

Instant Insight

Can the Dangote Refinery Deliver on its Promise?

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Introduction

In Nigeria, energy cost is the predominant driver of prices for all goods and services. With a population of over 200 million people, Nigeria is a member of the Organization of the Petroleum Exporting Countries (OPEC) and a major producer of crude oil in Africa. However, supply volumes from the country have been irregular; often fluctuating from below 1 million to over 2 million barrels per day due to vandalism and theft of the oil by organized criminal gangs (OCG), including corrupt stakeholders (Barnett 2023; Cartwright and Atampugre 2020; Yusuf 2022). Consequently, the country has persistently failed to meet its OPEC supply quota by over 21% of the expected supply (Grover and Lawler 2023). The downstream sector of the industry in Nigeria is also not spared of these challenges. Until January this year, the country had a total crude oil refining capacity of 445 kb/d, most of which were not functional or were operating at very low utilization (EIA 2023; Mbachu 2024). For these reasons, Nigeria imports almost all the refined petroleum products consumed in the country. In 2022, Nigeria imported about US\$23 billion worth of refined petroleum products from mostly Belgium, the Netherlands, and Norway (United Nations 2024).

Moreover, with a growing population and a developing economy, Nigeria is also confronted with other economic challenges occasioned by limited diversification and heavy dependence on crude oil exports as the primary source of foreign exchange earnings. Consistently posting a negative trade balance, there is often an imbalance in supply and demand of the U.S. dollar (USD) for international transactions. Having a fixed exchange rate between the Nigerian naira (NGN) and the USD did not ease the situation either; instead, it made repatriating foreign capital difficult amid the surging demand for USD. High demand for USD to facilitate imports of goods and settle external transactions significantly outstrips forex inflows, especially post COVID-19. Consequently, the economy demonstrates high sensitivity to changes in both crude oil and refined products prices. High energy prices – especially gasoline prices – have always been a source of discontent, which often resulted in strike actions and protests by organized labor and the populace

(Mbachu 2024; Dzirutwe and Eboh 2023; Anyaogu 2024; Oladipo 2024). Therefore, the Nigerian government subsidizes gasoline imports to control prices.

In 2023, following a change in government, the newly inaugurated president, Bola Ahmed Tinubu, announced on May 30 the end of gasoline subsidies and adoption of a free-floating exchange rate for the naira in the foreign exchange market. Prior to the inauguration, government officials had participated in the opening ceremony of a new mega refinery, the Dangote Refinery, which is reported to have a capacity of 650,000 barrels per day (kb/d) and a majority ownership by the Dangote Group. The Nigerian National Petroleum Company Limited (NNPCL) had also committed to a 20% stake in the refinery with a part of that commitment to be met through crude oil feedstock supplies (Payne and George 2023; Anyaogu 2024; Oladipo 2024). Nigeria also has a regulation under its Petroleum Industry Act (PIA) that

requires upstream companies in the country to allocate sufficient supplies of feedstock to local refineries (Eze and Okonkwo 2022). Nevertheless, crude oil exports are an important source of forex for the upstream companies, which are mostly international oil companies (IOC), with some having forex denominated debt obligations and long-term international supply contracts. Having floated the exchange and removed fuel subsidy, the government anticipates that domestic refining with the crude oil feedstocks and refined products traded in the local currency would release the pressure on forex supply.

Currently, these challenges have manifested in an ongoing crude oil supply crunch in Nigeria. Recently, Nigerian refineries, including the Dangote Refinery, increased their domestic crude requirements for the year

2024 from 483 kb/d to 598 kb/d, representing about 55% of feedstock demand at 100% utilization of existing refining capacities (Anyaoğlu 2024). So far this year, the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) has only been able to secure about 178 kb/d for the local refiners. Apart from the PIA provisions for priority supplies to domestic refiners, stake acquisition in the refinery by NNPC also entails allocation of crude supplies to the refinery. Facing various other commitments, including international oil-backed loans, NNPC has reduced their stake in the refinery to 7.25% as the Dangote Refinery seeks to sell the ownership share balance of 12.75% to new buyers (Oladipo 2024). In the ongoing supply constraints, the refinery began to source and import crude oil from abroad.

