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Economic Analysis of the Potential benefits to Nigeria of the new Dangote Oil refinery

Yusuf Usman Ahmed[1], Muhammad Usman[2*]
[1]PE Energy Limited Port Harcourt, Rivers state.
[2*]Gafai Education Resource and Research Centre, Katsina.
Corresponding author: usmanmuhammad27@gmail.com

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Abstract

Nigeria is among the largest oil producers and consumers in the world. The lack of sufficient domestic refining capacity necessitated the country to rely on the import of petroleum products. Adequate domestic refining capacity can substitute the import, improve its deficit balance of payment (BOP), add value to GDP, strengthen Naira, etc. Fortunately, a Dangote refinery with a projected refining capacity of 650,000 barrels per day is under construction in the country and is expected to begin operation in 2023. This study sourced time series data from the period 1995 to 2020 on Nigeria's total balance of trade (proxy of BOP), Oil import, and GDP to forecast their future values until the year 2040 without the refinery's contribution using the conventional Econometric Methodologies. Furthermore, Sensitivity Analysis along with the Monte Carlo Simulation was used in forecasting the refinery's output, input, output price, and input price values between 2020 to 2040, those values were used in estimating the refinery's contribution to Nigerian BOP and GDP. Findings reveal that without the refinery, Nigeria's BOP deficit will escalate. Conversely, the refinery's output will satisfy local demand and export surplus, and GDP will be enhanced by the refinery's value added. However, the colossal refinery might abuse the dominant market position if the government failed to create an enabling environment for competition.

Key Words: *Dangote, Refinery, Nigeria, Petroleum*

1.0 Introduction

Nigeria is the largest producer of petroleum in Africa and the sixth largest oil producer in the world. Over two million barrels (320,000 m^3) are produced daily in the Niger Delta region of the country, estimates revealed that the region's oil reserves are about 38 billion barrels (Isumonah, 2013). Whereas BP's statistical Review for 2021 reported Nigeria's proven oil reserves of 36.9 billion barrels at the end of 2020. Oil operations started in the 1950s in the region, which were conducted by multinational corporations thus, provided the country with the essential technology and finance to drill oil. Nigeria is a country that is blessed with huge oil reserves and about 200 million people which positioned the country among the largest oil producers and the most populous country in Africa. The giant of Africa consumes a huge quantity of petroleum products. However, the lack of sufficient domestic refining capacity necessitated the country to be importing a significant quantity of refined petroleum products which is negatively affecting the country's balance of payment, gross domestic product, foreign exchange, etc. Interestingly Aliko Dangote refinery that is under construction has the potential of changing the status quo. Therefore, the study aimed to analyze the impact of the forthcoming refinery on our economic development.

From 1990 to date, Nigeria's total refining capacity is 445,000 barrels per day of crude oil. The country has four refineries which estimated to provide 60,000 bpsd, 150,000 bpsd, 110,000 bpsd, and 125,000 bpsd for Port Harcourt refinery I, Port Harcourt refinery II, Kaduna Refinery, and Warri Refinery respectively (*Refineries and Petrochemicals*, no date). The country's refining capacity is not significant to satisfy even its domestic need for refined petroleum products not to mention for export purposes. For many decades Nigerian government through NNPC has been making efforts to increase its refining capacity but some setbacks peculiarly high rates of corruption in the country have made it unsuccessful. A large refinery can improve the country's economic condition through import substitution which will yield the economy foreign exchange earnings, positive balance of payment, increase gross domestic product (GDP), reduce inflation rate (15.63% as of 2021 NBS report), currency appreciation, reduce the unemployment rate, etc.

The purpose of this study is to estimate the potential benefits of the Dangote refinery to the Nigerian balance of payment and the wider economy. From the construction phase to the ongoing operation phase of the refinery will bring direct, indirect, and induced economic impacts to the Nigerian economy (Goldberg, 2013).

2.0 Literature Review

2.1 Mega Domestic Refinery as an Antidote to Nigeria's 'resource curse'

"The theory of resource curse" postulates that in most cases resource-rich countries do experience negative socioeconomic consequences from their abundant natural resources. Ideally, possession of significant natural endowments even by a developing country should cause sound economic growth as these resources should be utilized to boost various sectors of the economy. However, most of the developing countries are paradoxically experiencing low economic growth, civil conflict, inefficient institutions, more dependent on developed countries, adverse balance of payment, high rate of unemployment, more income inequality, depreciation of currency (Dutch disease), etc (Omoregie, 2019).

Studies observed that resources-rich countries fail to achieve economic growth due to the enclave state of their oil industry. In other words, the economic activities of the upstream sub-sector oil industry are dominated by foreign investors and employees, and its output is geared towards export as the downstream sub-sector is inefficiently managed by the national (low refining capacity) thus the value added of the refining activities is benefited by the foreign economies leaving the resource-rich countries with merely a fraction of economic rent from upstream (rentier economy). Any policy by developing countries that will foster domestic refining capacity will improve their economic growth via import substitution and multiplier effects on various sectors of the economy, but some political considerations made it difficult for developing countries to easily accomplish that.

According to Baur, S. (2014), a developing country like Nigeria can overcome its resource curse by improving its domestic refining capacity which will enhance its economic and institutional performance. Enhancement of the downstream sub-sector particularly the refining activities will boost the availability of petroleum products, and their consumption, improve linkages to other sectors and consequently diversify the economy. Baur's empirical results revealed that there is a positive correlation between economic growth and a reduction in refined petroleum products importation (Baur, 2014). Nigeria can maximize the benefit of the oil sector by expanding its supply chain through the Dangote Mega refinery.

2.2 Import Substitution Strategy

In the 1950s and early 1960s primary products export were no longer lucrative for many developing countries, a persistent increase in their balance of payment deficit became a predicament and the general perception was of their minimum level of industrialization. Thus, they adopted a development strategy known as “import substitution”. The approach implies an attempt to replace imported products hitherto, with domestically manufactured products. The strategy uses Tariffs and quotas on the targeted imported commodities to handicap their competitiveness against the newly established domestic industries, (infant industries) products until the infant industries attained economies of scale (lower average cost)(Todaro, 1992). Furthermore, the balance of payment will improve eventually as the importation of the consumer good is drastically reduced and export replaced the prior import. However, after about twenty years of import-substituting experience, particularly in Latin America some adverse effects emerged. First, the foreign firms were set up in third-world countries, well protected with tariff walls, liberal tax, investment incentives, etc. by the government but these foreign investors remitted most of their gains abroad and the remainder usually accrues to the wealthy local industrialists with whom the foreign investors colluded to maneuver the system. Secondly, the foreign (and domestic) companies had to import heavy and often government-subsidized capital and intermediate products and that’s a minus to the balance of payment. The worst scenario was the foreign manufacturers deliberately set up capital-intensive industries to patronize their parent and sister companies abroad and that is not helping the purpose of import substitution. Thirdly, import substitution came with the artificial over the value of the local currency against foreign currency which has a detrimental effect on the local primary commodity producers' export.

