FNAS Journal of Mathematical Modeling and Numerical Simulation
Print ISSN: 3027-1282
www.fnasjournals.com
Volume 2; Issue 2; March 2025; Page No. 53-60.

Domestic Market Prospects for White Petroleum Products in Nigeria: An Analysis of Current Trends and Future Potential

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Abstract
The ancestry of the Nigerian petroleum industry is traced to 1956 when oil was struck in commercial quantities in the country. The first refinery came into existence in 1965, giving rise to the expansion of the oil industry vocabulary to include white products. The study focused on the trends and prospects for PMS, Kerosene and LPG in the domestic market. A 22-year time series of data was collected from reliable databases on the prices, production and consumption of the white products. Treated econometrically, trend equations were estimated, which showed that both consumption and prices were upward in the period under review for PMS, consumption was going downwards while prices were increasing for kerosene, and consumption was increasing for LPG, even with higher prices. Generally, the domestic market prospects were bright for all three white products investigated. The raw data were then transformed into their natural logarithm equivalents to estimate price elasticities for PMS and kerosene, and to estimate the cross elasticity between the rival products, kerosene and LPG. The own-price elasticity of demand for petrol came up as LPMSC = 1.816 + 0.02605 LPMSP, as LKeroC = 2.110- 0.3542 LkeroP for kerosene, and LGLPGC = -0.608 + 0.497 LKeroP for the case of cross elasticity. These interpreted to an unusual inelastic demand for PMS, an expected highly elastic demand for kerosene, and a theoretically correct positive cross elasticity between kerosene and LPG. These provided a basis for recommendations that urgent steps be taken to find substitutes for PMS to eliminate the captive market situation, and that the promotional efforts at LPG consumption be intensified, among others.

Keywords: Consumption, prices, price-effect, substitution-effect, elasticity.

Introduction
The ancestry of the world's petroleum industry is formally traced to 1859, in Pennsylvania, USA. According to Nnadi (1997), it was Edwin Drake who first struck oil following earlier studies conducted by Benjamin Siliman. In Nigeria, the era of oil began effectively in 1956 when oil was discovered in Oloibiri, in present Bayelsa State. Today, the country has five refineries whose operational activities have given rise to both white and black petroleum products. Wartsila (2023) lists black oils to include crude oil, furnace oil, fuel oil, tar and asphalt while the white span kerosene, petrol and benzene. The Nigerian domestic market for oil is dominated by the white products, including cooking gas or, more technically, liquefied petroleum gas. The paper is concerned with the trends in this market for these white products, namely petrol, kerosene and cooking gas. The objective is to establish whether the market for each is expanding or contracting as a basis for extrapolating into the future; to pinpoint the role of open market prices in these trends; and to evaluate the alleged substitutionality between kerosene and cooking gas on account of the trends affecting them.

Economic theorizing
In the market, buyers represent demand, and prefer lower prices while sellers, representing supply, prefer higher prices (Nnadi & Falodun, 2003). These contradictory tendencies create a constant tension in the market around the prevailing prices. It follows that higher prices create an economic incentive for buyers to reduce their consumption and foments a rivalrous economic incentive for sellers to increase their production. This brings up the price-effect and manifests in evident

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consumption variations attributable to the substitution-effect and the income-effect. The substitution effect occurs when more of a product, say LPG, is consumed as a direct result of a fall in its price; while the income effect occurs when the price ratio so changes as to make a consumer end up with more money to spend, as if his income increased (McKenzie, 2022). The consumer could just buy the old quantity and still go home with some change, called the consumer surplus, simply because there is a fall in the price of the product. However, the ease with which the substitution- and income-effects operate depends on the price elasticities of the goods involved and the cross elasticities between them, bordering on whether they relate in complementarity or in substitutionality.

