46% in 1975 and further to 86% in 1992, before declining to its current level of 76.5%. Similarly, between 1970 and 2000, Nigeria earned over $300 billion as a major oil exporter. This amount represents 94.89% of total foreign exchange earned in the economy over the period. Since the government, which is the single largest investor in the economy, is the direct repository of oil earnings, oil determines the quantum of investment that is undertaken in the economy in any given year. Figure 1 shows key indicators of the oil–economy linkages in Nigeria.

Figure 1: Oil–economy linkages in Nigeria



Despite the oil sector's significant contribution of resources to the Nigerian economy, it has also introduced large distortions into the economy. These distortions include the familiar Dutch disease syndrome, which led to a shift in the structure of domestic incentives to the import and non-tradeable sectors, as well as the policy of maintaining cheap domestic energy prices in the face of rising domestic inflation rates.

Energy supply and demand structure: An overview

A key factor in understanding the performance of the energy sector is an understanding of the supply–demand nexus and especially the underlying market structure. Market disequilibrium can be triggered by either or a combination of factors influencing demand or supply. In this section, we examine trends in key factors that affect demand and supply of energy in Nigeria.

Trends in petroleum demand structure

Energy consumption growth was very high before the onset of economic recession in the early 1980s, far exceeding the rate of economic growth.

The rapid expansion in aggregate energy consumption was halted and then reversed in the early 1980s and replaced by a systematic decline until 1986. The recovery in consumption commenced thereafter. The key factors in the rapid growth in energy consumption prior to the downturn were rapid income expansion due to strong oil export performance, and low and controlled energy prices. Other factors include the rapid pace of modernization and industrialization, importation of fuel inefficient second-hand vehicles from abroad, high population and urbanization growth rates, and smuggling. Smuggling has assumed an increasing dimension in recent years as domestic prices lag significantly behind prices in neighbouring countries. Table 1 and Figure 2 show trends in demand for major petroleum products in Nigeria.

Table 1: Trends in total demand of major petroleum products, growth rates and share of total demand (1981–2001)

Year	Total		HHK		PMS		AGO		FOIL	
	Total demand (litres)	Grw %	Share	Grw %	Share	Grw%	Share	Grw %	Share	Grw %
1981	11,629,586	19.3	8.6	-31.7	56.5	23.6	26.9	-10.6	7.9	-31.7
1982	12,280,054	-7.6	7.5	-12.8	54.6	-3.4	26.3	-2.2	11.6	45.7
1983	11,007,750	95.7	16.5	120.0	43.9	-19.6	27.6	4.9	17.4	50.4
1984	9,675,342	-4.9	17.8	7.9	41.5	-5.5	24	-13.0	16.7	-4.0
1985	9,075,244	-11.8	16.8	-5.6	41.7	0.5	20.2	-15.8	21.3	27.6
1986	8,513,280	26.8	22.6	34.5	42.3	1.4	21.8	7.9	13.3	-37.5
1987	8,575,699	4.6	23.5	4.0	42.3	0.0	20.5	-6.0	13.7	3.1

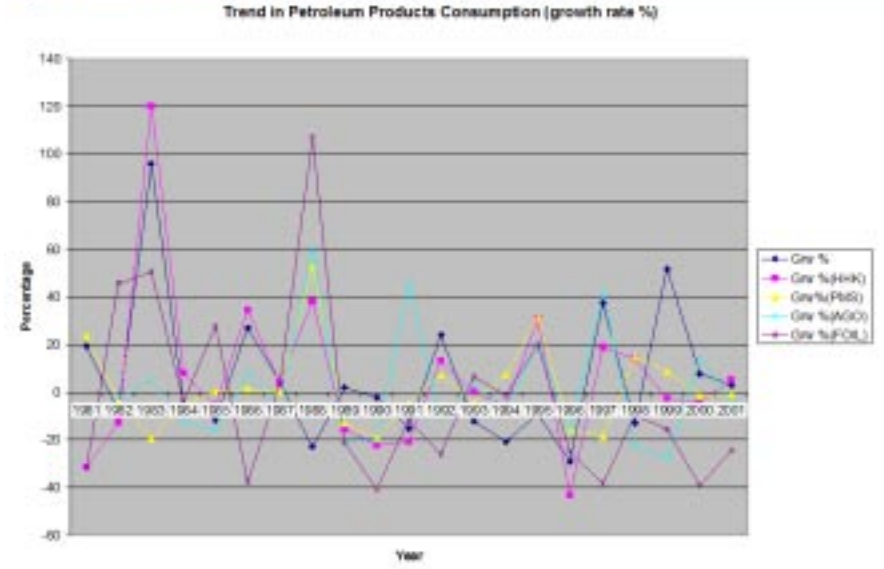
continued

Year	Total		HHK		PMS		AGO		FOIL	
	Total demand (litres)	Grw %	Share	Grw %	Share	Grw%	Share	Grw %	Share	Grw %
1988	4,801,021	-23	32.4	37.9	64.6	52.7	32.8	60.0	28.4	106.7
1989	5,795,432	1.9	27.3	-15.7	56.2	-13.0	25.8	-21.3	22.3	-21.3
1990	7,293,689	-2.3	21.2	-22.3	45.3	-19.4	20.5	-20.5	13.2	-40.8
1991	7,830,960	-15.2	16.8	-20.8	43.2	-4.6	29.8	45.4	11.7	-11.7
1992	8,581,871	24	19	13.1	46.3	7.2	26.6	-10.7	8.6	-26.1
1993	7,506,501	-12.3	19	0.0	44.4	-4.1	27.4	3.0	9.2	6.4
1994	6,313,806	-20.8	17.9	-5.8	47.8	7.7	25.3	-7.7	9.0	-1.4
1995	4,366,451	-9.5	23.4	30.7	62.7	31.2	30.6	20.9	10.8	19.8
1996	5,435,055	-29.1	13.3	-43.2	52.8	-15.8	25.7	-16.0	8.1	-25.0
1997	6,322,417	37.3	15.8	18.8	43.1	-18.4	36.4	41.6	5.0	-38.4
1998	5,496,913	-13.1	18.0	13.9	49.4	14.6	28.2	-22.5	4.5	-9.9
1999	8,337,602	51.7	17.5	-2.8	53.7	8.7	20.4	-27.7	3.8	-15.7
2000	8,976,870	7.7	16.8	-4.0	52.9	-1.4	23.3	14.4	2.3	-39.2
2001	9,225,618	2.8	17.7	5.2	52.5	-0.9	22.4	-4.1	1.7	-24.3

Key: HHK = Household kerosene, PMS = Premium motor spirit, AGO = Aviation gas oil; FOIL = Fuel oil;. Grw = Growth rate.
Source: CBN Annual Reports and Statement of Accounts, various issues.

The table shows that oil demand growth has recovered in recent years compared with the decline between 1993 and 1998. Factors mentioned above, in particular the massive importation of fuel inefficient second-hand vehicles, contributed significantly in this regard. The table also shows that PMS or gasoline is the dominant petroleum product consumed in Nigeria over the period.

Figure 2: Trends in demand for major petroleum products



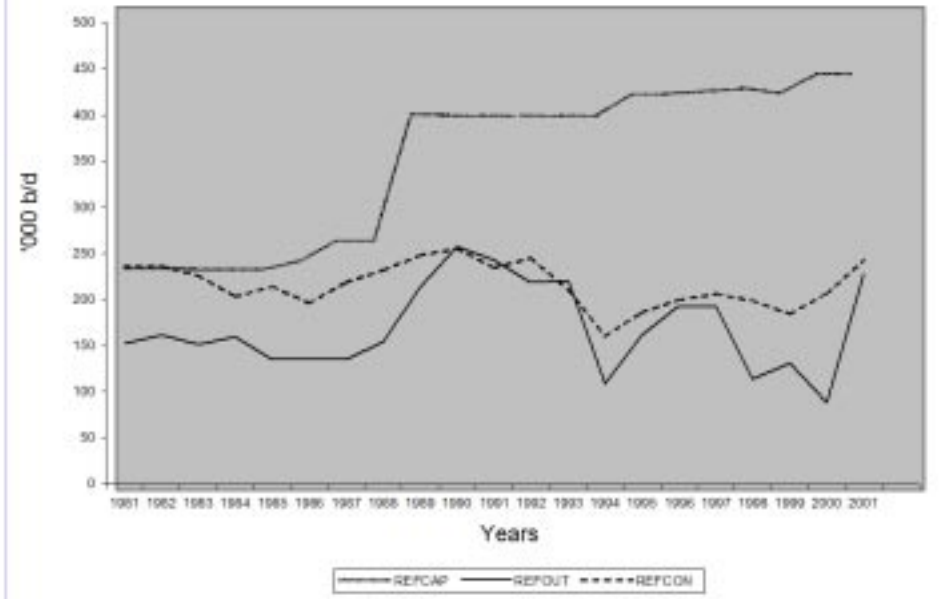
Trends in supply

The growth in energy demand was taking place at a time of declining supply. Until 1973, when the government introduced the uniform pricing policy, the market was doing a good job of efficiently mediating the supply and demand of petroleum products. Fuels were generally available at fuel stations. Hoarding, adulteration of petroleum products and smuggling were uncommon.

Until 1979, the only refinery in the country was the old Port Harcourt refinery commissioned in 1965 as a joint venture between government, Shell and British Petroleum (BP) and managed by BP. The refinery ran as a process refinery with marketers supplying crude and the refinery processing the crude for a fee. The introduction of uniform pricing in 1973 and the government takeover of the downstream sector altered the market condition. The construction of two additional refineries in Warri and Kaduna in 1980 and another one in Port Harcourt in 1989 boosted local refinery capacity to 445,000bpd but could not provide sufficient mechanism for managing soaring domestic demand. Since the early 1990s, supply shortages have become a regular feature all over the country. Petroleum product supplies have been erratic and occasionally products are adulterated. In spite of significant price reviews in recent years, the market has failed to meet the needs of its growing number of customers.