Many economists and governments of developing countries in the early post-war years considered “import substitution” as the most effective strategy of development, and industrialization as a solution to their economic vulnerability. Import substitution involved setting up domestic industries protected by tariffs and quotas. Initially, the process began with manufacturing consumer goods then later capital goods were incorporated into the process. It was anticipated that imports would be substituted, and economic growth would be evolved. Additionally, it was hoped that the cost of the strategy will be shifted to the advanced economies that are supplying them with manufactured commodities. Unfortunately, the consequence of the process turned out to be adverse as their balance of payment deficit improved and their dependence on the advanced economies escalated instead. There was import structural change: intermediate goods and raw materials became of high significance while finished consumer goods become trivial. The second adverse effect was that export was discouraged as the domestic exporters had to purchase inputs at higher prices vis-à-vis the world market from indigenous firms hiding behind tariffs and quotas. Furthermore, the policy allowed the exchange rate to be overvalued relatively which disadvantaged export as the foreign exporters found it expensive to import from developing countries. The policy also worsens income inequality. The wage rate in cities became higher than the rural wage rate, which brought rural to urban migration, and consequently, unemployment in the urban areas evolved (Pearce, 1992).

3.0 Methodological Framework

This study utilizes a descriptive research design, and the decision was based on the fact the study covers an empirical and analytical structure (Brooks, 2008). A time series data was sourced from the National Bureau of Statistics (NBS), Central Bank of Nigeria Statistical bulletin, and Nigerian Petroleum Corporation Limited between the period of 1995 to 2020. Furthermore, Data on Dangote Refinery throughput was collected from the refinery's websites as well. Data on crude oil prices were also collected from the BP Statistical Review of World Energy 2022. The balance of trade was a proxy for the balance of payment in the study. The objective of this study is to use the collected data on Nigeria's balance of trade, oil import, and Gross Domestic Product in forecasting future values of the variables without considering of Dangote refinery used the refinery's projected output value and input value (only crude oil) to predict import substitution and value-added to be contributed by the refinery to Nigerian balance of payment and Gross domestic product respectively. Servicing of Debts by the dan Dangote refinery to foreign creditors will be negative on the BOP account but that was ignored in the study. The study assumed all the refinery's crude oil will be sourced domestically for the period.

3.1 Model Specification

The classical linear regression model assumption was used in this research as we have three macroeconomic variables to forecast their future values.

Time series data are normally subject to seasonality, trend, and stationarity problems at their level form (Table 1). Hence data are expected to undergo tests to find the existence of those components (if any) in the level form of the series. Furthermore, some series exhibit explosive behaviors (convexity) and that has to be treated with logarithmic transformation to reduce the non-linearity of the series (make it concave) (Zainodin and Yap, 2013).

After plotting the graph, running the correlogram test and unit root test results showed that the T-BOT series is stationary at level (Tables 2 and 3). On the other hand, oil imports exhibited explosive patterns and non-stationary levels. However, after it was log-transformed and differenced once it became stationary (Tables 4 and 5). Similarly, the GDP series was non-stationary at the level until after the first difference was taken it became stationary as well (Tables 6 and 7). Therefore, both the oil-import and GDP series are integrated of order one I (1) (Brooks, 2008).

Having all three series stationary the data is set for further econometric modeling as otherwise non-stationary series cannot be used for forecasting. From among the multiple tentative models (with different lag lengths and structures) the study opted for the following models for its regression.

This study assumed that the future values of the balance of trade can be accurately predicted using its past values as well as current and past values of oil-import and GDP in Nigeria (exogenous variables) subject to a constant and independently distributed random disturbance term/ white Noise innovation (ε_t). In other words, the fact that the balance of trade future values would be affected by other variables apart from the ones mentioned is completely disregarded (Brooks, 2008). Hence the model can be mathematically specified as;

$$BOT = B_0 + B_1BOT_t + B_2IMP_t + B_3gdp_t + \varepsilon_t$$

Where:

BOT = Total balance of trade

IMP = Oil-Import

Gdp = Gross Domestic Product

B_0 to B_3 = are the slope parameters

ε_t = Error term

Therefore, as more than one exogenous variable is considered to contribute to the dynamic evolution of the balance of trade series (dependent variable) Autoregressive Distributed Lag Model (ARDL (p, q_1, q_2)) is employed to forecast the future values of the dependent variable (Pesaran, 2016). The p, q_1, and q_2 denote the lags of the BOT, IMP, and GDP respectively.

This study assumed that the future values of the oil import and GDP series in Nigeria can be accurately predicted using their history only (subject to white noise) implying that the empirical impression of the series would be influenced by other relevant variables is disregarded in the short run. Thus, the Autoregressive process (univariate time series model) was employed in forecasting the future values of these two variables (Pesaran, 2016).

These can be mathematically specified in model language as;

$$IMP = \varnothing_0 + \varnothing_1 IMP_{t-1} + \varnothing_2 IMP_{t-2} + \text{---------} + \varnothing_3 IMP_{t-3} + \varepsilon_t \text{ ---------------} (2)$$

$$GDP = \varnothing_0 + \varnothing_1 gdp_{t-1} + \varnothing_2 gdp_{t-2} + \varnothing_3 gdp_{t-p} + \varepsilon_{t.} \text{ -------------------------} (3)$$

3.2 Refinery's Output and Input values forecast.

As a deterministic approach is not appropriate in projecting the future values of Dangote refinery's output and input due to uncertainties surrounding the oil industry thus the study used Monte Carlo Simulation in predicting the refinery's output and input value. There are multiple by-products from refining however, this study considered only the main ones (PMS and AGO) for its analysis. The refinery has expended a huge amount of money to import specialized capital equipment which will affect the balance of payment negatively and increase the refinery's input value however, this study disregarded such capital expense instead only crude oil value is considered as an input in the calculation of value-added of the refinery (that is refinery's output value minus its input value). Where the refinery's output value is the sum of the PMS output value and AGO output value (table A).