Methodology

The study follows an *ex post facto* research design, a quasi-experimental procedure. The data on Premium Motor Spirit (PMS) or petrol; Kerosene and Liquefied Petroleum Gas (LPG) or cooking gas span a 22-year time series from 2000 to 2021. The sources are the US Energy Information Administration (EIA) and the National Bureau of Statistics. The statistics collected were analysed using an econometric approach. At the first stage, the raw data were used to calculate the trends showing price movements and the corresponding consumption of the products in the period under review. In the next stage, the figures were transformed into their natural logarithm equivalents and subjected to the Ordinary Least Squares (OLS) regression to produce the elasticity coefficients. All computations were done applying the Minitab Version 18 software. The log transformations were carried out with the IBM SPSS Version 20 software.

Results

First, the trends for the consumption of PMS, Kerosene and LPG are presented both geometrically and algebraically in Figures 1 – 6.

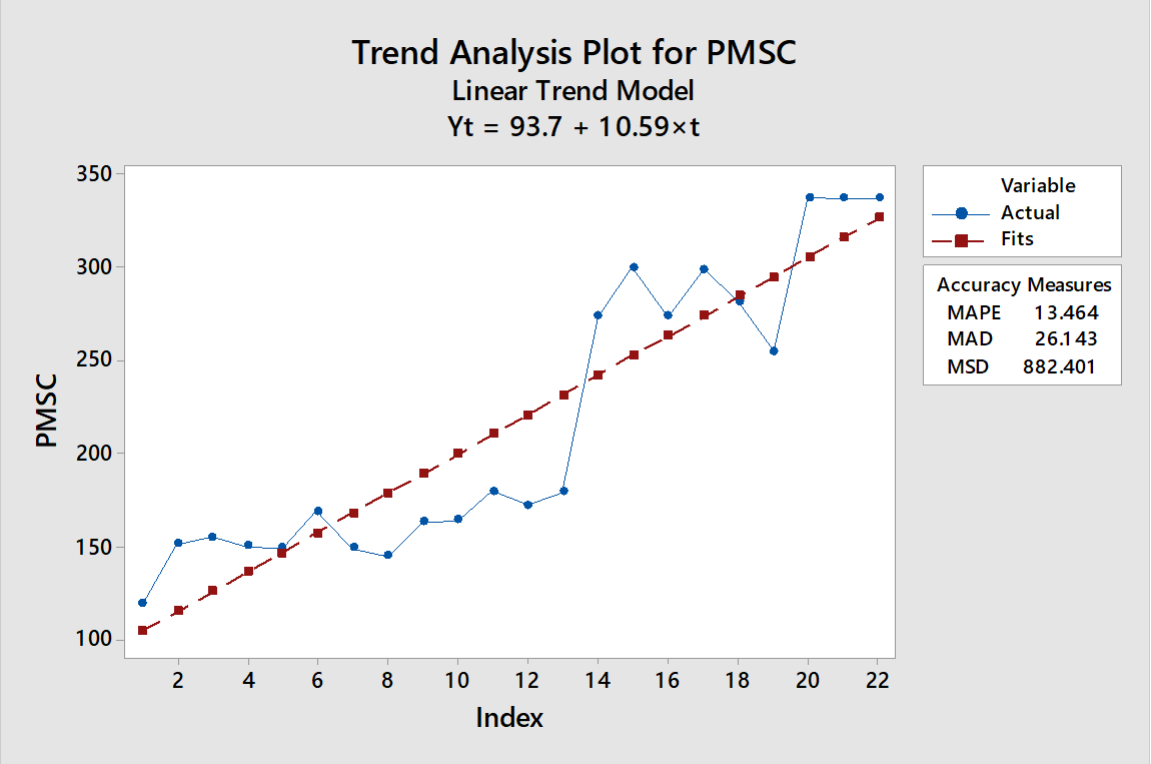

Figure 1: Petrol consumption trend

In the period under review, petrol consumption was rising as represented by the positive coefficient (10.59) in the embedded equation of the trend and demonstrated by the upward slope of the fitted line in Figure 1.