Figure 3, showing the trends in refinery capacity, refinery output and refinery consumption in Nigeria over 1981–2001, highlights the increasing gap between refinery capacity and refinery output. And for most of the years covered in the graph, refinery consumption exceeded refinery production. Usually, the shortfalls are met through importation. While this was not much of a problem in the 1980s when the country was awash with petrodollars, and the exchange rate and inflation rates were well under control, the economic difficulties experienced after the oil market collapse in the mid 1980s made the oil subsidy increasingly difficult to sustain.

Figure 3: Trends in refinary capacity, output and consumption



The gap between refinery capacity and refinery output shown in Figure 3 is a reflection of the poor state of domestic refineries. Table 2 provides a succinct summary of the state of Nigerian refineries. The performance of the crude distillation units (CDU) and fluid catalytic cracking unit (FCC) in the three refineries remains poor and well below international standards.

Table 2: Efficiency indicators of Nigerian refineries, 1996

	PHRC* 1	WHRC	KHRC	PHRC 2
Year of establishment	1965	1980	1980	1989
Capacity (TBD)	60	125	110	150
Operating capacity (%)		52	47	58
Unit capacity utilization (%)				
CDU		52	47	58
FCC		55	47	26
Unit time efficiency (%)				
CDU		31	94	58
FCC		23	70	26

Note: * The refinery has been out of operation since a fire incident occurred in 1989.
TBD = Thousand barrels per day; CDU = Crude distillation unit; FCC = Fluid catalytic cracking unit
Source: Adenikinju (1998).

The poor state of facilities in the refineries is a major contribution to the present fuel crisis. All the refineries are at present producing below capacity. It is only the Port Harcourt refinery that is producing at between 80 and 85% capacity. Problems facing the refineries are legion. The failure of the Nigerian National Petroleum Company (NNPC) management to effect regular turnaround maintenance (TAM) on the various plants to prevent a breakdown and sustain high capacity utilization has been the major problem facing the refineries. A TAM overhaul of the refineries is recommended to be carried out every 18 or 24 months. Between 1992 and 1999, however, no TAM was carried out in Kaduna or in Port Harcourt. NNPC management blamed this failure on lack of funds. The corporation said it was starved of funds during the military era: Between 1994 and 1996, for example, it got only 10% of its budgetary allocation from the federal government. Table 3 shows current state of major equipment in various depots across Nigeria.

Table 3: Current status of major equipment in the depot and pipeline network nationwide, June 2000

S/n	Equipment	No. installed	No. serviceable	% serviceable
1	Main line pumps	84	46	55
2	Booster pumps	44	32	73
3	Loading pumps	234	157	67
4	Loading arms/meters	262	193	74
5	Generating sets	104	60	58
6	Borehole pumps	40	28	70
7	Fire water booster	64	56	88
8	Transfer pumps	39	38	98
9	Fire trucks	30	26	87
10	Product tanks	268	239	89

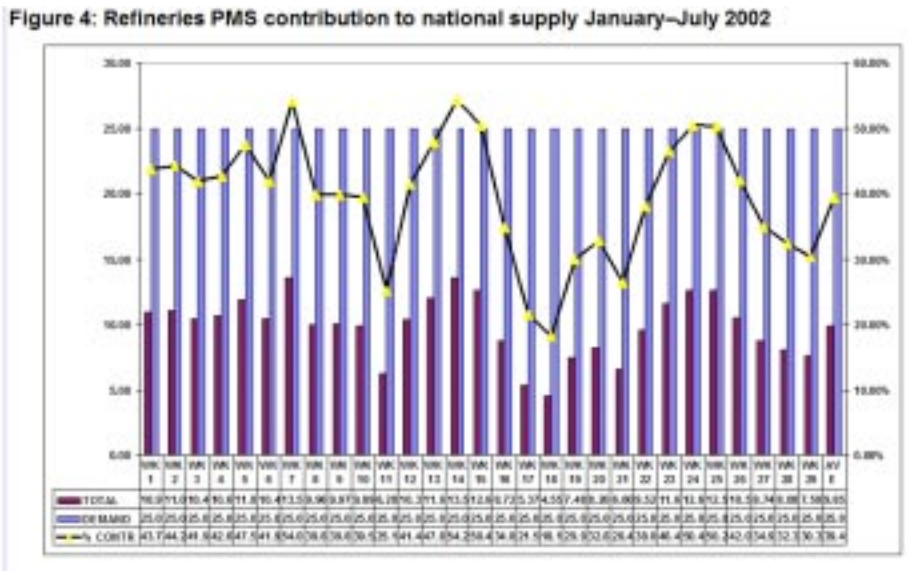
Source: Report of the Special Committee on the Review of Petroleum Products Supply and Distribution, October 2000.

One consequence of the deteriorating state of the refineries is the rise in import share of petroleum products in total domestic consumption. In fact, in the first half of 2002, Nigeria spent as much as $1.6 billion importing petroleum products.

The supply and distribution networks of petroleum products

Crude oil is delivered to the local refineries by pipelines from the exploration fields. The crude oil is allocated by the government to NNPC at a government-set price of $18.0 per barrel, even when international prices of crude oil are much higher.[1] Government allocates 300,000bpd to NNPC for refining to satisfy domestic need. However, the combined refining capability of the refineries, as at October 2000, was 93,000bpd and the balance of 207,000bpd is sold by NNPC at the international market price. The proceeds are applied towards the importation of products by the NNPC to satisfy domestic consumption. (See Figure 4 for the refineries' contribution to national supply.)

Figure 4: Refineries PMS contribution to national supply January–July 2002



Source: Nigerian National Petroleum Company (NNPC).

The Pipeline and Products Marketing Company (PPMC) uses pipelines to transport crude oil to the four refineries, at a total distance of 719km. The multi-product pipelines are used to move products from the refineries/import receiving jetties to the 21 petroleum storage product depots. The pipeline network covers a distance of 5,001km. The PPMC also keeps a fleet of chartered marine vessels, which are used to transport products from the refineries to water-fed facilities. Products moved into the Lagos area are first discharged at the Atlas Core Terminal, where they are received into storage tanks for onward pumping to Mosimi Main Deport near Shagamu, Ogun State.

In order to ensure continuous availability of petroleum products to areas of need, the PPMC resorts to trucking products by road from the southern depots (Port Harcourt, Calabar, Enugu, Mosimi, Lagos Satellite, Ibadan and Apapa) to other parts of the country. This method is referred to as "bridging". The use of roads instead of pipelines and rail to move products from one part of the country to another has created supply bottlenecks as the tankers used in the haulage are not well maintained and have frequent accidents.

Distribution of refined products is carried out by eight major marketers and about 1,800 independent oil marketing companies. The major marketers account for approximately 67% of total industry volumes (1996: 66%, 1995: 69%, 1994: 68%). The majors are CONOIL Plc., Mobil Nigeria Plc., Total Plc., AP Plc., Agip Plc., Texaco Plc., OANDO Plc., and Elf Oil Nigeria Ltd.

There are about 4,500 retail outlets, of which the major marketers control around 45%. With a total vehicle population (cars, lorries and buses) of about 900,000 in the country, customer satisfaction can be measured by the service offered to 200 vehicles per outlet.

The major marketers operate depot facilities at Apapa for the receipt and distribution of petroleum products while the independent marketers operate depot facilities at Ibafon. Some major marketers also have satellite storage facilities at key cities like Kano, Port Harcourt, Maiduguri, Jos and Kaduna.

Price factors

The policy of cheap energy prices has aggravated the distortion in the domestic oil market. Prices, fixed at below the market clearing level, have not been allowed to signal to consumers the real cost of energy use. On the other hand, the low price has not allowed suppliers to receive sufficient returns to maintain their infrastructure as well as expand capacity. World Bank staff estimated that about US$4.2 billion per year is lost in the energy sector alone as a result of inappropriate pricing, over investment, neglect of maintenance, wrong policies and corruption. Of these, inappropriate pricing of petroleum products accounts for the colossal amount of US$3.3 billion (World Bank, 1993).

The history of energy prices in Nigeria shows a period of stable nominal prices, punctuated by sudden price changes. It is obvious from the charts in Figure 5 that changes in nominal prices take place in step-like fashion. Nominal prices often remain at the same level until the government is compelled to revise them upwards. One fact that is very clear from the figure is that changes in real prices lag significantly behind nominal prices. For example, while the average increase in nominal price of gasoline (PPMS) rose by 31.3% between 1970 and 2002, the real price only increased by an average of only 4.5% over the same period. The same trend holds for diesel (AGO), kerosene (DPK) and fuel oil (FOIL).

The regime of fixed prices has also precluded active private sector participation in the refinery segment of the downstream sector. Although the government issued licences to 18 private refineries in June 2001, they have been reluctant to start operation.