The official estimates of the refinery's yearly output on PMS and AGO are used as an average output, then 20% of that is added and deducted to determine maximum and minimum ranges respectively for simulation of PMS and AGO output from 2021 to 2040 subject to a triangular probability distribution. Furthermore, the official estimate of crude oil volume to be refined yearly is taken as the average, then 20% of the volume is added and deducted to obtain the maximum and minimum ranges respectively for simulating the yearly crude oil volume that will be needed by the refinery from 2021 to 2040, Triangular distribution was used as well because some data set of PMS and AGO output of Refinery were plotted on a graph and they have shown a triangular distribution pattern whereas there is a high correlation between PMS and AGO output with the Crude Oil demand by a refinery.

The refinery projected an output of 50 million litres of PMS and 15 million litres of AGO to be refined daily when operation begins (NS Energy, 2021). After conversion to yearly outputs, the quantities became 18,250 and 5,475 litres of PMS and AGO per year respectively. 20% of the PMS output per year (20% of 18,250) has been added and subtracted to the average quantity of the PMS (18,250) to determine the maximum and minimum ranges of 21,900 and 14,600 litres per year respectively for the Monte Carlo Simulation. Similarly, 20% of the AGO output per year (20% of 5,475) has been summed up and deducted to obtain the maximum and minimum of 6,570 and 4,380 litres per year respectively for the Monte Carlo simulation (Table A). Conversely, the refinery estimated it crude oil processing capacity of 650,000 bpd (NS Energy, 2021). After conversion to yearly and litre units of measurement (1 barrel to 159 litre), the quantity became 103,350,000 litres of crude oil per year. 20% has been added and subtracted to determine the maximum and minimum ranges of 124,020,000 and 82,680,000 litres per year respectively for the Monte Carlo simulation (Table A)

Nigerian Petroleum Industry Governing Act (PIGA) stipulated that subsidies shall be removed on petroleum products (Anyanechi, 2021). Also, the Minister of State, Petroleum Resources, assured that the subsidy will be over by the year 2023 (Guardian, 2022). Regarding the circumstance, the study used the PMS and AGO Landing cost of the year 2020 for the refinery's output price. Conversely, the international market price of Nigerian Forcados crude oil is used. Using the exchange rate of the year 2020 ($1 to #461.33) for conversion to Naira. The principle of plus 20% and minus 20% of the original PMS or AGO or Crude oil prices were used to determine maximum and minimum ranges of yearly prices for simulating the series of PMS, AGO, and Crude oil prices from 2021 to 2040 was used. Incidentally, uniform probability distribution was used for the simulation after plotting some data sets of PMS, AGO, and Crude Oil prices and then found them to depict Uniform Distribution.

The landing cost of N 282 and N360 per litre of PMS and AGO respectively were used as an average price whereas the maximum and minimum of 338 and 226 per litre of PMS were used. Similarly, through the same principle of sensitivity analysis of plus/minus 20% of the average we determine 432 and 288 as the maximum and minimum of the average AGO price (N360 per litre) for the Monte Carlo simulation. Furthermore, according to the Bp statistical review of world energy 2022, Nigerian Forcados crude oil was $42.31 per barrel in the year 2020, hence the price was used as an average crude oil price for the analysis. After conversion to litre and Nigerian Naira, the price became N122.76 per litre of crude oil. Using the 20% sensitivity analysis principle, the maximum and minimum prices of crude oil per litre are N147.31 and 98.21 respectively.

Table A

Monte Carlo Input Sheet

PMS Output	output		Price
Minimum	14600		226
Maximum	21900		338
Most likely	18250		282.7931
PMS Varying	18906.44577		
prob	0.663675477		
AGO Output			
Minimum	4380		288
Maximum	6570		432
Most likely	5475		410.9858
Prob	0.721261138		
AGO Varying	5752.424482		
Crude oil output			
Minimum	82680000		98.21
Maximum	124020000		147.31
Most likely	103350000		103.6901
Prob	0.169562175		
oil Varying	94717047.2		

4.0 Presentation of Data and Results

4.1 ARDL (4,4,4) model for BOT=f(BOT, IMP, GDP), (Table 8 graph 1).

Based on diagnostic checks; the model has six significant lags (P-values) at a 10% level of significance. On the Wald test result (Table 9) we reject the null hypothesis and conclude that at least one of the coefficients is significant in explaining the balance of trade since the P-value; is 0.0001 less than the 10% level of significance. Similarly based on F-stat: 20.43092 and critical value: df (3,10) = 2.73 (check F-table). We still reject the null hypothesis as the F-stat is greater than the critical value. The goodness of the fit is satisfactory at 96% (check adjusted R-squared). Durbin-Watson stat is above 2 (desirable). S.E of regression is less than both mean dependent var and S.D. dependent var (desirable). Akaike info, Schwarz, and Hannan-Quinn criteria are lesser than the other tentative models.

Residual diagnosis: The residual series of the balance of trade was found to be stationary at a level (Table 10); that is desirable. Breusch-Godfrey serial correlation LM Test result (Table

11) confirmed that there is no serial correlation between error terms as we cannot reject the null hypothesis having P-values: 0.2065, greater than our significance level of 10%. Breusch-Pagan-Godfrey Heteroskedasticity test results (Table 12) revealed that we cannot reject the null hypothesis that the residual series is Homoscedastic having P-values: 0.6118; greater than the 10% level of significance, that is in line with the assumption 5 of Gauss-Markov assumptions. The OLS estimator has the required properties; unbiased, efficient (BLUE), and white noise. Thus, the model is fit for forecasting (graph 2)

4.2 AR (3) model for oil-import series (Table 13 and graph 3)

Based on diagnostic checks; two lags are significant (P-values). On the Wald test result (Table 14) we reject the null hypothesis (P-values:0.0001). Similarly F-stat: 16.41417 is greater than the critical value: df(2,19) = 2.61 thus we conclude that at least one of the coefficients is significant in explaining oil import. The stability test result (Table 15) confirmed that all the AR roots are within the circle (stable). A correlogram of the oil-import residual series (Table 16) confirmed the stationarity of the residual series at the level. The serial correlation test of the residual (Table 17) indicated lack of serial correlation of error terms (white noise). The goodness of fit is excellent at 99%, and the Durbin Watson stat is above two (2.088203). Therefore, the study used the model for the forecast (graph 4).

4.3 AR (4) model for GDP series (Table 18 and graph 5)

Based on the diagnostic checks (Tables 20,21,22, and 23) the model is fit for the forecast (graph 6).