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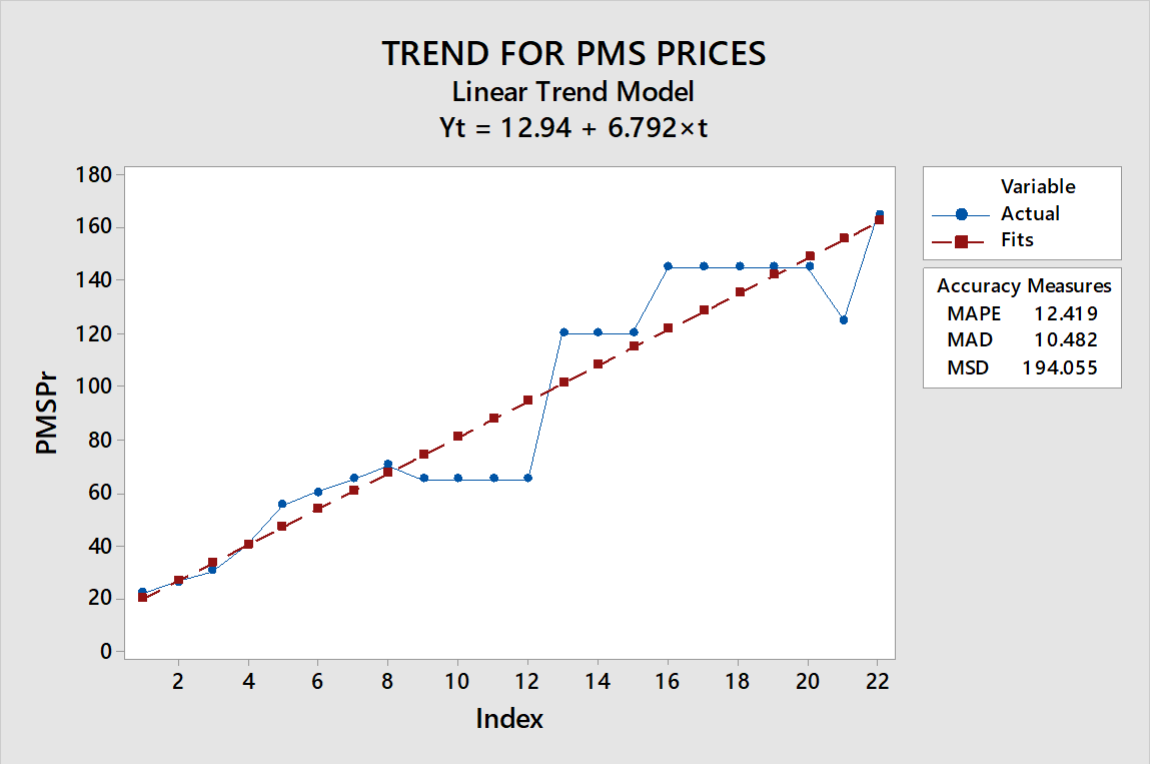

Figure 2: Petrol price trend

In the period under review, petrol prices were rising as represented by the coefficient (6.792) and demonstrated by the upward fitted line in Figure 2.