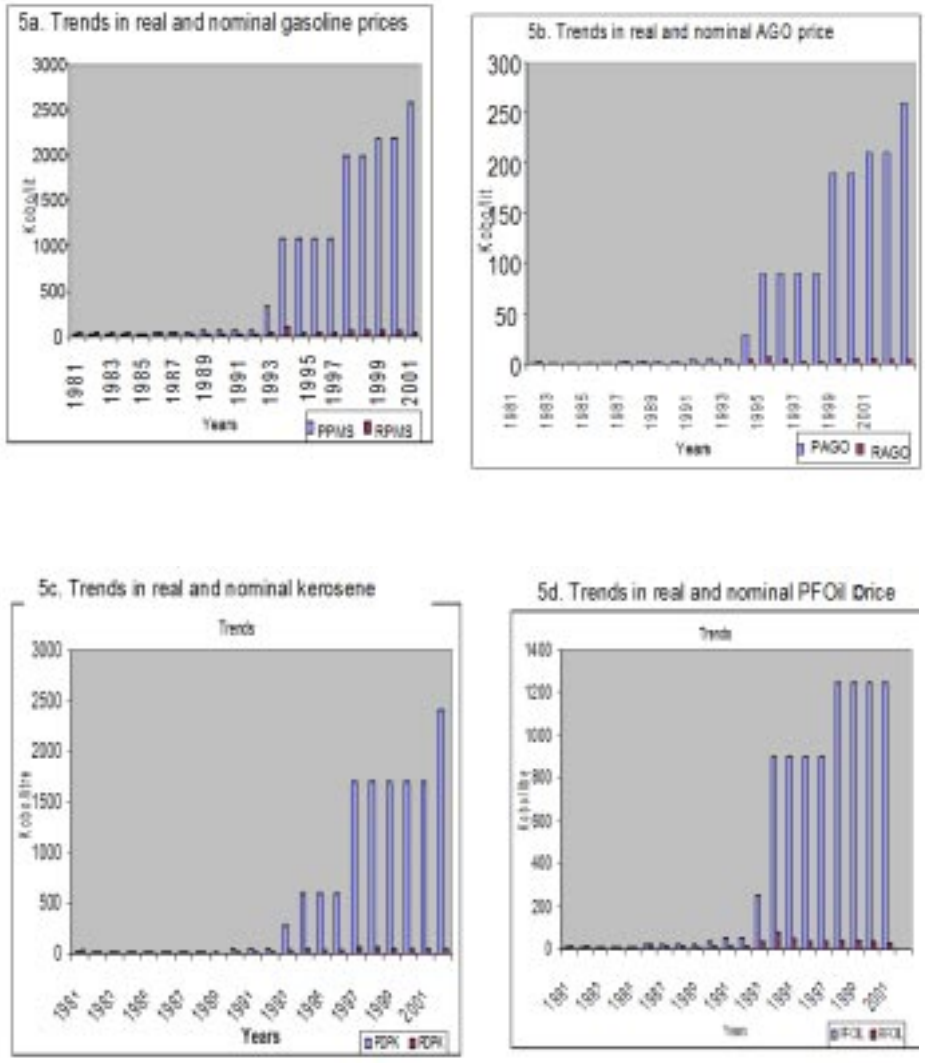
Table 4 also shows that on a comparative basis, Nigeria's gasoline price is among the lowest in the world. Prices in neighbouring countries of Togo, Cameroon, Chad and Ghana, for example, are several multiples of the Nigeria price. This combined with the very porous Nigerian border has made smuggling of petroleum products from Nigeria a thriving business. It is estimated that as much as 30% of Nigeria's oil supply is smuggled to these countries.

Table 4: Comparative gasoline prices for selected countries in 2000 (US$ per litre)

Countries	Price ($/litre)	Index (Nigeria=100)
Nigeria	0.22	100
Ghana	0.39	177
Chad	0.77	350
Côte d'Ivoire	0.69	314
Togo	0.42	191
Cameroon*	0.66	300
Guinea	0.65	295
Burkina Faso	0.71	323
Senegal	0.69	314
Kenya	0.69	314
Morocco	0.77	350
Saudi Arabia*	0.26	118
Venezuela*	0.15	68
UK*	0.90	409
USA*	0.40	182
France	1.20	545
Brazil	0.60	273

* oil producing countries.
Source: Report of the Special Committee on the Review of Petroleum Products Supply and Distribution, October 2000 FGN (2000).

Figure 5: Trends in prices of selected petroleum products



The distribution margin the government offers to the marketers is too low for them to replace their ageing capital assets. In order to recoup investment, these marketers smuggle the products to neighbouring countries where prices are much higher. Low margins have also resulted in product hoarding. These products are then sold at black market prices that are more than double the official rates, depending on the severity of the product shortage. This hoarding is most noticeable in the case of PMS. Low margins have also brought about product adulteration. Adulterations increase product volume and, thus, turnover.

Petro politics

We cannot ignore the impact of political developments, especially internal factors, in explaining energy supply shocks in Nigeria. Oil is both an economic and a political commodity in Nigeria. The current oil exploration and commercial activities are concentrated in the Niger Delta basic acreage and continental shelf. Almost 65% of production is on-shore, although there are increasing activities offshore with the dominant players being Shell, Chevron, Elf and Agip. Years of neglect of the Niger Delta area by successive administrations has bred militants who have continued to mount strong opposition to government and oil companies' activities in the Delta. Since 1990 the intensity of crises and conflicts in the Niger Delta has increased. This has made oil pipelines the targets of politically motivated vandalism by aggrieved persons in the area. Table 5 shows the trend in pipeline ruptures and vandalization between 1993 and 2000.

Another factor that we cannot ignore in discussing the problem of oil supply in Nigeria is corruption. Successive military regimes preferred importing fuel rather than financing the repairs of the refineries. According to a former member of the National Economic Intelligence Committee (NEIC), against the Committee recommendation, former Head of State General Sani Abacha resorted to wholesale importation of $420 million worth of fuel in a year rather than spend $300 million to repair all the nation's refineries (*TheNews*, 1 March 2003, p. 38). Also, the 1994 TAM of the Warri refinery was dipped in scandal. Over $35 million was later recovered from renegotiation of over-invoiced materials. The Kaduna refinery's TAM of $214 million awarded to Total International by the Abacha regime in 1996 was discovered to be inflated by $160 million (*TheNews*, ibid.).

Table 5: Summary of pipeline ruptures/vandalization, January 1993 – June 2000

Cases	93	94	95	96	97	97	99	Jan–Jun 2000	Total
Ruptures	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

Areas mostly affected by vandalization are:

- Warri–Benin line and Warri–Jetty line
- Port Harcourt Enugu (20km up and downstream Aba depot and Okrika Jetty PHRC line)
- Enugu–Auchi line
- Ascravos–Warri line
- Atlas Core–Mosimi Line
- Mosimi–Ore line, Satellite line and Ibadan line

Source: Report of the Special Committee on the Review of Petroleum Products Supply and Distribution, October 2000.

Recent developments in the Nigerian oil sector

It must be acknowledged that the government has embarked on significant reforms of the oil sector in recent years. These reforms are targeted at improving the efficiency and performance of the sector. The reforms include the following measures. First, NNPC has been commercialized and government has stated its commitment to privatize the refineries.[2] The government proposed a bid for the sale of the refineries in the second quarter of 2004. In addition, 20 private refiners were granted licences to start private refineries. Government, in spite of massive resistance from labour and civil society, has made efforts to liberalize product prices and to involve the private sector in imports of petroleum products.

Endeavouring to improve its financial and operational transparency, NNPC has started publishing its quarterly reports in national media. Its management has regularly appeared before the National Assembly to defend its operations and financial transactions. More importantly, Nigeria recently joined the Extractive Industry Transparency Initiative (EITI). This is part of a global initiative aimed at following due process and achieving transparency in payments by extractive industry (mining, oil and gas) companies to governments and government linked entities (including different levels of the state and state-owned companies). In addition, the Initiative aims to attain transparency in the flow of revenues in extractive industries. The National Stakeholders Working Group (NSWG) of the EITI in Nigeria was inaugurated on 16 February 2004 by President Obasanjo, who subsequently formally launched the Initiative on the nineteenth.

Since 1999, the government has set up different committees to examine various issues in the petroleum sector. In 2003, after a protracted nationwide fuel scarcity, the government inaugurated a panel headed by the Obi of Onitsha to among other things examine the causes of the crisis and proffer lasting solutions.

A similar panel had been earlier set up in 2000. The 34-member Committee, known as the Special Committee on the Review of Petroleum Products Supply and Distribution, was inaugurated by the Secretary to the Government of the Federation on 14 August 2000. According to its terms of reference, the Committee was to review all aspects of petroleum products supply and distribution in the Nigerian economy; recommend a structure of petroleum products supply and distribution to be developed over the next financial years that is self-financing and sustainable; recommend a structure characterized by absence of monopoly and freedom of several competing marketers to import and export products while encouraging private ownership of refineries; recommend "phased reform and price adjustments which will achieve the necessary self financing and sustainable system and prevent the trauma and economic disruption usually associated with adjustment of petroleum pricing"; and recommend a programme of consultation and public enlightenment to facilitate the smooth implementation of the necessary reforms.

The Committee has since submitted its report, although the labour group in the Committee came up with a minority report. Some of the recommendations even have time dimensions – immediate terms, those to be effected within 3–6 months; short term to be effected within 6–9 months; and medium term to be achieved within 9–12 months.

3. Review of the empirical literature

Energy plays a critical and positive role in economic development. It serves as an intermediate input to production, and thus changes in its quality and quantity affect the profitability of production and the productivity of other factors of production. Given the role of energy in the economy, most governments – especially in the developing countries – intervene extensively in the energy market.

However, the overwhelming dominance of government in energy supplies has led to failures in the supply of these products. Faced with declining economic fortunes and dwindling revenue, most governments in developing countries have found it increasingly difficult to keep pace with adequate provision and maintenance of the energy supply infrastructure. Moreover, the perception by government that the provision of the energy infrastructure is a social service affected its pricing and consequently its effectiveness. Not these alone, the traditional inefficiency associated with public monopolies in charge of energy affects the quality and reliability of their services.