4.3.1 Forecast and Monte Carlo results

Table 23 below shows the forecast of the balance of trade, total import value (N million), and GDP (N Billion) of Nigeria without the Dangote refinery from the year 2021 to 2040. Furthermore, the Monte Carlo simulation output value and value-added (N million) of the Dangote refinery from 2021 to 2040 are in columns 4 and 5 of table 23 respectively.

Table 24

Years	Import Forcast	B O T Forcast	GDP Forcast (N'B)	M C Output of Refinery	M C Value -added
2021	2778844.243	-9102056.986	66470.6558	7128762.437	7118571.574
2022	2819094.357	-5401752.315	67300.80895	7326337.985	7310312.631
2023	2856712.34	-3850136.632	68080.66973	7769802.037	7758752.244
2024	2891866.316	-7421243.868	68813.2653	5938563.615	5928073.205
2025	2924714.864	-8576679.197	69501.44645	5529552.96	5516717.175
2026	2955409.788	-5842242.059	70147.89614	7983665.883	7968014.325
2027	2984093.725	-3346357.196	70755.13815	8813762.984	8801781.681
2028	3010898.723	-3674493.286	71325.54563	6552445.907	6539031.452
2029	3035947.36	-5260282.731	71861.34955	6233592.217	6222378.611
2030	3059354.401	-5729644.969	72364.64674	6932209.007	6919025.976
2031	3081227.519	-4986734.804	72837.40768	6327326.813	6315756.132
2032	3101667.406	-4453271.945	73281.4839	7781900.539	7767673.717
2033	3120768.003	-4793245.358	73698.61502	7590131.534	7577856.987
2034	3138617.003	-5393296.624	74090.4354	7234406.891	7219585.227
2035	3155296.382	-5562045.32	74458.48043	6359505.112	6348729.696
2036	3170882.797	-5378596.604	74804.1925	7865998.632	7853033.538
2037	3185447.888	-5309146.216	75128.92657	7096216.041	7083897.165
2038	3199058.58	-5506220.343	75433.95544	8230736.614	8217103.69
2039	3211777.405	-5742987.708	75720.47477	5535835.134	5524583.069
2040	3223662.8	-5824299.493	75989.60765	7556214.256	7544895.061

4.3.2 Import forecast without refinery

#(M)

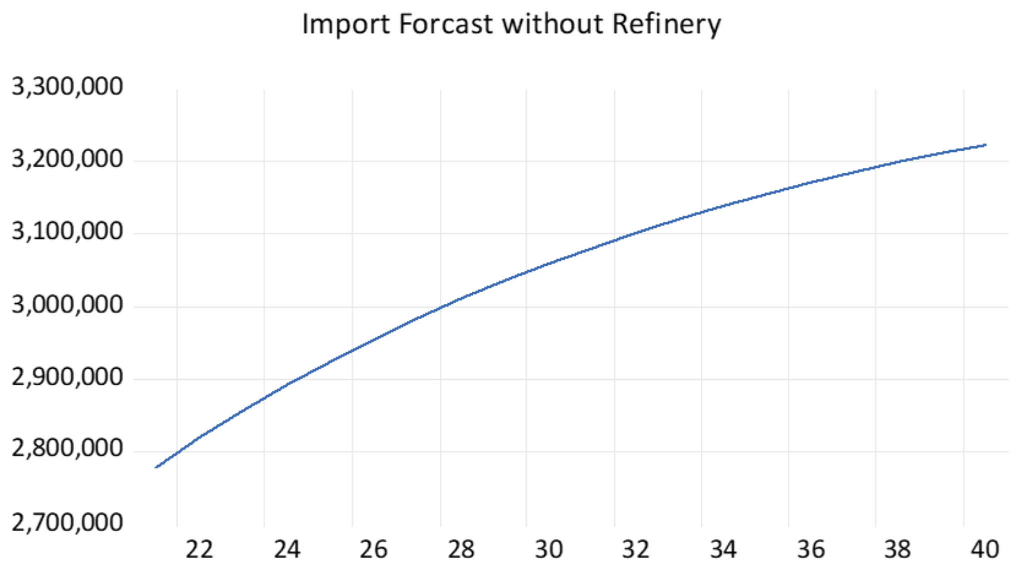

Figure 7

The forecasted values of the Nigerian oil import without the Dangote refinery's contribution from the period of 2021 to 2040 show an increasing value from 2021 to the next 20 years. The series indicated an upward trend without any tendency to revert to a constant value which implies that, the country will continue burdening its foreign reserves with the import and that will escalate the deficit balance of payment, depreciation of the local currency, inflation rate, etc.

4.3.3 Balance of trade forecast without refinery

#(M)

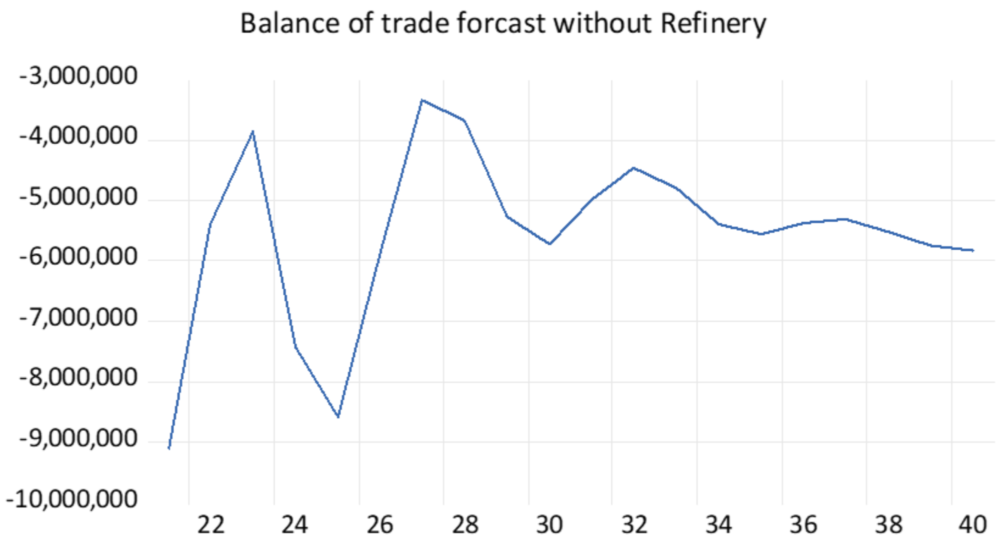

Figure 8

The predicted series of the Nigerian total balance of trade between 2021 to 2040 without the refiner's contribution which is a proxy for the country's balance of payment for this study indicated a deficit balance of payment throughout the 20 years (Negative BOT values) which implies that the country's imports will exceed its export for the forecast period, that is undoubtedly occasioned by its progressive imports of goods and services particularly refined petroleum products (*Importing & Exporting Economic Impacts Explained*, no date). As imports increase the balance of the trade deficit worsened. However, the fluctuation of the series is revolving around a constant value (-6,000,000 million nairas) which personifies a mean reversion behavior. In a nutshell, the balance of payment is not promising.