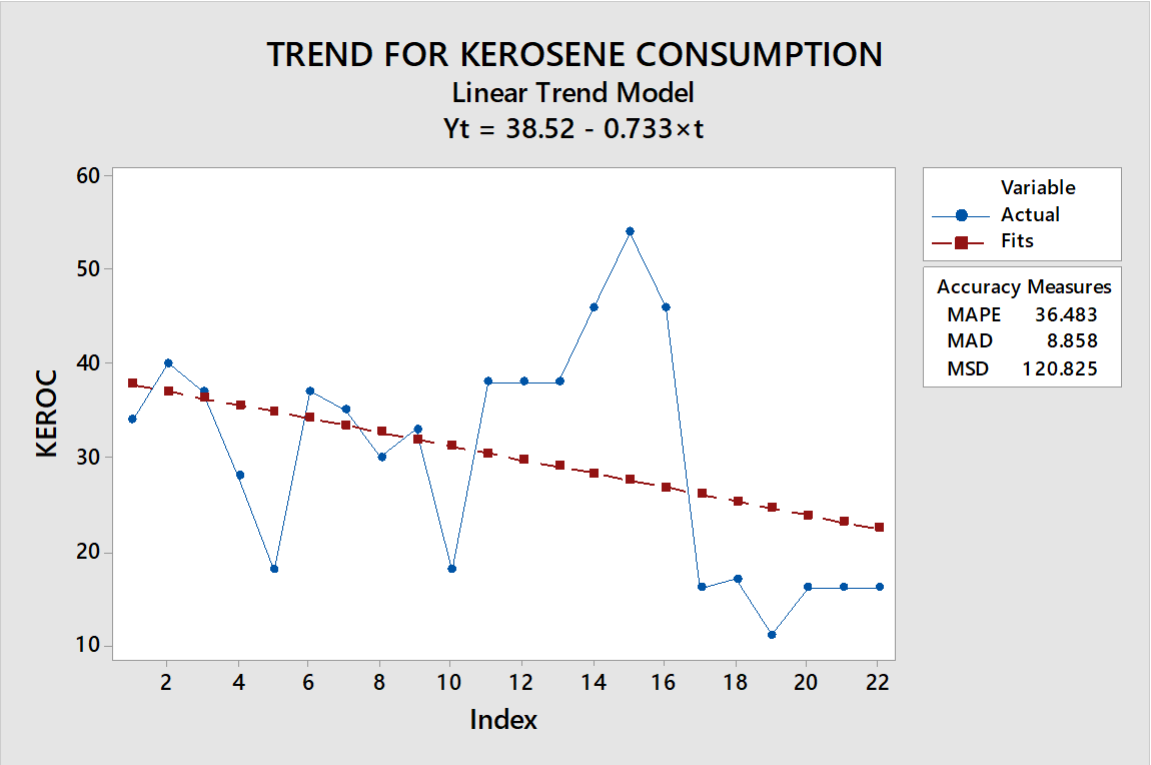

Figure 3: Kerosene consumption trend

In Figure 3, kerosene consumption was decreasing as indicated by the negative coefficient of the trend function (-0.733) and reflected in the downward sloping fitted line.

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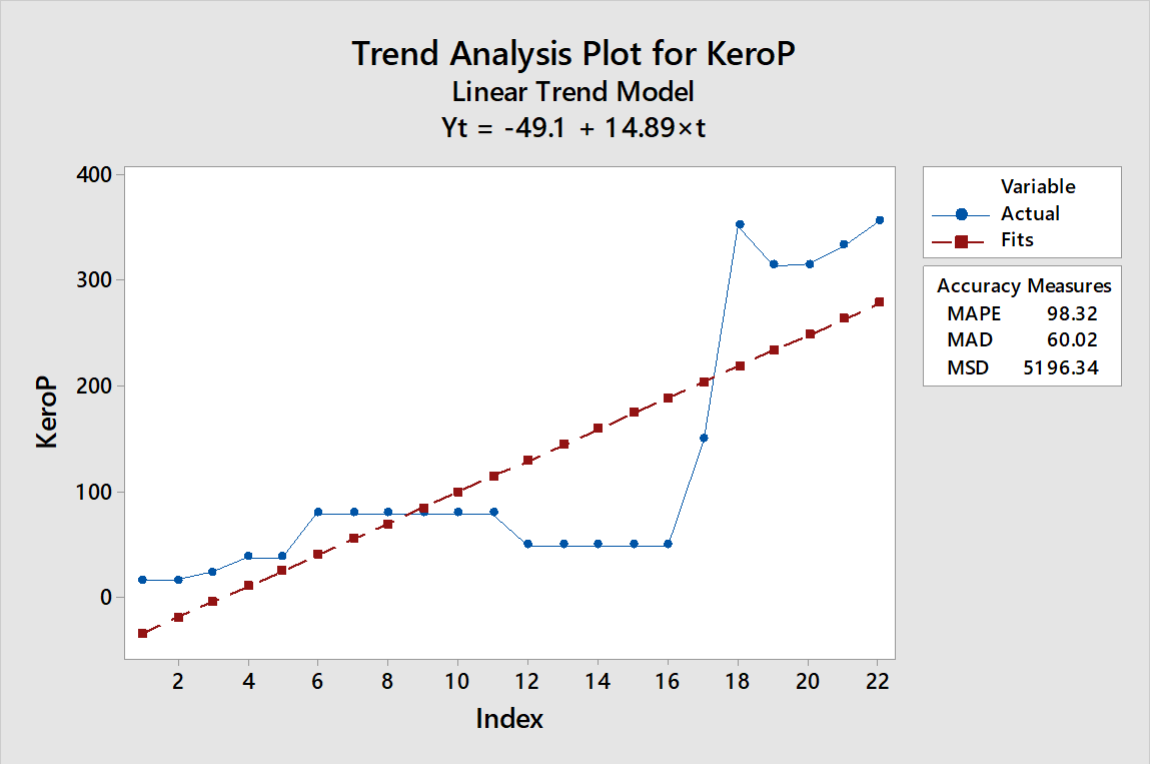