The poor state of energy supply in developing countries has had a negative impact on economic performance. Producers have to resort to private provision usually at a higher cost. Lee and Anas (1992) report that manufacturing establishments in Nigeria spend on average 9% of their variable costs on infrastructure, with electric power accounting for half of this share. Elhance and Lakshamanan (1988) show that changes in the stock of economic infrastructure have important implications for the cost structure of manufacturing firms in India.

Similarly, a 1987 study focusing on the effects of power outages in Pakistan estimated that the direct costs of load shedding to industry during a year, coupled with the indirect multiplier effects on other sectors, resulted in a 1.8% reduction in GDP and a 4.2% reduction in the volume of manufactured exports. In India, a 1985 study concluded that power outages were a major factor in low capacity utilization in industry, and estimated the total production losses in 1983/84 at 1.5% of GDP (USAID, 1988). Similarly, power rationing in Colombia was estimated to reduce overall economic output by almost 1% of GDP in 1992 (Kessides, 1992).

Other enterprise level surveys conducted in several countries have found infrastructure costs and problems of unreliability to rank high among issues in the business environment. A 1991 survey of small enterprises in Ghana cited power outages, transportation costs and other infrastructure problems among the top four problems of operations (behind taxes), with this response strongest among “micro” and small firms. Small firms ranked electricity among their top four constraints to expansion (Steel and Webster, 1991).

Adenikinju (2005) examined the cost of electricity shortages on the Nigerian manufacturing sector. Utilizing the data obtained from a 1998 nationwide survey, the study confirms that the cost of electricity failures to the Nigerian manufacturing sector is quite high. Nigerian firms were found to incur huge costs on the provision of expensive back up to minimize the expected outage costs. The average costs of this backup are three times the cost of publicly supplied electricity. The marginal cost estimates also indicate that the cost of kWh of unserved electricity in Nigeria is very high. Small-scale firms bear the greater proportion of the cost of the power failure.

While most of the empirical studies have examined the impact of electricity failures and other infrastructure inadequacy on economic performance, only a few have bothered about the economic consequences of fuel supply shocks. The few examples include Chu and Grais (1994) and Grais (1987). Chu and Grais (1994) explore the short-term macroeconomic effects of energy supply shocks in Ukraine, and Grais (1987) examines the distributional and macroeconomic effects of higher energy prices on Thailand. Both studies adopted the methodology of the CGE model.

In the case of Nigeria, earlier studies on energy supply shocks have focused primarily on the electricity sector (Lee and Anas, 1991, 1992; Uchendu, 1993; World Bank, 1993; Adenikinju, 2005). These studies, using mostly primary data sources and a revealed preference approach, have examined the costs to the economy of electricity failures. While publicly supplied electricity has been a major militating factor against private sector growth in Nigeria, the private response to the electricity failure has also been hampered by fuel scarcity: There are cases of generators without diesel to run them. Hence, the impacts of oil supply shocks on the economy deserve a separate study. This is our focus in this study.

4. Theoretical framework

The theoretical framework adopted for this study follows conventional demand and supply analyses. We also assume a partial equilibrium framework where markets are presumed to be independent of other markets. In a free market equilibrium, the interplay of the forces of demand and supply provides an equilibrium that clears the market. At this equilibrium price *P**, demand and supply are equal and the desires of both suppliers and buyers are reconciled. Under strict assumptions about the nature of the supply and demand functions, the equilibrium freely arrived at should be stable and unique. Disequilibrium is temporary and transitory.

However, this analysis presumes that the market is allowed to operate without external interference, especially when prices are under one form of control or the other. Let us assume a commodity *x* is used by private and public sector but is supplied by the public sector. We assume further that the price of the commodity is essentially fixed by the government and is below the equilibrium market price. This is similar to the maximum price control case in economic theory. Under such a condition, excess demand occurs, and a parallel market develops where opportunities are created for privileged economic agents to receive rents as $P'>P$ is charged for consumers who are desperate to have access to the rationed commodity.

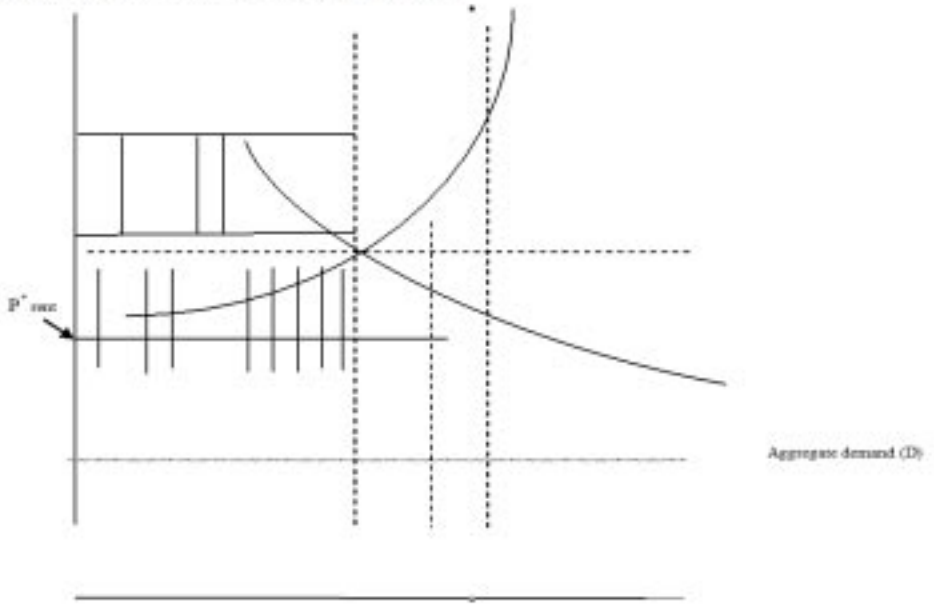
In the case of oil, however, we must take on board a number of factors in the analysis. A pseudo market equilibrium could be achieved where the official price, although lower than equilibrium price, does not lead to excess demand as long as the government or its agency is willing to absorb the difference between the theoretical equilibrium price and the price paid by consumers and as long as available supply is able to meet consumer demand at the prevailing price. Now from a society welfare point of view this may not necessarily be suboptimal as long as there is a mechanism available for the society to freely reveal its preference function.

A problem is likely to occur when the government is unable to fund the subsidy $S (= (P^*- P)*q)$. A maximum price control under this condition then creates consequences in which rationing becomes the dominant allocative mechanism, especially when demand exceeds supply at the controlled price. The maximum price breaks down as consumers bid among themselves for the available supply and where only those that are able to pay the price premium avail themselves of the limited supply. The opportunity for collecting rent in the parallel market then sucks supply from the open market, further reducing supply in the open market.

Now, the problem becomes aggravated when there is a significant supply shock. The gap between demand price and supply price increases and opportunity for rent rises. The problem with price control under this scenario is that the effective price is higher than the equilibrium price and the available quantity would be lower than the equilibrium quantity. In the absence of trade, the economic consequences of the supply disruptions are much higher under the controlled pricing policy, especially where the commodity serves as both an intermediate and final good.

One possibility for addressing the supply deficit is through trade. However, opening up the commodity to trade, if the commodity is a tradeable, may ameliorate but not fully address the problem. In the short run the supply shortages may remain binding and in the longer term, as long as the official price remains binding in the open market, private traders may be unwilling to import the commodity. Whereas we presume early that the government is unable to fund the resultant subsidy, the supply deficit will remain binding. The optimal solution in both cases is for the commodity price to be liberalized. Figure 6 illustrates.

Figure 6: The market for energy tradeables



5. Discussion of the modelling framework

There are two aspects of energy shocks that this study investigates – causes and consequences. In the first instance we try to provide an understanding of the causes of fuel scarcity and in the second to evaluate the consequences of the supply shocks on economic agents and economic activities in the economy. A computable general equilibrium (CGE) model was developed to enable us to capture the macroeconomic and distributional impact of energy supply shocks. The advantage of a CGE model is the endogeniety of prices and quantities and the importance of relative prices in resource allocation. This is particularly important in the Nigerian economy, which is undergoing deregulation and shifting of emphasis from government led to market forces.

The basic model follows the structure developed by Dervis, De Melo and Robinson(1982) and its application to Nigeria by Dorosh (1995). It also incorporates important elements from Chu and Grais (1994). The distinguishing features are the incorporation of unemployment equilibrium and the treatment of the energy sector.

The economy was disaggregated into 14 sectors, made up of 12 non-energy and 2 energy sectors, indexed *s* and *k*. This is to enable us to capture the feedback between energy and the rest of the economy and the differences among market closures, which depends on the tradeability of the commodity or specific policy interventions.

The price block

We assume that producers face given world prices for their exports. The equations in the price block define the domestic prices of the various categories of goods distinguished in the model. Thus the domestic prices of importables (PM_i) and exportables (PE_i) are given by the following two equations:

$$PM_i = PWM_i * (1 + tm_i) * ER \quad (1)$$

$$PE_i = \frac{PWE_i * ER}{1 + te_i} \quad (2)$$

where ER is the naira/US dollar exchange rate, PWM_I and PWE_1 are the world market prices (in US dollars) of imports and exports, respectively, tm_i is the ad valorem import tariff, and te_I is the export tax rate. For non-competitive imports, the domestic price PIM_i is also defined as:

$$PIM_i = PWI_i * (1 + tim_i) * ER \quad (3)$$

As far as producer prices are concerned, the price of the composite producer good XS_i is defined from the equation giving the value of domestic output, D_i:

$$P_i * XS_i = PD_i * D_i + PE_i * E_i' \quad (4)$$

where PD_i is the domestic sale price at factory gate, D_i domestic sales (valued at factory gate) and E_i the level of exports.