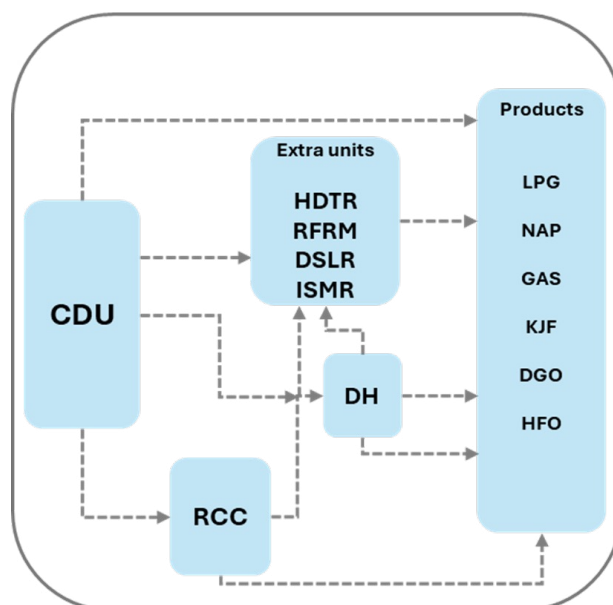
Dangote Refinery in Focus

The Dangote Refinery is the biggest single train refinery in the world, located in Lagos, Nigeria. It is reported to have cost about US\$19 billion to build with a crude distillation capacity of about 650 kb/d. According to the Dangote Group (the parent company), the refinery is expected to meet the liquid fuels demand in Nigeria and be able to export some of the products into the international market (Mbachu 2024). The refinery was started up in late 2023 and began supplying refined products to the market in December 2023. From startup of the plant to the middle of this year, it secured 18 million barrels of domestic crude and about 9 million barrels of West Texas Intermediate (WTI).

Using the KAPSARC Oil Refinery Analyzer (KORA) model and input data about the Dangote Refinery from Platts World Refinery Database, the refinery's design configuration has been identified as a Configuration 7 according to a refining complexity-based classification scheme presented in previous research (Umeozor 2024). Figure 1 shows a simplified process flow of the refinery indicating major process units and products considered.

On a refinery complexity scale of 0 to 39, the Dangote plant is considered a relatively low-complexity refinery. It is designed to optimize performance with crude oil feedstocks of low density and low sulfur content – known as light-sweet crude oil – while producing high yields of liquid fuels such as gasoline and diesel.

Figure 1. Simplified process diagram of the Dangote Refinery (see the Appendix for nomenclature list).



Source: Author.