Figure 4: Kerosene price trend

In Figure 4, kerosene prices were increasing as indicated by the positive coefficient of the trend function (14.89) and reflected in the upward sloping fitted line.

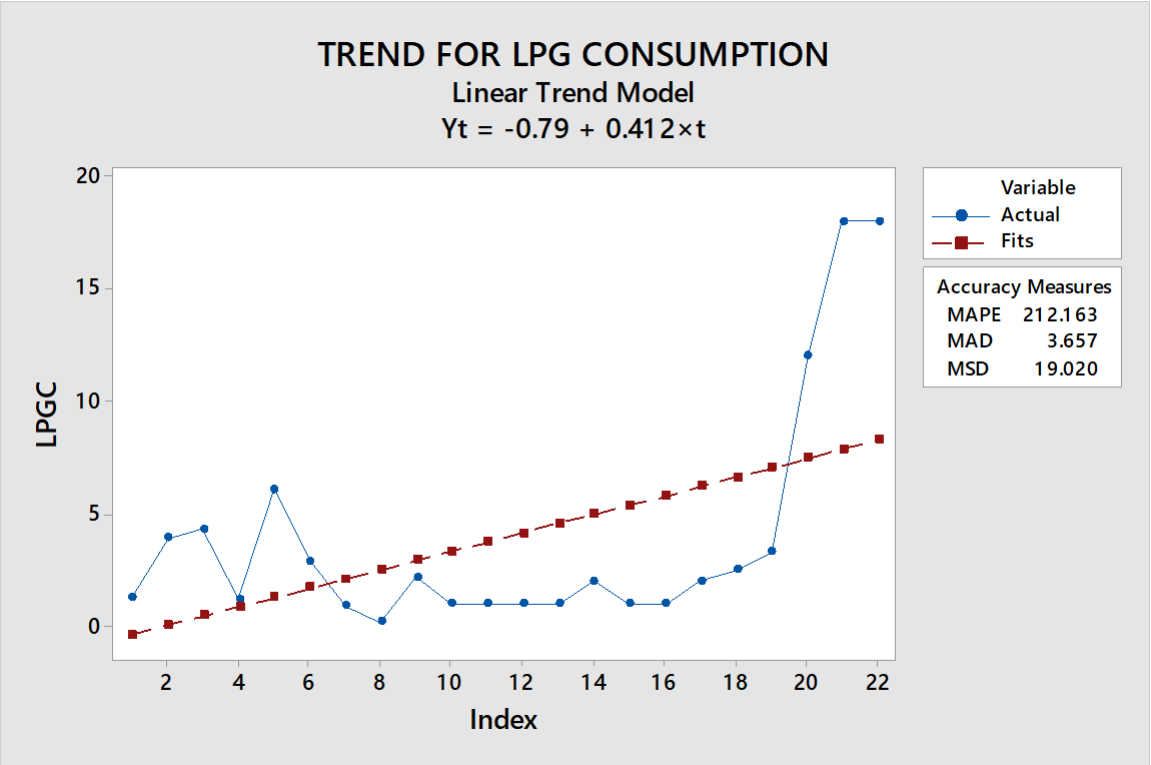

Figure 5: Cooking gas consumption trend

Figure 5 shows that cooking gas consumption was rising in the period under review. Algebraically, this is indicated by the positive parameter estimate of the trend function (0.412) and reflected in the upward slope of the fitted line.