The equation giving the net price or unit value-added of an activity is:

$$PVA_j = P_j(1 - tprod_j) - \sum PC_i a_{ij} \quad (5)$$

where $tprod_j$ is the indirect tax rate in the sector, PC_i is the price of the consumer composite good to be defined later and a_{ij} the relevant input-output coefficients.

The user price (PC_i) of the consumer composite good is derived in a manner analogous to the derivation of the price of the producer composite good. Use is made here of the equation giving the value of domestic sales. We thus have:

$$PC_i * Q_i = PD_i * D_i + PMi * M_I \quad (6)$$

Two additional prices are defined in the model, the price of capital goods and the aggregate price index. The first of these is described by Equation 7:

$$PK_j = \sum PC_i * IMAT_{ij} \quad (7)$$

where PK_j is the price of a unit of capital in sector j, and $IMAT_{ij}$ is the (i,j) element of the capital composition (or investment) matrix, i.e., the demand for investment good i per unit of investment for sector j.

Finally, the aggregate price index is computed as a weighted average of user prices for composite goods. Thus:

$$PINDEX = \sum_I \vartheta_i * PC_I \quad (8)$$

where ϑ is the share of consumption goods i in total private consumption.

The supply block

The supply block is broken into two segments – the non-energy sector and the energy sector. The former comprises issues of labour, imports and export demand, among others. The main consideration in the latter is equipment.

Non-energy sector

The model assumes that the wage rate is fixed, implying that there is some rigidity in the labour market. Capital is assumed to be fixed in each sector and to be immobile. Sectoral production is guided by profit maximization subject to economic and technological constraints. We assume a simple Cobb–Douglas production function to represent value added in each sector. The choice is dictated by the ease of estimation and also because previous studies have shown it is appropriate for describing the Nigerian economy (Adenikinju, 1994).

$$XS_j = AD_j L_j^{\alpha} K_j^{(1-\alpha)} \tag{9}$$

where AD_j is a constant.

On the assumption that capital is fixed in each sector, perfect competition prevails and producers seek to maximize profits. This implies that labour input will be demanded up to the point where its wage equals its marginal value product. This condition is translated as follows:

$$W * L_j = \alpha_j * PVA_j * XS \tag{10}$$

The wage rigidity in the labour market then leads to unemployment equilibrium:

$$\sum_j L_j + u = L^S \tag{11}$$

where u is the endogenous unemployment level.

The producers allocate their output between local sales D_i and foreign markets E_i on the basis of relative prices and substitution parameters. Similarly, imported final goods and those that are domestically produced are aggregated into composite goods using the Armington principle of imperfect substitution between locally produced goods and their imported counterparts.

In terms of export demand, we also follow the example of most CGE models that assume some market power to the country, implying that the country faces a downward sloping demand curve for its exports. This is given by the following equation:

$$E_i / EO_i = \left(\frac{PWEO_i}{PWE_i} \right)^{\eta_i} \tag{12}$$

where $PWEO_i$ is the initial world price of exports and η_i is the elasticity of demand for exports of sector i.

Furthermore, if we assume that the allocation is made so as to maximize the value of domestic output given by Equation 3, subject to constant elasticity of transformation between domestic sales and exports, then:

$$XS_i = AT_i\left(\gamma_i E_i^{\psi_i} + (1-\gamma_i)D_i^{\psi_i}\right)^{1/\psi_i} \tag{13}$$

and the relative export supply is given by:

$$\frac{E_i}{D_i} = \left[\frac{PE_i^*}{PD_i} * \frac{(1-\gamma_i)}{\gamma_i}\right]^{\phi i} \tag{14}$$

For imports the country is assumed to face a perfectly elastic supply of imports at given world prices.

$$Q_i = AC_i(\delta_i M_i^{-pi} + (1-\delta_i)D_i^{-pi})^{-1/p_i} \tag{15}$$

where AC_i is a constant and δ_i is the share parameter.

Minimizing the cost of acquiring a unit of the composite commodity yields the following relative demand for imports:

$$\frac{M_i}{D_i}\left(\frac{PD_i^*}{PM_i^*} * \frac{\delta_i}{1-\delta_i}\right)^{\sigma_i} \tag{16}$$

where $\sigma = 1/(1+\rho_i)$ is the elasticity of substitution.

The non-tradeables market is distinguished by the absence of any foreign trade. The level of activity would be determined by the relative prices of inputs and outputs. The prices that users are charged clear the market. The equations for non-traded goods are simpler than those for traded goods. For non-exportable goods, Equation 13 reduces to:

$$XS_i = D_i \tag{17}$$

For non-importable goods, the aggregation Equation 15 becomes:

$$Q_i = D_i \tag{18}$$

The energy sector

Technology in the energy sector does not allow for flexibility, and labour demand is linked directly to the level of output. In the energy sector, existing capital determines the level of output. We assume that energy sector production is limited by equipment available

to exploit known reserves. The model captures the limitation by imposing a rigid relation between the capital stock and output of the sectors. Energy outputs are thus perfectly inelastic.

$$XS_k = \sigma_k K_k \qquad k = energy\ goods \tag{19}$$

$$L_k = a_k XS_k \qquad k = energy\ goods \tag{20}$$

The demand block

The model also identifies four institutions – households, firms, government and the rest of the world. Given the concern of this study with equity, we identify two types of households – the poor and the rich. The households save, consume and are taxed; the firms produce commodities, collect revenue from sales, are taxed and save; the government purchases goods and services, imposes taxes, provides subsidies, and saves or dis-saves; and the rest of the world purchases and sells goods and services to the economy and also saves.

Intermediate demand

Given the assumption that the amount of intermediate input i required in the production process j is in direct and fixed proportion to the level of output in sector j, the total demand for good i for intermediate use is given by:

$$INT_i = \sum_j a_{ij} XS_j \tag{21}$$

Private consumption

The consumption of commodity i by the household is assumed to be a fixed share of total expenditure:

$$PC_i * CD_i = Cles_i * \sum_h (Y_h - S_h - TDIR_h * Y_h) \tag{22}$$

where CD_i stands for real consumption of commodity i.

Savings is defined as

$$S_h = s_h * Y_h \tag{23}$$

Total income of households has two basic components: wages and returns to capital. Households derive their income from labour income flowing from the production process and from a share of the profit going to the firms in the economy.

The total income received by households is given by:

$$Y_h = \sum WL_{ih} + \lambda_h * \sum_i R_i K_i \tag{24}$$

Government current accounts

Let β_i^G and CG stand, respectively, for government expenditure shares and real government consumption; then government consumption of good i is given by the equation:

$$GD_i = \beta_i^G . CG \tag{25}$$

Government revenues are equal to import tariffs ($TARIFF$), export duties ($DUTY$), indirect taxes on production ($PRODTX$), direct taxes on households ($DIRTX$), direct taxes on firms ($DFIRM$) and tariffs on non-competitive imports ($COMPETE$):

$$GR = DFIRM + TARIFF + DUTY + PRODTX + DIRTX + COMPETE + TGF \tag{26}$$

$$TARIFF = \sum_i TM_i * PWM_i * ER \tag{27}$$

$$DUTY = \sum_i TE_i * PE_i * E_i \tag{28}$$

$$PRODTX = \sum_j TPROD_j * P_j * XS_i \tag{29}$$

$$DIRTX = \sum_h TDIR_h * Y_h \tag{30}$$

$$DFIRM = TK * (1 - \lambda) * \sum_i R_i K_i \tag{31}$$

$$COMPETE = \sum_I Tim_i * IMT_i * XS_i * PWI_i \tag{32}$$

Government savings is defined as:

$$GOVSAV = GR - \sum_i PC_i * GD_i \tag{33}$$

Other institutions

Firms receive all the incomes (YF) accruing to capital and allocate this amount as dividend payments to households and tax payments to firms (TK), while the balance is regarded as the savings of the firms (SF):

$$YF = \sum_i R_i K_i \tag{34}$$

$$SF = YF - ((TK + \lambda) * \sum_i R_i K_i) \tag{35}$$

Investment demand

Since this is a static model, it is worth mentioning that even though investment is a source of demand, it does not affect current capital stock. Investment by sector of origin is determined by the composition of investment in each sector:

$$ID_i = \sum_j IMAT_{ij} * DK_j \quad (36)$$

where DK_j is investment by sector of destination and $IMAT_{ij}$ are the fixed shares of investment good I in total private investment in sector j. Thus:

$$PK_j * DK_j = KIO_j * SAVINGS \quad (37)$$

where $SAVINGS$ is total savings and is equal to the sum of total household savings (S), government savings (SG), savings of firms (SF), foreign savings ($FSAV$) multiplied by the exchange rate (ER) and depreciation ($DEPRECIA$):

$$SAVINGS = \sum S_h + SG + SF + FSAV * ER + DEPRECIA \quad (38)$$

Depreciation is assumed to be a fixed percentage ($DEPR_j$) of the value of the capital stock in each activity j:

$$DEPRECIA = \sum DEPR_j * PK_j * K_j \quad (39)$$

Total disposable income Y is simply total factor earnings less depreciation:

$$Y = \sum_j PVA_j * XS_j - DEPRECIA \quad (40)$$

$$\sum_i PWM_i * M_i + \sum PMI_i * IMT_i * XS_i = \sum_i PWE_i * E_i + FSAV * ER \quad (41)$$

Macroeconomic adjustment and closure

The last block represents various equilibrium conditions and constraints. These include employment conditions in factor and goods markets. Capital is assumed to be sectorally immobile. In addition, the economy is assumed to be savings driven. Capital inflows are given in foreign currency; the country cannot borrow from the international market to finance its chosen level of domestic aggregate demand. Thus, the available savings generated domestically or transferred from abroad determines investment. The numeraire chosen for the model is the price of the basket of goods consumed in the economy.