4.3.4 GDP forecast without refinery.

#(B)

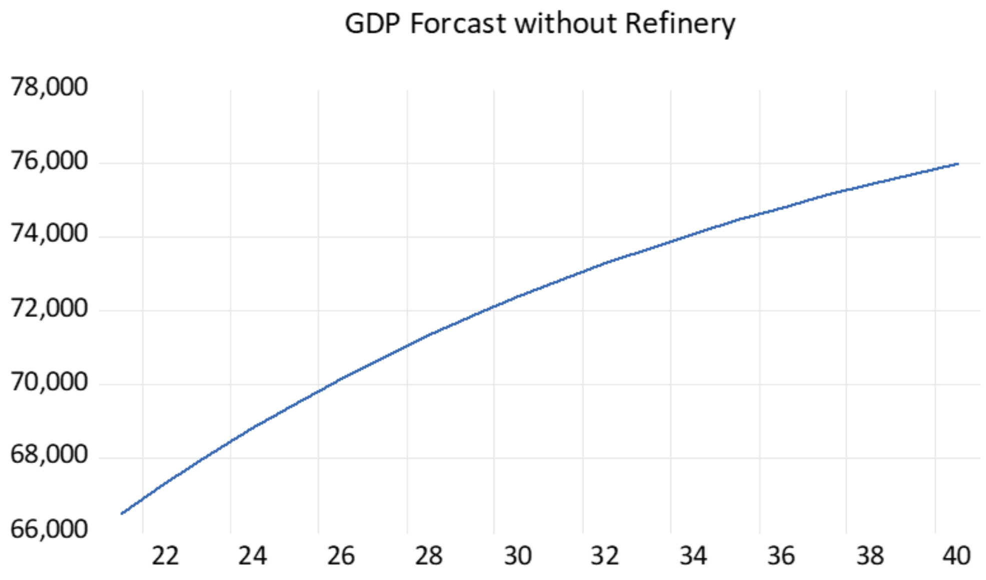

Figure 9

The forecasted series of the Nigerian GDP (N' Billion) for the 20 years without the refinery's value-added had shown an upward trend which is desirable economically. In other words, some sectors of the economy will be contributing to the future GDP values even without the refinery.

5.2.4 Output value of Dangote refinery

#(M)

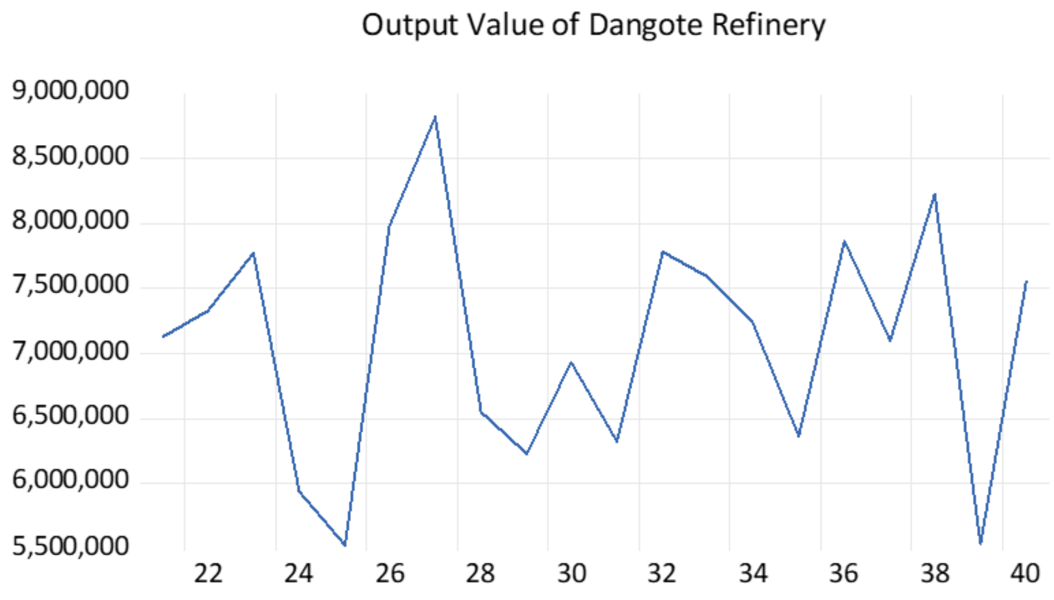

Figure 10

The series shows a mean reversion behavior however, there is an irregular fluctuation in the series, supposedly due to short-run fluctuations which are randomly unpredictable, and normally oil industry faces these contingencies (Brooks, 2008). The refinery's output value had a sharp drop between 2024 to 2026, then it spiked in 2027 and dropped to N6,250,000 million in 2029. There was a random shock that made the series to oscillated irregularly until 2039 when it plummeted to nearly N5,500,000 million. Therefore, it had a dramatic increase in 2040. The output value of the refinery constituted its contribution to import substitution

4.3.5 Value-added of Dangote Refinery

The refinery's value-added series follows a similar pattern to the refinery's output value due to their high correlation. When the refinery's output increases its value-added follows its footsteps. The value-added constituted the refinery's contribution to the Nigerian GDP from the year 2021 to 2040. In the year 2027, the refinery will contribute its maximum value-added to the GDP.