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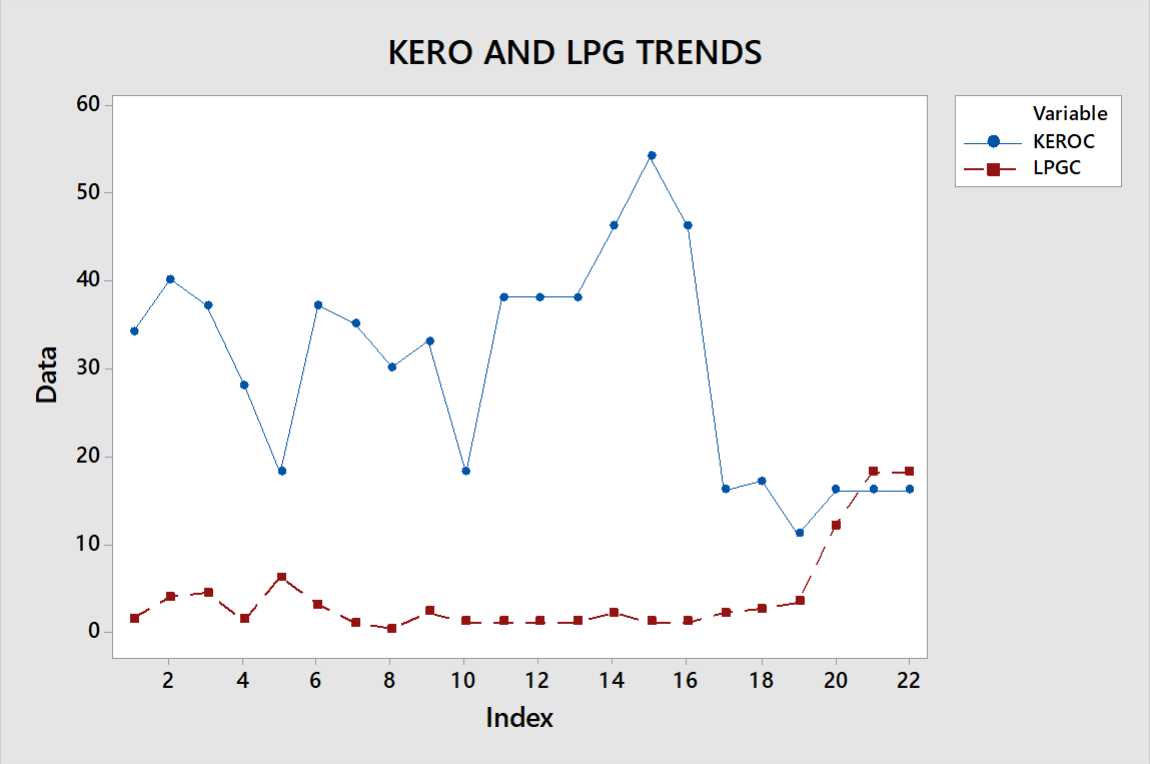

Figure 6: Kerosene and cooking gas consumption trends

Figure 6 features the trends for kerosene and cooking gas consumption together. The graphs show that kerosene consumption has been much higher than that of cooking gas, until after 2020 when the later equalised and outpaced the former.