The current account and foreign savings

The current account equation defines foreign savings (expressed in terms of foreign currency) as the total value of imports less the total value of exports:

Supply–demand balance

With respect to goods market, for each composite good *i*, supply must equal demand:

$$Q_i = INT_i + CD_i + GD_i + ID_i \quad (42)$$

where CD_i is total household consumption of commodity *i*.

Data sources

We derive our data from two sources – the CGE model and a survey of stakeholders in Nigeria's energy sector who represent economic actors in both the supply and demand of petrol products.

CGE model

At the centre of the CGE is the social accounting matrix (SAM). The SAM provides a snapshot of the economy in a given year. The equations for the CGE model follow closely the structure of the social accounting matrix. For this study a SAM based on 1999 data was used. Additional information was obtained from sources at the NNPC, PPMC, depots, etc.

An aggregated SAM for the economy in 1999 is presented in Table 6.

Table 6: An aggregated social accounting matrix for Nigeria – 1999 (in naira)

	Production	Commodities	Factors	Institutions	Capital	Gross output
Production	850,703	2,162,435			1,207,171	4,220,309
Commodities			3073,864		3,073,864	
Factors	3,153,521					3,153,521
Institutions	126,656		3,124,682	2,577,082	8,478	5,836,8961
Capital	89,430	911,429	28,839	185,951	92,486	1,308,135
Gross output	4,220,309	3,073,864.	3,153,521	5,836,897	1,308,135	

Source: Computed from FOS National Accounts, 1999 and FOS (1995) Input-Output table as updated by the Nigeria Institute of Social and Economic Research (NISER).[3]

Survey

We administered a total of 501 questionnaires to provide a microeconomic perspective on agents' perceptions of the causes and impact of fuel scarcity on their economic activities.[4] Although the questionnaires were limited to the city of Ibadan, arguably the largest city in Nigeria, which together with Lagos accounts for over 60% of total gasoline consumption in Nigeria, nevertheless, we have strong belief that the situation in Ibadan is typical of experiences in other parts of the country. The following areas of Ibadan were selected for the study: Akobo – Ojurin, Basorun, Iwo Road, Sango – Mokola, Sabo, Apata, University of Ibadan – Ojo, Ashi – Bodija, Ife Road and Gate.

The survey covers economic actors on both the demand and supply sides. These are:

- Supply:
  - Petroleum marketers
  - NNPC depot supervisors
  - Fuel station attendants
  - Fuel hawkers
- Demand:
  - Commuters
  - Vehicle owners
  - Business owners

The survey yielded a total of 413 usable questionnaires. Responses were analysed using ratios and percentages. The distribution of the respondents across the various groups is presented in Table 7.

Table 7: Distribution of returned questionnaires

Respondent	No. of questionnaires	No. returned	Per cent
Marketers	40	34	85
Petrol attendants	80	76	95
Fuel hawkers	80	72	90
Depot supervisors	1	1	100
Vehicle owners	100	76	76
Commuters	100	78	78
Producers/Businesses	100	76	76
Total	501	413	82

6. Analysis of survey results

The survey investigated both the formal and informal markets for fuel in the city of Ibadan. Usually, during the period of fuel shortages, the black market (informal market) takes over as the main source or major supplement to the formal market in meeting the needs of energy consumers. One thing that is very obvious from our study is that the formal market is the main source of fuel to the parallel market.

Methods of operations of the black market in fuel

The key agents in the supply chain are the petrol attendants, station managers, depot supervisors, marketers and tanker drivers.[5] Usually, these people have agents within and around the petrol stations. These agents are then favoured in the allocation of the available fuel supply. Profits from the sales of the fuel are shared between the principal and the agents on agreed percentage basis. Materials used include jerry kegs, cars' fuel tanks and motorcycles, polyethylene bags, buckets, generators, vehicles (buses and cars), drums, etc.

In some cases, marketers and station managers hoard large quantities of fuel, which are sold at night at above official prices or diverted to their agents in the black market. Sometimes, fuel hawkers are allowed to park their vehicles in petrol stations prior to the arrival of fuels and many of these vehicles, with various locally fabricated tanks having capacities ranging from 100 to 250 litres, are then favoured in fuel allocation.

Marketers and station managers sometimes also use their personal cars to purchase fuel, which is then siphoned immediately after leaving the station; this can occur as many times as possible. They also make alliances with petrol attendants in selling fuel at night around 9.00–10.00pm or early in the morning from 12.00am and the prices range from N40 to N60 per litre. Some marketers divert their product right from the depots to neighbouring countries or sell to other marketers at prices ranging from N35 to N45 per litre.

For depot supervisors, arrangements are made with depot operators/workers to add an extra amount to the official price. Alternatively, alliances are made with drivers to divert part of the product to other stations with agreement of higher price.

On the part of the tanker drivers, methods of operation include illegal increase in the size of the tanker reserve or siphoning some fuel before arriving at the petrol station. Some individuals also operate alone. They simply wait on queues to buy fuels, which they then resell at higher prices. Some of the commercial drivers interviewed actually found this to be more profitable than their regular business.

At some stations, in addition to selling on the black market, sundry charges are also imposed on consumers – for example before a driver is allowed to enter the station and/or at the pump point – with the amount paid varying with the quantities of fuel purchased (full tank or half tank).

Our findings also show that the standard measure of fuel on the black market is the four-litre can. Price paid per four litres varies from one centre to another, however, depending on a number of factors (Table 8). In business-oriented areas prices are high because buyers are desperate to buy to enable them to conduct their businesses.

Table 8: Determinants of price variations across locations

Characteristic	High price area	Low price area
1. Number of fuel stations in the area	Low	High
2. Dominance of type of marketer	Independents	Majors
3. Distance from fuel depots	Far	Near
4. Concentration of business activities	High	Low
5. Location	Settlers dominate	Indigenes dominate
6. Presence of fuel hawkers	Low	High

We also tried to investigate the relative price of fuel from the various sources of black market, as shown in Table 9.

Table 9: Price of fuel per litre across various types of black market operators

Source	Price range per litre
1. Petrol attendants in alliance with managers	N40–50
2. Marketers	N35–45
3. Tanker drivers	N40
4. Petrol attendants only on commission basis	N30
5. Depot supervisors	N35–40
6. Fuel managers	N30
7. Individuals	N28–32

In Table 10, we present the data description of the outcome of the survey. The table yields a number of interesting results. In respect of supplies of fuel, the survey shows that the average supply of gasoline fell from about 71,118 litres before the current fuel shortages to about 39,031 litres during the crisis, a decline of about 45.1%. The marketers also report an average loss of N94,953.33 per day during the fuel crisis.

It is also obvious from the table that the amount paid per litre of fuel also went up as a result of the crisis. Before the onset of the shortages, the government controlled price was N26.0 per litre. Prices rose significantly – to N216.57 per litre on average – during the crisis. In fact, some people pay as much as N500 per litre during period of fuel scarcity. As the responses of vehicle owners showed, however, they were able to pass on the effect of the higher prices to passengers. While the average fare per route before fuel shortages was N20 per passenger, it rose to N29.64 during the crisis, representing an increase of 48.2%. At the same time, the vehicle owners are willing to pay a higher price per litre for fuel. The same willingness to pay higher fuel price was reported by commuters if that would guarantee a stable supply of fuel.

Table 10: Data description

Variable	Mean	Minimum	Maximum	SD
1. Marketers				
Years of operation	7.25	0.4	23	7
Average supply of fuel before crisis (litres)	71,117.65	15,000	165,000	47026.43
Average supply now (litres)	39,031.25	10,000	198,000	47674.76
Losses per day (N)	94,953.33	7,000	500,000	167729.49
2. Vehicle owners				
How much paid on fuel now (N)	216.57	26.0	500.0	127.30
Amt charged per passenger before crisis (N)	20	5.0	30.0	8.87
Amount charged now (N)	29.64	10.0	40.0	10.09
Maximum amount willing to pay (N)	30.86	23.0	50.0	5.56
3. Petrol attendants				
Quantity of 4 litres sold per day	117.77	0	1500	357.92
4. Hawkers				
Amount paid per 4 litres (N)	162.94	104.0	250.0	38.89
Amount sold per 4 litres (N)	312.50	200.0	450.0	57.79
Profit made per 4 litres (N)	124.75	50.0	280.0	58.14
Quantity of 4 litres sold per day	21.76	4.0	80.0	16.39
5. Commuters				
Amt spent per day on fare before now (N)	74.87	10.0	500.0	92.24
Amt spent per day on fare now (N)	142.95	25.0	1,000.0	197.67
Appropriate price for fuel per litre (N)	27.75	15.0	35.0	4.76
6. Business/producers				
Losses per day (N)	1,432.69	50.0	10,000	2157.36

Source: Survey results.

Table 10 further reveals that sellers on the parallel market are motivated by the significant profit incentives. Fuel hawkers report that they pay an average of N162.94 per four-litre can of fuel from their principals (marketers, fuel attendants, station supervisors, etc.) and then sell the same four litres at about N312.50 on the black market. Reported profit per four-litre can of fuel is N124.75. If we multiply this by the average of 21.76 four-litres sold per day, we have an average earnings of N2,714.56 per day or N81,436.8 per month, which is several times the monthly minimum wage of N7,500 for federal workers.