Competing in the Nigerian Downstream Markets

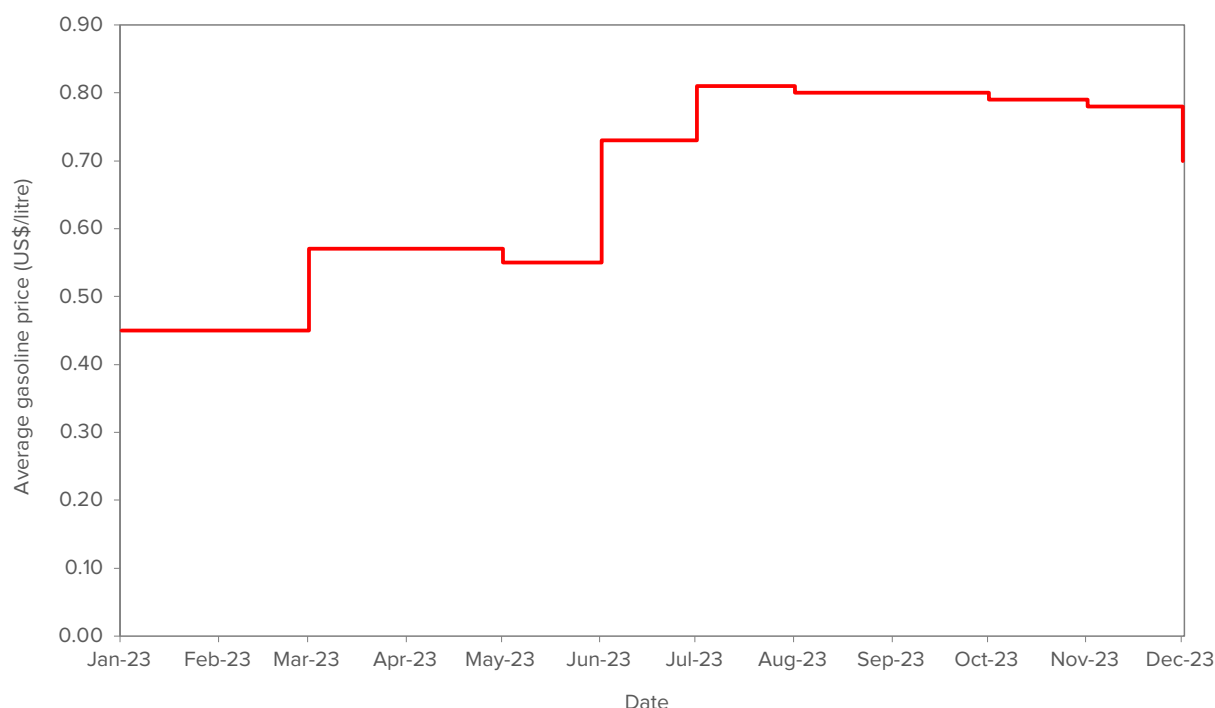
The transportation system in Nigeria relies heavily on gasoline-powered vehicles for both private and commercial movement of people and goods. Hence, inflation (especially CPI inflation) is known to be mainly driven by higher fuel prices impacting the transportation sector (Mbachu 2024). For this reason, the Nigerian government subsidized gasoline consumption in the country. Moreover, since most of the existing refining capacity in the country, prior to Dangote refinery's existence, could not supply enough refined products to the market, the government also subsidized imported gasoline. In 2023, the average gasoline price in Nigeria during the first five months (before subsidy removal) was US\$0.52 per liter. After subsidy removal occurred in June 2023, the average price of gasoline for the rest of the year was about US\$0.77 per liter, amounting to implied subsidy payments of about US\$0.25 per liter. Figure 2 shows the average gasoline price in Nigeria in 2023, including pre- and post-subsidy prices.

Before subsidy removal, daily gasoline consumption in Nigeria was estimated at about 66.9 million liters. After subsidy removal, the daily consumption estimates by the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) dropped to about 28% (Reuters 2023). Some of the reasons for the sharp decline in demand include the collapse of gasoline smuggling into black markets in the neighboring countries like Cameroon, Benin, and Togo, as well as fraudulent importers engaging in round-tripping by collecting multiple subsidy payments for the same gasoline cargo. Considering the pre-subsidy demand and the fact that practically all of it has been imported amounts to annual subsidy payments of about US\$6.1 billion, of which about US\$1.7 billion was lost

to fuel smugglers and fake invoicing. Furthermore, the annual value of gasoline imports can be estimated at about US\$19 billion. United Nations Comtrade database reported a total trade value in imported refined petroleum product in Nigeria during 2023 to about US\$21 billion (United Nations 2024).

Within the last year since subsidy removal, inflation has jumped from about 22% to 34% (Mbachu 2024). The local currency has also depreciated from around NGN 500 to about NGN 1,500 against the USD. The country has seen a series of protests by labor unions calling for a return to the subsidy regime. As the Dangote Refinery ramps up supplies of various products into the local

Figure 2. Average price of gasoline in Nigeria (before and after subsidy removal in June 2023).