#(M)

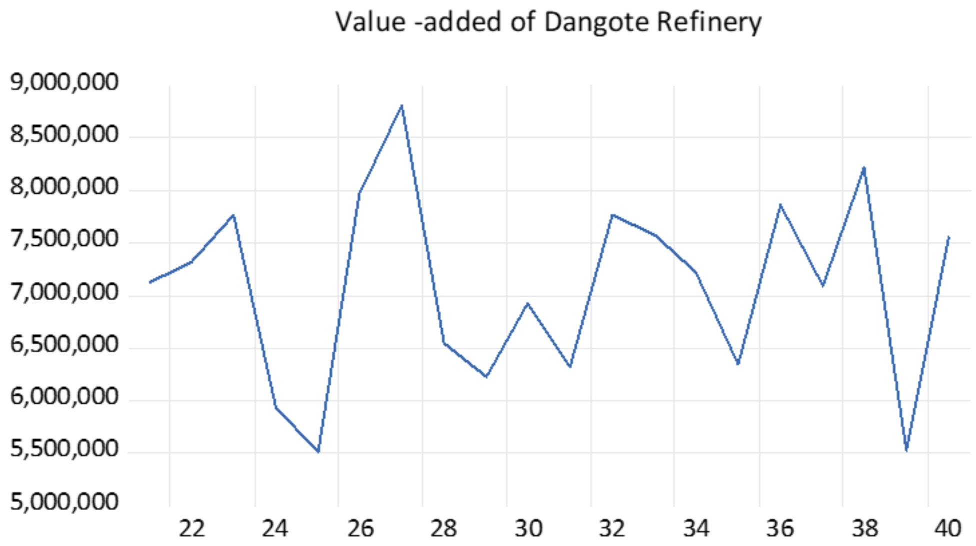

Figure 11

4.3.5 Import forecast without refinery vs output of Dangote refinery

#(M)

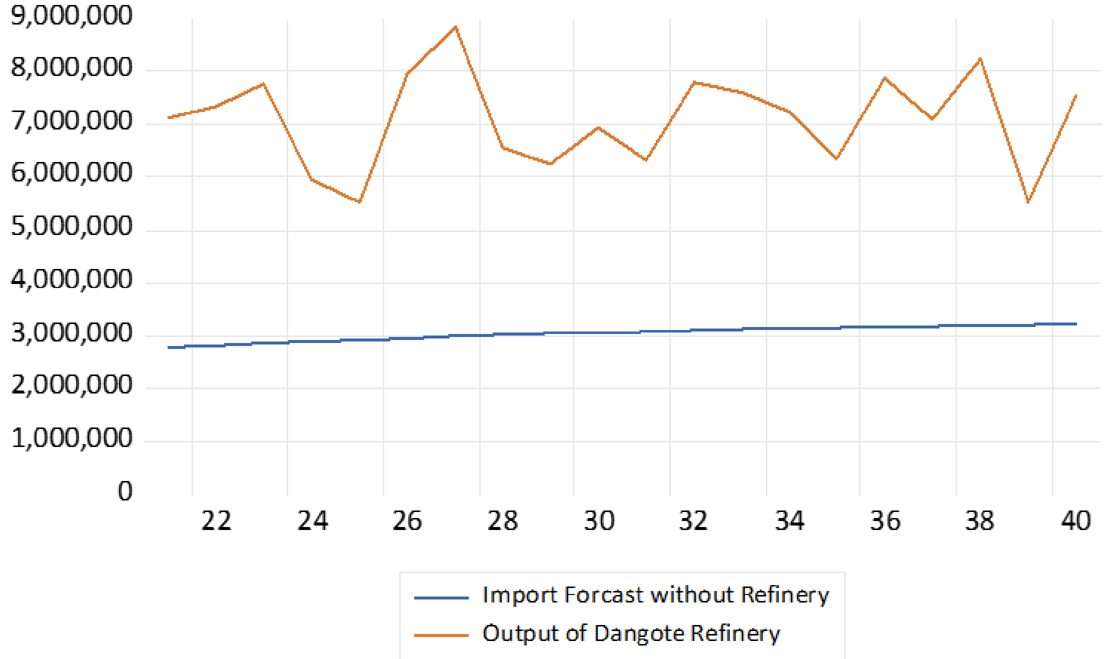

Figure 12

The output value of the refinery is above the import forecast without the refinery, implying that the refinery will satisfy the domestic demand of PMS and AGO and be left with a surplus for export. The area under the import forecast without the refinery curve (straight line) constitutes import substitution by the refinery while the area between the output value of the refinery curve (zig-zag curve) and the import forecast curve constitutes the refinery's surplus for export as projected by the refinery. The result solidified the projection made by the Dangote refinery's Group Managing Director, Devakumar Edwin that the refinery can meet 100% of the local demand for petroleum products. While 60% of the production can satisfy the entire domestic requirement of gasoline (PMS), Diesel (AGO), Kerosene (DPK), and aviation jet fuel (Jet A-1), the rest 40% will be exported to generate foreign exchange (FOREX).

5.0 CONCLUSION

This study was successful in finding the extent of import substitution and value added to be contributed by the Dangote refinery to the Nigerian balance of payment and Gross Domestic Product respectively. The literature review laid the conceptual underpinning for the relevance and appropriateness of import substitution as a growth driver to the Nigerian economy. The study employs conventional econometric methodologies such as the correlogram test, and ADF unit root test to test the stationarity of the total balance of trade, oil-import, and GDP series. Furthermore, the Wald test, residual correlogram test, Heteroskedasticity test, Breusch-Godfrey serial correlation test, and other diagnostic checks were conducted to test the plausibility of the ARDL(p_1, q_1, q_2), AR(3), and AR(4) Models used for the forecasts of the three macroeconomics variables without the refinery's contribution for the period of 2021 to 2040. Time series data between 1995 to 2020 were used for the forecasts.

Furthermore, Sensitivity Analysis along with Monte Carlo Simulation was used in forecasting the refinery's output, input, output price, and input price values between 2020 to 2040. The forecasted series were used to calculate the refinery's output value and value-added for the period, which represent its contribution to the country's BOP, and GDP respectively.

The results of the forecast without the refinery show that the country will continue increasing its import in the next 20 years. Its balance of payment deficit will worsen in the future, between the year 2022 to 2026 there will be random shocks in the environment that will make the BOT series fluctuate dramatically, then it will flatten after 2027 to the rest of the forecast period. However, its GDP will keep improving in the 20 years even without the refinery's contribution. Whereas the output value of the refinery had shown a mean-reverting behavior in the period of forecast, the irregular fluctuations in the series will be occasioned by the volatility of oil prices in the international market. the value-added of the refinery follows a similar movement to the output value due to their correlation. In a nutshell, the main finding of the research is that Nigeria's balance of payment deficit will escalate in the future without the existence of the Dangote refinery's operation. However, the refinery will substitute the whole country's import of petroleum products and export a significant portion of its output. The GDP of Nigeria will improve further by the refinery's value-added. Note that findings are based on the assumptions incorporated in the modeling and on some policies e.g., subsidy removal in the year 2023.