We can also gauge the effect of the fuel scarcity from the amount spent by commuters on transport fare. As shown in Table 10, amounts spent per day on commuting rose from N74.87 before the fuel crisis to N142.95, representing an increase of 91% during the period of fuel shortages.

The following sections provide more detailed information about the various aspects of the fuel market during fuel crisis.

Petrol hawkers

Tables 11–14 clearly indicate that most of the actors in the sales on the black market are in the informal sector and are not first timers in the trade. In addition, the official market is the main source of supply to the parallel market. Furthermore, we see that prices paid from the various sources of fuel into the market vary.

Table 11: What job were you engaged in before coming into the business?

Prior profession	% of respondents
Driver	33.3
Artisan	22.2
Military	5.6
Business	16.7
Unemployed	8.3
Students	11.1
Others	2.8

Table 12: Is this your first time in hawking fuel?

Whether first time as fuel hawker	% of respondents
Yes	44.4
No	55.5

Table 13: Sources of fuel to hawk

Source of fuel supply	% of respondents
Agents to petrol attendants	47.2
Petrol station owners	11.1
Direct purchase from pump	27.8
Others	13.9

Table 14: Do the prices vary across source of supply?

Do you pay the same price across sources of supply	% of respondents
Yes	8.3
No	83.3
No response	8.3

Petrol attendants

Tables 15–19 reveal the perception of petrol attendants in respect of fuel crises. About 63% of the respondents agreed that they derive some benefits from petrol scarcity. The benefits come mainly in terms of opportunity to make more money (39.5%) and increased self-esteem (18.4%). About 57.9% of the respondents reported an increase in income during fuel crises.

Table 15: Do you derive any benefit from fuel shortages?

Any benefit	% of respondents
Yes	63.2
No	36.8

Table 16: Nature of benefit

Type of benefit	% of respondents
Opportunity to make more money	39.5
I feel more important	7.9
I have extra time for myself	18.4
Others	5.3
No response	28.9

Table 17: Impact of fuel crisis on total income

Impact	% of respondents
Increase significantly	23.7
Increase slightly	34.2
Remains unchanged	34.2
Decreased	7.9

Table 18: Do you sell black market?

Sell black market	% of respondents
Yes	31.6
No	63.2
No response	5.3

Table 19: On the average how many 4 litres do you sell per day?

No of 4 litres sold per day	% of respondents
Less than or equal to 10	15.8
10–20	5.3
20–30	7.9
30–40	0.0
41–50	10.5
51+	5.3
No response	55.3

Vehicle owners

Vehicle owners' perceptions of the impact of fuel scarcity on their operations and their adaptive responses are given in tables 20–28. A very high proportion of the vehicle owners reported that they found it more difficult to get fuel and spent almost a whole day at fuel stations before they could buy fuel. Most of the vehicle owners (71.1%) prefer government to monitor fuel stations and 24% support increase in the price of fuel in order to solve the fuel problem. Most of the vehicle owners were able to transfer the higher cost of fuel to their passengers.

Table 20: How do you get fuel for your vehicle?

Source of fuel	% of respondents
From fuel station only	50.0
From black market only	15.8
From both sources	34.2

Table 21: Compared with the past, how difficult is it to get fuel?

Ease of obtaining fuel	% of respondents
More difficult	86.8
Remains unchanged	13.2

Table 22: On the average how long does it take to get fuel at fuel station?

Length of time spent on queue	% of respondents
Less than 1 hour	5.3
1hr – 3hrs	21.1
3hrs – 6hrs	18.4
A day	28.9
More than a day	23.7
No response	2.6

Table 23: Which of these options would you prefer to solve the problem

Option to solve crisis	% of respondents
Increase price per litre	23.7
Go for black market	-
Government to monitor fuel stations	71.1
No response	5.3

Table 24: What is the state of your earnings now compared with before the crisis?

State of earnings during fuel crisis	% of respondents
Remains unchanged	26.3
Increases significantly	5.3
Increases marginally	15.8
Decreases significantly	18.4
Decreases marginally	18.4
No response	15.8

Table 25: How has this fuel crisis affected your work?

Impact of fuel crisis on work	% of respondents
I make less money per day now	13.2
I spend more time looking for fuel	39.5
The amount I spend on fuel has gone up	34.2
Reduce the number of trips I make	10.5
No response	2.6

Table 26: Would you support higher fuel prices?

Support for higher fuel prices	% of respondents
Yes	57.9
No	42.1

Table 27: Respondents willing to pay higher price for fuel by vehicle category (in percentages)

Vehicle type	Yes	No
Commercial	50.0	50.0
Private	62.5	37.5

Table 28: Maximum amount willing to pay for fuel per litre by vehicle category (in percentages)

Vehicle type	≤ N30.0	> N30 ≤ N35	> N35 ≤ N40	> N40 ≤ N50
Commercial	77.8	0.0	21.2	0.0
Private	84.2	5.3	5.3	5.3

Producers and business operators

Fuel scarcity has a major impact on the operations of producers and businesses (tables 29–32). It should be mentioned that this study focuses mainly on the informal sector operators. This notwithstanding, it is clear that fuel scarcity has a major negative impact on their activities. This comes in terms of higher cost of operations (74%), fall in capacity utilization (61%), decline in sales (74%), fall in profits (82%) and lateness of workers to office (32%).

Table 29: Has the cost of your business increased?

Impact on cost of doing business	% of respondents
Significantly	73.7
Not significantly	13.2
No change	7.9
No response	5.3

Table 30: Have you increased the price of your product?

Whether price of product has increased	% of respondents
Yes	15.8
No	26.3
No response	57.9

Table 31: Is the increase in the price of your product higher than that of your cost?

Increase in price higher than cost	% of respondents
Yes	31.6
No	52.6
No response	15.8

Table 32: Those who responded yes on the impact of fuel crisis on production component

Impact on aspect of business	% of respondents		
	Yes	No	No change
Capacity utilization has fallen	60.5	15.8	10.5
Sales have declined	73.7	18.4	7.9
Profits have declined	81.6	15.8	
My workers come late to work	31.6	31.6	23.7

Perceptions of causes and solutions to fuel scarcity by various respondents

Tables 33–36 show the respondents' perceptions of the causes of and solutions for fuel scarcity in Nigeria. A significant proportion of the respondents attributed the fuel crisis to the breakdown of refineries or inefficiency of the NNPC. Most of the buyers of fuel also pointed to political factors and the activities of marketers as aggravating the crisis.

Suggestions for resolving the crisis are mainly in terms of repairs of the refineries, increase in the pump price of oil, construction of more refineries and privatization of NNPC, in that order. Table 36 reveals that quite a significant proportion of actors in the demand and supply chains are willing to support higher fuel prices if that would guarantee stable fuel supply.

Table 33: Causes of fuel scarcity by respondent group (%)

Cause	Marketers	Attendants	Hawkers	Vehicle owners	Commuters	Businesses
Breakdown of refineries	52.9	44.7	47.2	47.4	35.9	42.1
High import cost	17.6	28.9	0.0	7.9	10.3	2.6
Political factors	11.8	7.9	50.0	18.4	43.6	34.2
Inefficiency of NNPC	17.6	18.4	2.8	18.4	10.3	21.1
Price too low				7.9		

Table 34: Who is responsible for the present petrol crisis by respondent group (%)

Factor	Marketers	Attendants	Commuters	Businesses
Government	82.4	60.5	48.7	34.2
Marketers	11.8	15.8	38.5	47.4
NNPC	5.9	21.1	10.3	0.0
Importers	0.0	2.6	2.6	2.6
Others				10.5

Table 35: Suggestion for solving fuel crisis by respondent group (%)

Cause	Marketers	Attendants	Vehicle owners	Commuters	Businesses
Privatization of NNPC	5.9	10.5	15.8	17.9	10.5
Increased the price of fuel	11.8	13.2	18.4	5.1	5.3
Repairs of the refineries	76.5	71.1	50.0	69.2	65.8
Others (build more refineries, increase monitoring)	5.9	2.6	13.2	7.7	18.4
No response		2.6			

Table 36: Proportion of those that support price increase

	Marketers	Attendants	Vehicle owners	Commuters	Businesses
% saying Yes	47.1	34.2	57.9	43.6	63.2

7. Analysis of simulation results

Two simulation runs were carried out to examine the major macroeconomic adjustments that took place during oil supply shocks. The simulation in Case 1 involved a 10% reduction in capacity utilization in the refineries. For Case 2, the simulation entailed the Case 1 scenario plus 20% increase in the import price of petroleum products.

The bases for the simulations are as follow: Case 1 is consistent with the recent experience of refineries that are currently operating at below full capacity. The fall in capacity utilization of the refineries has been the main reason for the petroleum shortages experienced in the country. Hence, modelling the fall in capacity utilization will enable us to understand the quantitative implications of the low capacity utilization in the refineries.

Case 2 combines reduction in capacity utilization with the possibility of an increase in the import price of petroleum products. This scenario recognizes the fact that an increase in demand for imports would also result in increased import prices.

To assess the impact of the simulation results a base run or benchmark equilibrium was first performed. We were able to replicate the initial equilibrium. Then we implemented the various scenarios to determine the effect of the shocks on the aggregate economy. The results are then compared with those of the base run and with each other in terms of changes in economic performance.