Source: PPPRA¹.

market, the government hopes that it will relieve the demand for dollars, stabilize the naira and reduce fuel prices. Although the refinery has been operating in its commissioning phase and is scheduled to start producing gasoline from this month, it has been supplying other refined products to the market. Since it started supplying the market, diesel prices have dropped from NGN 1700 to NGN 940 per liter. However, if the exchange rate had not been floated by the government last year, these prices would have been around NGN 570 and NGN 310, respectively. So, Nigerians are still very concerned about high energy costs and how that has translated into higher costs of other goods and services in the country.

Some experts have argued that Nigeria cannot float the naira and remove the fuel subsidy at the same time; one of these needs to be controlled to manage forex speculation and its impact on the prices of imported goods, especially given the forex scarcity and heavy dependence on imports (Mbachu 2024). Dangote is also

requesting that the government enforces provisions of Nigeria's PIA requiring all upstream operators to meet the crude oil demand of local refiners before exporting, and to do so in local currency, even though the PIA provision also permits such transactions to be done in U.S. dollars as well (Mbachu 2024; Eze and Okonkwo 2022).

The Dangote Refinery is a private business that must compete with refined petroleum product importers and other local refineries to survive. This raises questions about the competitive strategy needed for the Dangote Refinery to be able to sustainably deliver on its targets of supplying competitively priced products into local and international markets. How much of the local gasoline demand can Dangote satisfy? Apart from the locally sourced feedstock, is there a competitive opportunity from other major feedstock suppliers such as the United States or Saudi Arabia? What is the best tradeoff if government policies on exchange rate and fuel subsidy must incentivize energy affordability for Nigerians?

¹ Petroleum Products Pricing Regulatory Agency (PPPRA) of Nigeria which was recently collapsed into the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA).

To address these questions, KORA is used to model production and assess performance of the Dangote Refinery under three scenarios:

- Baseline – the refinery is run with 100% Nigerian light-sweet crude oil.
- Optimal GAS – the refinery is run to optimize yield of gasoline (GAS) regardless of feedstock diet.
- Optimal NCM – the net cash margin (NCM) is optimized regardless of feedstock diet.

Subsequently, the implications of policy options on exchange rate, fuel subsidy, and PIA regulation compliance on gasoline prices and refining margin performance are also investigated for each scenario. KORA categorizes world crude oils into six grades based on density and sulfur content. Grades such as Brent, WTI, and most Nigerian crudes are of low densities and sulfur contents; therefore, they are under the light-sweet crude category. Table 1 shows the crude oil quality classification criteria used in KORA.

Table 1. Categories of crude oil grades based on density and sulfur characteristics.

Crude Grade	Density (API)	Sulfur (%)
LSW	> 34	< 0.6
LSO	> 34	> 0.6
MSW	> 25 & < 34	< 0.6
MSO	> 25 & < 34	> 0.6
HSW	< 25	< 0.6
HSO	< 25	> 0.6

The Arab Super Light from Saudi Arabia is also under this category, with an API gravity of 48-50 degrees and sulfur content of 0.05%-0.1%. Arab light and Arab extra light are also light crudes but with slightly higher sulfur contents, classifying them as light-sour crude grade. Table 2 shows details of crude grade categories included in the analyses with KORA. The average Brent price for

2023 is adopted as a benchmark, and grade differentials are assigned to the other crude grades, as shown in the table. Additionally, S&P Global Platt's average 2023 price assessments for refined products in Amsterdam, Rotterdam, and Antwerp (ARA) – the main export ports for shipping refined products to Nigeria – are also utilized in KORA.

Table 2. Data inputs to KORA for crude grades and refined products, including grade differentials.