The Elasticities

The elasticities here, presented as mathematical equations, are of two kinds. The first is the own-price elasticity – which measures the responsiveness of quantity demanded or consumed of a product to small changes in its own price. Of interest here are PMS and kerosene. How do these products respond to changes in their own prices as an index of the market outlook ahead? This is answered by looking at the coefficients of own-price elasticities.

The other elasticity is a cross-price elasticity – which measures the responsiveness of the demand or consumption for one product to changes in the price of another product, usually a rival or substitute. In this case, the attention is focused the responsiveness of the demand for cooking gas to small changes in the prices of kerosene, a well-known rival and substitute for cooking purposes. Details of the estimation procedure and output from computations are shown in the Appendix 2. According to Li et al (2023), the elasticity of demand is a measure of the response of demand to changes in factors that affect it, and may be positive or negative. Urbanek (2019) has applied the concept to public transport based on ticket sales data of a city in Poland.

Regression Equation 1: Own-price elasticity of demand for petrol

$$LPMSC = 1.816 + 0.2605\ LPMSP$$

Regression Equation -2: Own-price elasticity of demand for kerosene

$$LKeroC = 2.110 - 0.3542\ LkeroP$$

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Regression Equation 3: Cross-price elasticity of demand between LPG and Kerosene

LGLPGC = -0.608 + 0.497 LKeroP

Discussion

The major findings from the results of the analysis so far are now itemised. First, in the case of PMS reflected in equation 1, both prices and consumption were rising in the period under review, showing own-price inelasticity of demand, which has been satisfactorily analysed by Wu (2020) in relation to social services. For now, car ownership is a status symbol in Nigeria. Another explanation is that many vehicles on the road are driven for commercial purposes; creating a compulsive desire to remain on road to make more money as found by Yaman and Offiaeli (2022). Furthermore, to Nigerians, PMS is a necessary product having the characteristic of own-price inelasticity of demand as confirmed in out-of-pocket health care expenditures in Mauritius (Jeetoo & Jaunky, 2022). Second, equation 2 finds that the consumption of kerosene is quite both alert and responsive to own-price shifts - declining as price increases. The situation is characterised as one of own-price elastic demand. The third scenario here relates to equation 3 – the cross elasticity between cooking gas and kerosene. The results show that as kerosene prices go up, more of cooking gas is consumed, a classical example of substitutes since the coefficient of cross elasticity came up with a positive sign (+ 0.497). Pathak (2021) defines "complements as goods that individuals prefer to consume with another good, and substitutes as goods individuals prefer to consume instead of another good."

Conclusion

The market trends and prospects for PMS are still excellent at present. The characteristics of the outlook are one of price inelastcity and a growing trend of consumption. The combination of these two features means that pump prices can be increased without loss of demand and patronage. In fact, historical data shows that PMS customers will keep up their consumption levels and even increase this irrespective of pump price movements. A product enjoying such patronage is experiencing an ongoing boom. The main reason for this state of affairs is that for now, PMS has no close substitute and therefore seems to be benefitting from a captive market in consumers have nowhere else to turn to.

In respect of kerosene as a white product, the reverse is the case. That is, the market prospects are grim and the message could be said to be one of an obituary! Analysis of the database made it clear that there is unusual sensitivity of consumption to price movements. The upward trend in prices gave rise to a downward trend in consumption as patronage experiences a decline in the face of any increase in open market prices. Any market manifesting this characteristic is exiting and both production and sales will begin to nosedive. The major explanatory factor for this gloomy market outlook for kerosene is that it suffers from very keen competition from the substitute and rival product LPG.