Case 1: 10% reduction in capacity utilization in the refineries

This simulation considers a 10% decline in refining capacity. The model assumes a rigid relationship between capital and output. The scenario was therefore implemented by reducing capital stock in the refining sector by 10%. The macroeconomic and distributional impact of the reduction in capacity utilization is presented in Table 37. From the table, we see a decline in real GDP of 0.47%. The fall in real GDP is also mirrored in the real income of the households. All households in the economy suffered as a result of the decline in fuel supply. Real income of rich households declined by 0.13%, and those of the poor households by 0.45%. This implies that the impact of the fuel supply decline is more severe on the poor households. This underscores the fact that there is distributional impact resulting from fuel scarcity.

Another macroeconomic implication of the fall in fuel supply is reflected in the external balance. The increase in price index leads to the appreciation of the naira, making imported

goods relatively cheaper than domestic goods. This results in the increase in aggregate imports by 0.11%, while exports rose by 0.05%, implying deterioration in the balance of payment position of the country.

Table 37: Impact of 10% reduction in refinery capacity on macroeconomic variables (percentage change from the benchmark case)

Variable	% change from base
Real GDP	-0.470
Price index	0.20
Import	0.112
Export	0.054
Private consumption	-0.224
Investment	-4.105
Government revenue	-2.487
Unemployment	3.632
Real income:	
Rich households	-0.126
Poor households	-0.447

Expectedly, aggregate private consumption fell by 0.22% and investment by 4.11%. The fall in aggregate output and real household incomes also resulted in a fall of 2.49% in government revenue. Finally, the fall in refinery output led to an increase of 3.63% in unemployment level.

Apart from its macroeconomic impacts, there are also sectoral impacts arising from decline in refinery output. As can be seen in Table 38, the following sectors recorded deceases in their production due to reduction in fuel supply: agriculture, paper, refinery, rubber and plastics, metals, transport, other manufacturing, and infrastructure. Only four sectors recorded increases: food, oil, textiles and services.

In the same vein, sectoral imports rose in some sectors, especially refinery with a sectoral increase of 184.9%. Other sectors that experienced increase in imports are rubber and plastics, metals, transport, and paper. Some sectors recorded a fall in exports. Exports also declined expectedly in some sectors led by the refinery sector with a decrease of 51.21%. This decline was mainly in those sectors that experienced a fall in sectoral output.

Sectoral prices increased in most of the sectors. Sectoral refinery prices recorded the highest growth of 108.33%, other manufacturing 10.9%, metals 4.18% and paper 3.32%. Agricultural prices rose marginally. Those sectors that were able to shift away from energy inputs were able to reduce their prices.

Table 38: Sectoral impact of 10% reduction in refining capacity (% change from benchmark case)

Sector	Output	Import	Export	Consump.	Price	Labour
Agriculture	-0.238	-0.087	-0.310	-0.300	0.091	-7.710
Oil	0.015	-1.420	0.109	0.390	-0.604	0.015
Food	0.117	-2.030	0.197	0.713	-0.925	3.310
Textiles	0.106	-1.495	0.927	0.732	-0.901	1.820
Wood	1.154	-2.800	3.259	2.154	-2.320	21.725
Paper	-0.602	5.016	-3.468	-3.420	3.317	-15.813
Chemicals	0.100	0.232	-0.185	-0.217	7.163	0.127
Refinery	-10.00	184.137	-51.208	-52.104	108.837	-10.00
Rubber & plastic	-0.002	2.917	-1.522	-1.887	1.702	-0.189
Metal	-3.708	5.427	-8.183	-4.221	4.181	-43.371
Transport	-0.049	0.005	-0.072	-0.220	0.300	-6.188
Other manufacturing	-2.831		-16.672	-10.027	10.904	-30.063
Infrastructure	-0.405	-0.420	-0.399	-0.212	0.005	-6.255
Services	0.102	-0.314	0.413	0.031	-0.248	3.750

Employment level also varies across the sectors in response to the fuel shortage. Most sectors reduced their employment levels. Only three sectors experienced marginal increase in employment. The sectors that recorded the sharpest decline in labour employment are metal products, other manufacturing, refinery and wood products.

Case 2: 10% decrease in refinery capacity and a 20% increase in refinery import prices

The second scenario we consider is similar to the first case plus an additional 20% increase in the import price of refinery products. The macroeconomic and distributional consequences of the scenario are reported in Table 39. The results follow the same trend as the first scenario. Real GDP fell by 0.50%, while real incomes of both the rich and poor households also declined by 0.10% and 0.45%, respectively. Overall price index rose by 0.22%. Aggregate imports increase by 0.21%, while exports declined

marginally by 0.05% due mainly to fall in domestic output. In the same vein, private consumption fell by 0.19% and domestic investment decreased by 4.04%. The impact of all of these on government revenue is also negative. Government revenue fell by 2.50% arising from the fall in real GDP, real income and exports. Furthermore, the overall unemployment level rose by 3.91%.

Table 39: Macroeconomic impact of Case 2 (percentage change from the benchmark case)

Variable	% change from base
Real GDP	-0.500
Price index	0.220
Import	0.214
Export	-0.053
Private consumption	-0.193
Investment	-4.040
Government revenue	-2.495
Unemployment	3.908
Real income:	
Rich households	-0.101
Poor households	-0.446

The sectoral impacts of the scenario are reported in Table 40. Output in most of the sectors fell, with the refining sector leading the pack. The key sector of agriculture also declined, albeit marginally. Output increased in six sectors, however, including the services sector.

In the tradeable sectors, imports fell in seven sectors and rose in six. Refinery, metals and paper led the sectors where imports rose. The case of exports is slightly different: Exports declined in nearly all the sectors. The loss of competitiveness and fall in sectoral output are largely responsible for the decrease in exports. The two exceptions were oil and the wood sectors.

The increase in sectoral prices in most sectors also resulted in a fall in private consumption. This is expected given the inverse relationship between demand and price. The rising sectoral prices resulted in decline in consumption in those sectors where sectoral prices rose and increases in demand where sectoral prices fell.

Table 40: Sectoral impact of 10% reduction in refining capacity and 20% rise in import price of refinery products (% change from benchmark case)

Sector	Output	Import	Export	Consump.	Price	Labour
Agriculture	-0.271	-0.208	-0.303	-0.277	-4.252	-7.710
Oil	0.124	-1.520	0.116	0.406	17.210	0.124
Food	0.115	-2.285	-0.128	0.927	0.026	3.310
Textiles	0.077	-1.723	-0.565	0.826	0.345	1.820
Wood	1.291	-0.113	2.014	2.628	-21.39	21.725
Paper	-0.577	4.795	-3.367	-1.332	-5.451	-15.813
Chemicals	0.125	0.840	-0.261	1.368	-8.218	0.943
Refinery	-10.00	165.476	-57.002	-58.332	76.391	-10.00
Rubber & plastic	-0.032	3.722	-1.897	-0.341	8.908	-0.189
Metal	-3.662	5.780	-9.754	-4.396	9.611	-43.371
Transport	-0.120	0.268	-1.577	-0.249	9.358	-6.188
Other manufacturing	-2.921		-18.763	-9.706	9.662	-30.063
Infrastructure	-0.461	-0.149	-1.871	-0.268	-3.883	-6.255
Services	0.186	-0.379	-1.103	0.065	-4.620%	3.750

From Table 40 we can also see the employment implications of the scenario. For most of the sectors, employment fell by as much as 42.96% in the metal sector, 30.8% in other manufacturing and 14.4% in the transport sector. This is largely a result of the fall in sectoral output given that demand for labour is a derived demand.

8. Summary and conclusions

This study has provided an analysis of the impact of energy supply shocks on the Nigerian economy. The study showed the structure of the energy market in Nigeria and provided an insight into the working of the parallel market in energy in the presence of supply shocks.

The use of both survey methodology and a computable general equilibrium model enabled us to obtain the perceptions of the key actors in the demand and supply chain of the downstream sector, as well as derive some insights into the operation of the market. The CGE model provides an opportunity to address the issues within a holistic framework. The model we employed reflected some key features of the Nigerian economy such as unemployment, structural rigidities in both labour and product markets, and the important role of government investment in the economy.

Our simulations gave us an indication of the magnitudes of the effects of supply shocks on the Nigerian economy. Two scenarios corresponding to the main sources of supply disruptions were considered in the study: first, a reduction in capacity utilization in the refineries, and second, a fall in refinery capacity utilization in the presence of rise in import prices.

The findings from this study show that quantitative restrictions on energy supply have negative impacts on the economy that are varied and intensive. The price changes required to clear the market when there is a supply shock could be quite high due to attendant distortions in the economy. This implies that the government must reduce its extensive involvement in the energy sector and allow the market to play a greater allocative role in the sector. The results of the survey also show that few players in the market chain benefited from supply disruptions and that in the final analysis only the consumers and the poor bear the main burden of these shocks.

Finally, we must emphasize that the modelling results presented in this study are indicative of the qualitative directions of impacts of policies and shocks on the economy. The quantitative values reported in this study should be seen as an approximate indication only. This is because the available data are only rough estimates of the actual developments in the various sectors. Moreover, comparative static simulations cannot fully capture the dynamic aspects of adjustment involving investment and economic growth.

Notes

1. Even then, until recently the dollar exchange rate was set at the government official exchange rate, which was substantially lower than the market rate.

2. It has been claimed that many oil companies prefer a management contracting approach to reforming the refineries rather than a direct sale (http://www.nnpcgroup.com, accessed 9 January 2004).

3. I thank G. Falokun for making the updated 1999 IO available to me.

4. The absence of a sample frame for Ibadan is a major limitation of the survey. After identifying the areas to be covered for the survey, the enumerators were instructed to ensure that the choice of respondents was fairly random.

5. Some fuel hawkers claimed that officers of the police force also supply about 2,000 litres of fuel to them every other day.

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