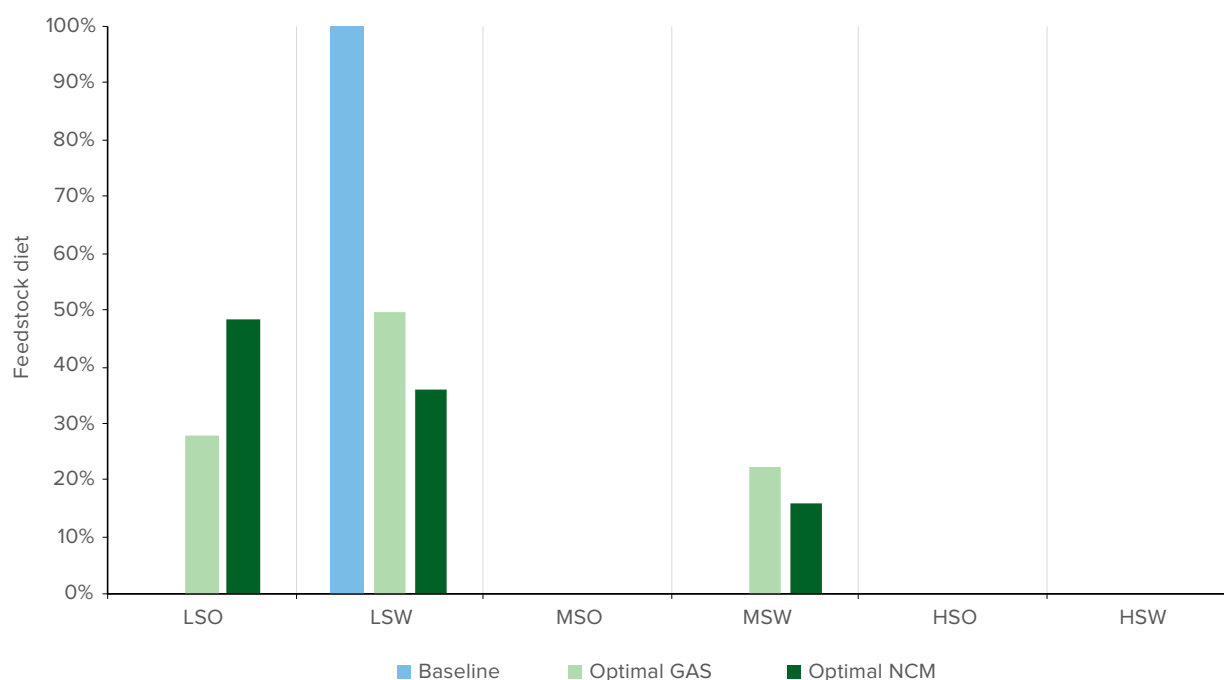
Crude Feed (grade)	Average Price (US\$/bbl)	Grade Differential (US\$/bbl)	Product Type	Average Platt's Assessed 2023 Price in ARA (US\$/bbl)
LSW	82.62	0	LPG	43.60
LSO	80.62	2	NAP	71.87
MSW	78.62	4	GAS	102.75
MSO	76.62	6	KJF	111.55
HSW	74.62	8	DGO	110.85
HSO	72.62	10	HFO	74.46

*See acronym definitions in the Appendix.

In the baseline scenario, the refinery operation is simulated with a diet of only one crude grade – the LSW, which is assessed at the average price of Brent crude. In the Optimal GAS scenario, KORA optimizes the yield of gasoline from the refinery using historical information of existing best-in-class refineries of the same design

configuration as the Dangote Refinery to benchmark operational parameters. In the Optimal NCM scenario, the objective function in KORA is set to refining margin (net cash margin – NCM basis) maximization. Figure 3 shows the feedstock diets for the three scenarios investigated with KORA.

Figure 3. Compositions of crude feedstock by grade in the three scenarios assessed.