Considering how colossal the Dangote refinery will be there will be an abuse of a dominant market position (Monopoly) by the refinery If the Government failed to create an enabling environment for domestic and foreign investors to compete with the refinery. The study used some assumptions, because there was no sufficient data, particularly on the refinery's capital and operating expenses hence limiting the robustness of the research. Future studies on the subject should incorporate adequate data to overcome that problem.

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Appendices

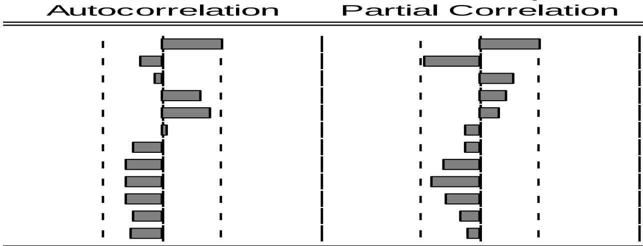
LIST OF TABLES

Years	Total-BOT (#' M)	Oil-Import (#' M)	GDP (#' B)
1995	195533.7	155825.9	21660.48707
1996	746916.8	162178.7	22568.86673
1997	395946.1	166902.5	23231.12313
1998	-85562	175854.2	23829.75843
1999	326454.1	211661.8	23967.59142
2000	960700.91	220817.69	25169.53879
2001	509773.52	237106.83	26658.62129
2002	231482.347	361710	30745.19206
2003	1007651.123	398922.31	33004.79634
2004	2615736.27	318114.72	36057.73778
2005	4445678.47	797298.94	38378.79606
2006	4216161.31	710683	40703.68138
2007	4397805.69	768226.84	43385.87708
2008	4836255.7	1319460.972	46320.01494
2009	3102373.138	1063557.89	50042.36065
2010	3827142.448	1748062.204	54612.26418
2011	4221068.048	3027600.63	57511.04177
2012	5345250.423	3049352.587	59929.89304
2013	5793815.887	2417368.143	63218.72173
2014	2433433.61	2213233.951	67152.78584
2015	-2219548.48	1711002.836	69023.92994
2016	-895232.7358	2384694.066	67931.23593
2017	3811512.56	3132106.081	68490.98034
2018	6235242.331	4368200.297	69799.94195
2019	-636849.9694	4174867.378	71387.82667
2020	-8168415.84	2985423.374	70014.37185

Table 1: Total-BOT, Import and GDP Data

Correlogram of Total-BOT

Date: 08/16/22 Time: 17:44
Sample (adjusted): 1995 2020
Included observations: 26 after adjustments



	AC	PAC	Q-Stat	Prob
1	0.409	0.409	4.8719	0.027
2	-0.128	-0.355	5.3714	0.068
3	-0.047	0.233	5.4416	0.142
4	0.257	0.188	7.6195	0.107
5	0.317	0.127	11.112	0.049
6	0.043	-0.097	11.179	0.083
7	-0.182	-0.094	12.446	0.087
8	-0.230	-0.236	14.578	0.068
9	-0.237	-0.295	16.984	0.049
10	-0.223	-0.209	19.251	0.037
11	-0.186	-0.110	20.923	0.034
12	-0.190	-0.073	22.800	0.029

Table 2: Correlogram of T-BOT series

Unit root test result of Total-BOT

Null Hypothesis: D(TOTAL_BOT) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.018825	0.0000
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

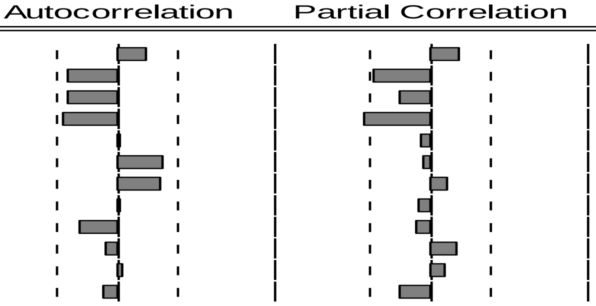
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TOTAL_BOT,2)
Method: Least Squares
Date: 08/16/22 Time: 17:56
Sample (adjusted): 1998 2020
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TOTAL_BOT(-1))	-1.516930	0.216123	-7.018825	0.0000
D(TOTAL_BOT(-1),2)	1.140828	0.181921	6.271016	0.0000
C	-35250.70	328846.4	-0.107195	0.9157

R-squared	0.719690	Mean dependent var	-312199.8
Adjusted R-squared	0.691659	S.D. dependent var	2807704.
S.E. of regression	1559074.	Akaike info criterion	31.47819
Sum squared resid	4.86E+13	Schwarz criterion	31.62630
Log likelihood	-358.9992	Hannan-Quinn criter.	31.51544
F-statistic	25.67479	Durbin-Watson stat	2.328431
Prob(F-statistic)	0.000003		

Table 3:Unit root results of Total-BOT

Correlogram of D (Oil-import)
Date: 08/16/22 Time: 15:49
Sample (adjusted): 1996 2020
Included observations: 25 after adjustments



	AC	PAC	Q-Stat	Prob
1	0.193	0.193	1.0441	0.307
2	-0.316	-0.367	3.9713	0.137
3	-0.312	-0.189	6.9516	0.073
4	-0.348	-0.437	10.840	0.028
5	0.018	-0.052	10.851	0.054
6	0.298	-0.045	14.016	0.029
7	0.285	0.114	17.055	0.017
8	0.024	-0.075	17.079	0.029
9	-0.247	-0.087	19.646	0.020
10	-0.078	0.173	19.922	0.030
11	0.048	0.092	20.031	0.045
12	-0.097	-0.193	20.515	0.058

Table 4: Correlogram of D (Oil-import)

Unit Root test for D(oil-import)

Null Hypothesis: OIL_IMPORT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.134885	0.0173
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL_IMPORT)
Method: Least Squares
Date: 08/16/22 Time: 15:56
Sample (adjusted): 1997 2020
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL_IMPORT(-1)	-0.720588	0.174270	-4.134885	0.0005
D(OIL_IMPORT(-1))	0.639714	0.210261	3.042473	0.0064
C	-471504.5	238203.3	-1.979420	0.0617
@TREND("1995")	113855.1	31153.09	3.654698	0.0016