The domestic market prospects for LPG are analogous to that for PMS. It is shown in the foregoing sections that LPG consumption is characterised by an upward trend. This is in spite of recent price increases. The rationale for the brightening prospects of LPG in the domestic market is that as the price of kerosene goes up, demand shifts away from it to LPG. Secondly, money not spent on high-priced kerosene becomes available as extra spending power to LPG users who thus increase their consumption. With this background, the current campaign for LPG consumption should continue.

Recommendations

1. The data yielded by this study provides adequate basis to recommend that conscious and more sustained effort be made to promote the use of fuels alternative to PMS. It is not cheering that demand remains strong for the product in the face of rising prices simply because there are no substitutes and consumers find themselves in a captive market. Captivity and bondage whether economic , political or spiritual are objectionable.
2. The study recommends that Compressed Natural Gas (CNG) and Liquefied Natural Gas (LPG) be used as alternative to petrol. According to Price Waterhouse Coopers (2020) the country has the ninth (9th) largest proven reserves globally. CNG offers improved fuel efficiency

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and is more environmentally friendly.

3. Also, on the basis of available evidence, the campaign to promote a switch to LPG seems to be yielding results. It is therefore recommended that the promotion be intensified through public enlightenment using the now heavily patronised social media, in addition to the tradtional use of the print and electronic media. Although the foregoing time series shows an upward trend in the use of the commodity, consumption is still low in Nigeria compared to some West African countries that do not produce oil.
4. The advocacy needs to expand to creating sufficient terminals, enhancing current storage facilities and the supply of the pressurised transportation vehicles that can take the commodity from the source to the ultimate consumers.

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Appendix 1

Year	Pet consumption (Mb/d)	PMS Consumption	PMS Price per litre (N)	GDP (B2015$PPP)	Dry Natural Gas production (*billion cubic feet*)b	Dry Natural Gas consumption (*billion cubic feet*)b	Kerosene production (million barrels per day)b	Kerosene consumption (million barrels per day)b	KeroseneAverage Price/litre (Naira) c	Liquefied Petroleum	Liquefied Petroleum Gas consumption (million barrels per day)b	Average Price /5 kg (Naira) c
2000	227	119	22	358.6	440	238	13	34	17	1	1.3	
2001	287	151	26	378.8	526	219	31	40	17	4.2	3.9	
2002	292	155	30	438	501	225	29	37	24	4.9	4.3	

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2003	280	150	40	470.2	717	301	16	28	38	1.1	1.2	
2004	280	149	55	513.7	770	329	12	18	38	0.7	6.1	
2005	310	169	60	546.8	791	366	25	37	80	2.9	2.9	
2006	250	149	65	579.9	1006	386	15	35	80	0.3	0.9	
2007	217	145	70	618.1	1148	374	6.3	30	80	0.2	0.2	
2008	277	163	65	659.9	1159	433	13	33	80	2.2	2.2	
2009	237	164	65	713	912	147	6.1	18	80	1	1	
2010	292	180	65	781.3	1024	178	12	38	80	2.8	1	
2011	280	172	65	819.9	1459	542	14	38	50	4.3	1	
2012	278	179	120	854.7	1503	547	11	38	50	3.4	1	
2013	429	274	120	900.4	1356	585	14	46	50	6.4	2	
2014	454	300	120	957.1	1548	667	13	54	50	2.4	1	
2015	410	274	145	982.9	1594	665		46	50		1	
2016	425	299	145	967.5	1475	653		16	150		2	2002
2017	426	282	145	975	1571	609		17	352		2.5	2377
2018	452	255	145	993.8	1609	654		11	315		3.3	2276
2019	483	338	145	1015.9	1635	663		16	316		12	1976
2020	493	337	125	997.5	1644	668		16	334		18	1979
2021	494	337	165	1033.5	1568	777		16	356		18	2923
2022												

Source: NBS - PMS Price Watch

US Energy Information Administration (EIA)

a. Statista

b. US Energy Information Administration (EIA)

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