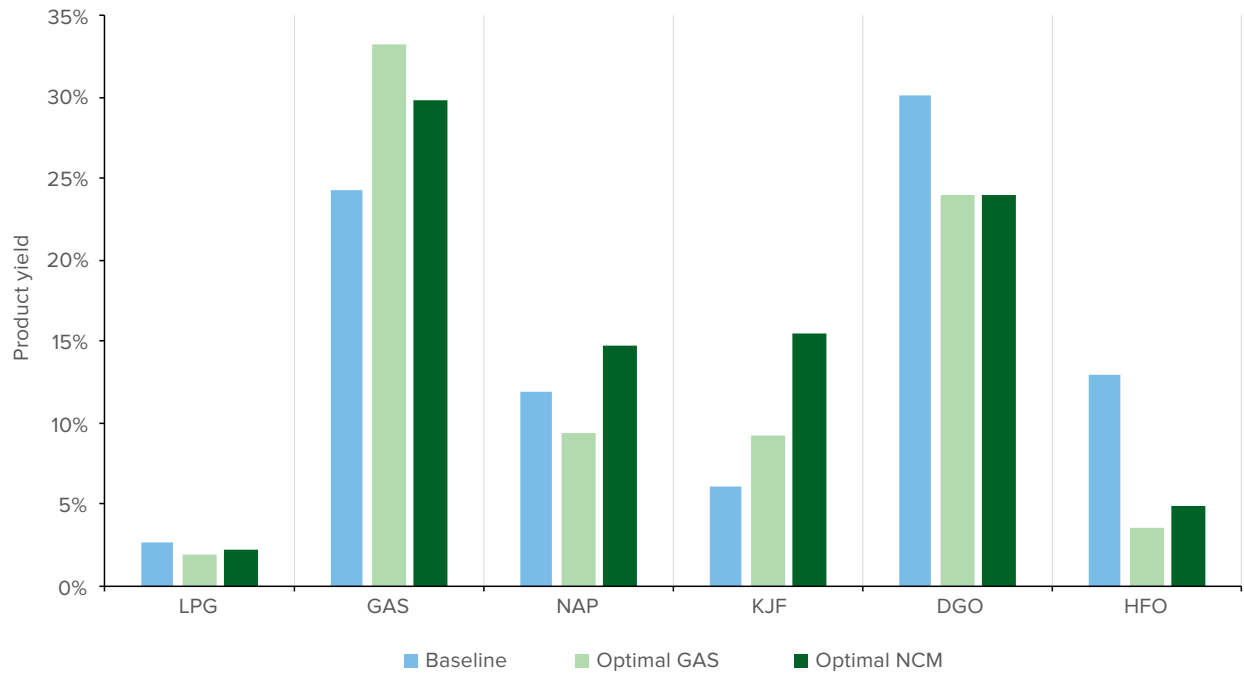


Source: Author.

Apart from the LSW crude, which is specified in the baseline scenario, two additional crude grades (LSO and MSW) are proposed in the optimal gasoline yield and NCM scenarios. Figure 4 shows the obtained refined

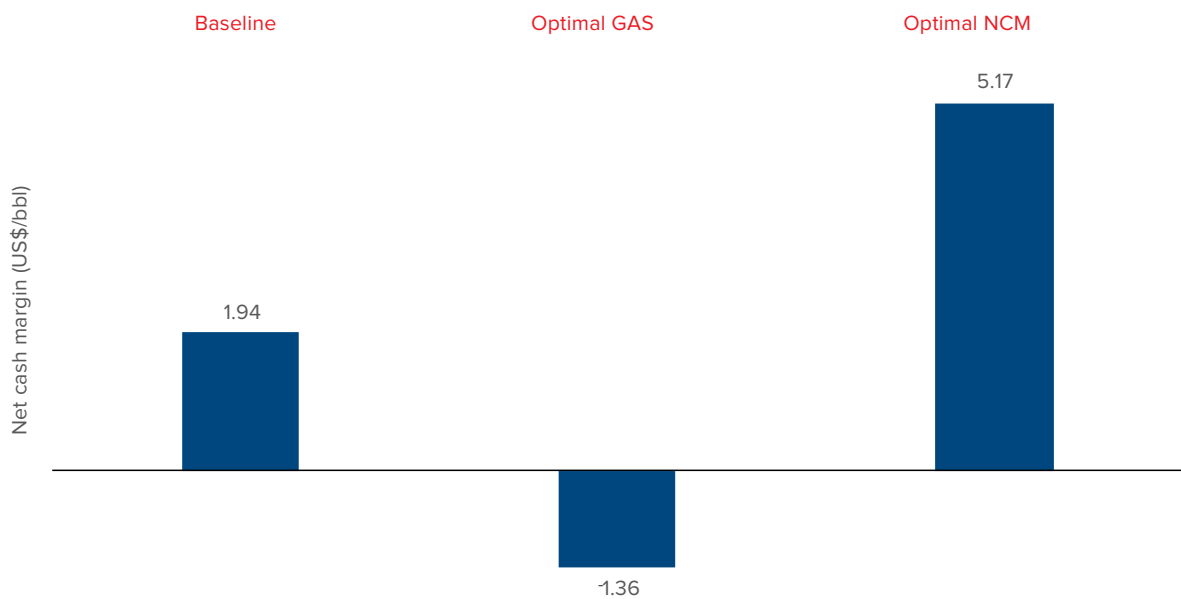
product yields from the Dangote Refinery under the assessed operational scenarios, whereas Figure 5 shows the corresponding refining margin of the plant under each scenario.

Figure 4. Refined product yields from the Dangote Refinery under the three scenarios analyzed with KORA.



Source: Author.

Figure 5. Evaluated Dangote Refinery margins under the three scenarios analyzed with KORA.



Source: Author.

The baseline scenario posts a refining margin of US\$1.94 per barrel with gasoline production of around 157.45 kb/d. The optimal gasoline yield scenario provides the highest gasoline yield of 215.25 kb/d from the refinery but it is also uneconomical, resulting in a loss of US\$1.36 per barrel on a net cash margin basis. The optimal margin scenario has the highest margin per barrel of feedstock of US\$5.17 and gasoline production of 194.07 kb/d. When these volumes are compared to the pre- and post-subsidy removal demand volumes of 420.75 kb/d (or 66.9 million liters per day) and 304.09 kb/d (or 48.4 million liters per day), respectively, as reported by the NMDPRA in Nigeria, it is expected that the Dangote Refinery cannot satisfy the total domestic demand for gasoline. Even if all the naphtha yield in each scenario is processed and added to the gasoline pool, it would amount to approximately 235 kb/d for the baseline, 276 kb/d for the optimal gasoline scenario, and 290 kb/d for the optimal margin scenario. All of these amounts are less than the post-subsidy demand.

Nevertheless, the optimal margin scenario would also supply the highest gasoline if all naphtha yields were channeled to the gasoline pool. It can be expected that the gasoline supply gap will be filled by other local refineries or imports. In terms of feedstock diet, the optimal margin scenario requires a crude blend of 36% LSW, 48% LSO, and 16% MSW compositions. This LSO requirement, totaling approximately 313.75 kb/d, could be procured by the refinery in the form of Arab Light crude from Saudi Arabia. This will help the Dangote Refinery overcome current feedstock supply challenges while improving its margin performance. Apart from crude oil cost, the typical global shipping rate for crude (including transportation and other logistical expenses) ranges between US\$2 to US\$4 per barrel. Considering the proximity of shipping from Saudi Arabia to the Lekki port where the Dangote Refinery is located, a shipping rate of US\$2.5 per barrel would translate to an official selling price (OSP²) of US\$0.5 per barrel to Dangote. For this scenario, this still leaves the Dangote Refinery with an NCM of about US\$2.67 per barrel, which is still higher than margins from the alternative scenarios.

² The OSP is calculated as the difference between cost, insurance, and freight (CIF) price (\$83.12/bbl) of supplied crude grade and the benchmark crude grade (Brent) price (\$82.62/bbl).

Policy Implications on Domestic Gasoline Price

The optimal NCM scenario would entail an annual forex demand for Arab Light procurements of less than US\$10 billion, which is less than half of the current receipts for petroleum product imports (both pre- and post-subsidy removal) from ARA. Considering the challenge to control fuel smuggling and fraudulent invoicing under the refined products importation and subsidy regime, it is reasonable to consider the foreign exchange rate as the viable instrument to improve fuel affordability while minimizing leakage under the current dispensation. Moreover, if the domestic crude supply transactions to the local refineries are completed in the local currency, forex demand would be reduced even further. Therefore, should the government sustain fuel subsidy removal but return the exchange rate to the pre-June 2023 level of around NGN 500 to US\$1, the average 2023 ARA-assessed price of gasoline of about US\$0.65 per liter (or US\$102.75 per barrel) would imply about NGN 325 per liter instead of about NGN 975 per liter at the current exchange rate.

Furthermore, if the difference between the average post-subsidy gasoline price of US\$0.77 per liter and the average ARA-assessed price during the same period stems from transportation and logistical costs (which are essentially absent for supplies from Dangote to the domestic market), this would imply a potential reduction in subsidy bill to around US\$0.13 per liter instead of the previous subsidy regime bill of US\$0.25 per liter. With this reduction, if a subsidy regime is reinstated at this new level, it would amount to about NGN 260 or NGN 780 per liter with the old or new exchange rates, respectively. The total annual subsidy budget would be about US\$2.3 billion. However, fuel smuggling into neighboring countries could add an additional subsidy cost of about US\$0.9 billion per year. Previous government subsidy payments on imported gasoline were said to have covered about US\$10 billion of the value of those imports (Reuters 2023).

Supposing that the Dangote Refinery was to transfer US\$0.5 per barrel of its optimal margin to the gasoline consumers as a discount, combining gasoline and naphtha yields in the optimal NCM scenario would produce about 0.45 barrels of gasoline equivalents per barrel of processed crude feed. This would translate to gasoline price reductions of only about NGN 10.5 per liter with the current exchange rate and NGN 3.5 per liter with the previous exchange rate. Consequently, Dangote's refining margins are unlikely to incentivize affordability for consumers. However, it is essential for the existence and sustainable operation of the plant. Essentially, the existence of the Dangote Refinery presents the government with policy options to effect affordability while minimizing forex demand.

Conclusions

The KAPSARC Oil Refinery Analyzer (KORA) model is used to simulate and optimize operational performance at full steady-state capacity of the new Dangote Refinery, located in Lagos, Nigeria. Three operational scenarios are evaluated, capturing the baseline operation, optimal gasoline, and optimal net cash margin, which are critical performance metrics relevant to the downstream market in Nigeria. The study highlights a potentially valuable opportunity for exporting Arab Light and Arab Extra Light from Saudi Arabia to the Dangote Refinery at a competitive OSP. It also addresses potential trade-offs by Nigerian policymakers in managing feedstock supply challenges and the affordability of refined products in the country. With a sustainable supply of suitable feedstocks to the refinery, it is positioned to have a positive impact on Nigeria's downstream market. Already, diesel supplies from the refinery have triggered competition and crashed retail prices by about 45% (Dangote Group 2024).

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Appendix

Table A. Nomenclature list.

Acronym	Definition
CDU	Crude distillation unit
DGO	Diesel/gas oil
DH	Distillate hydrocracker
DSLR	Desulfurizer
GAS	Gasoline
HDTR	Hydrotreater
HFO	Heavy fuel oil
HSO	Heavy sour crude oil
HSW	Heavy sweet crude oil
ISMR	Isomerizer
Kb/d	Thousand barrels per day
KJF	Kerosene/jet fuel
LPG	Liquified petroleum gas
LSO	Light sour crude oil
LSW	Light sweet crude oil
MMb/d	Million barrels per day
MSO	Medium sour crude oil
MSW	Medium sweet crude oil
NAP	Naphtha
RCC	Resid catalytic cracker
RFMR	Reformer



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