R-squared	0.488240	Mean dependent var	117635.2
Adjusted R-squared	0.411476	S.D. dependent var	555406.4
S.E. of regression	426081.7	Akaike info criterion	28.91366
Sum squared resid	3.63E+12	Schwarz criterion	29.11000
Log likelihood	-342.9639	Hannan-Quinn criter.	28.96575
F-statistic	6.360278	Durbin-Watson stat	2.021229
Prob(F-statistic)	0.003331		

Table 5: Unit Root test for D (Oil-import)

Correlogram of D(GDP-n-b million)

Date: 08/16/22 Time: 16:17
Sample (adjusted): 1996 2020
Included observations: 25 after adjustments

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.502	0.502	7.1012	0.008
		2	0.268	0.021	9.2126	0.010
		3	0.174	0.042	10.137	0.017
		4	0.270	0.219	12.476	0.014
		5	0.006	-0.304	12.477	0.029
		6	-0.232	-0.255	14.390	0.026
		7	-0.185	0.093	15.667	0.028
		8	-0.113	-0.061	16.174	0.040
		9	-0.188	-0.091	17.670	0.039
		10	-0.299	-0.047	21.701	0.017
		11	-0.269	-0.134	25.182	0.009
		12	-0.232	-0.159	27.969	0.006

Table 6: Correlogram of D (GDP-N-Billion)

Null Hypothesis: GDP N BILLION has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.176526	0.0361
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP N BILLION)
Method: Least Squares
Date: 08/19/22 Time: 12:34
Sample (adjusted): 2000 2020
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP N BILLION (-1)	-0.052097	0.016401	-3.176526	0.0063
D(GDP N BILLION (-1))	0.529371	0.218192	2.426166	0.0283
D(GDP N BILLION (-2))	-0.054456	0.251708	-0.216347	0.8316
D(GDP N BILLION (-3))	-0.165318	0.251306	-0.657833	0.5206
D(GDP N BILLION (-4))	0.646145	0.226771	2.849334	0.0122
C	2641.157	900.6834	2.932393	0.0103

R-squared	0.610350	Mean dependent var	2192.704
Adjusted R-squared	0.480467	S.D. dependent var	1530.256
S.E. of regression	1102.988	Akaike info criterion	17.08439
Sum squared resid	18248732	Schwarz criterion	17.38282
Log likelihood	-173.3861	Hannan-Quinn criter.	17.14916
F-statistic	4.699217	Durbin-Watson stat	2.207405
Prob(F-statistic)	0.008814		

Table 7: Unit root test of GDP-series

Dependent Variable: TOTAL_BOT
Method: Least Squares
Date: 08/10/22 Time: 18:23
Sample (adjusted): 1999 2020
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	224953.8	1963266.	0.114581	0.9120
TOTAL_BOT(-1)	1.149100	0.234999	4.889803	0.0018
TOTAL_BOT(-2)	-0.985407	0.361237	-2.727871	0.0294
TOTAL_BOT(-3)	0.467569	0.457178	1.022728	0.3405
TOTAL_BOT(-4)	-0.029167	0.342801	-0.085085	0.9346
OIL_IMPORT	1.220898	0.669838	1.822676	0.1111
OIL_IMPORT(-1)	-1.702943	0.638992	-2.665045	0.0322
OIL_IMPORT(-2)	1.745878	0.835779	2.088923	0.0751
OIL_IMPORT(-3)	-2.737943	0.890250	-3.075477	0.0179
OIL_IMPORT(-4)	1.114092	1.333873	0.835230	0.4312
GDP__N__BILLION_	207.6315	250.0374	0.830402	0.4337
GDP__N__BILLION_(-1)	-440.2930	404.4385	-1.088653	0.3124
GDP__N__BILLION_(-2)	412.7001	324.2280	1.272870	0.2437
GDP__N__BILLION_(-3)	490.7377	374.5890	1.310069	0.2315
GDP__N__BILLION_(-4)	-693.1659	248.8075	-2.785952	0.0271

R-squared	0.986436	Mean dependent var	2108977.
Adjusted R-squared	0.959309	S.D. dependent var	3295252.
S.E. of regression	664717.4	Akaike info criterion	29.87062
Sum squared resid	3.09E+12	Schwarz criterion	30.61451
Log likelihood	-313.5768	Hannan-Quinn criter.	30.04585
F-statistic	36.36331	Durbin-Watson stat	2.789150
Prob(F-statistic)	0.000037		

Table 8: ARDL estimates results

Wald Test:
Equation: OLS

Test Statistic	Value	df	Probability
F-statistic	20.43092	(3, 10)	0.0001
Chi-square	61.29276	3	0.0000

Null Hypothesis: C(1)=0, C(2)=0, C(3)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	1.279068	0.242580
C(2)	-1.204417	0.386359
C(3)	0.476315	0.427051

Restrictions are linear in coefficients.

Table 9: Wald test ARDL

Correlogram of Total-BOT Residuals

Date: 08/16/22 Time: 18:01
Sample (adjusted): 1999 2020
Q-statistic probabilities adjusted for 4 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.368	-0.368	3.4055	0.065
		2	0.028	-0.124	3.4260	0.180
		3	-0.236	-0.317	4.9694	0.174
		4	0.349	0.173	8.5426	0.074
		5	-0.096	0.086	8.8259	0.116
		6	0.059	0.082	8.9423	0.177
		7	-0.316	-0.220	12.456	0.087
		8	0.198	-0.083	13.939	0.083
		9	-0.083	-0.117	14.218	0.115
		10	0.083	-0.075	14.519	0.151
		11	-0.078	0.103	14.808	0.191
		12	0.038	0.031	14.884	0.248

*Probabilities may not be valid for this equation specification.

Table 10: BOT Residual Correlogram

Serial Correlation test on Total-BOT Residuals

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.933504	Prob. F(2,8)	0.2065
Obs*R-squared	7.168965	Prob. Chi-Square(2)	0.0278

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/16/22 Time: 18:05
Sample: 1999 2020
Included observations: 22
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TOTAL_BOT(-1)	0.275518	0.270419	1.018857	0.3381
TOTAL_BOT(-2)	-0.487845	0.482562	-1.010948	0.3416
TOTAL_BOT(-3)	0.653947	0.570346	1.146579	0.2847
TOTAL_BOT(-4)	-0.412156	0.378855	-1.087900	0.3083
OIL_IMPORT(-1)	0.643224	0.653029	0.984985	0.3535
OIL_IMPORT(-2)	-0.310837	0.944996	-0.328929	0.7507
OIL_IMPORT(-3)	-0.634653	0.982528	-0.645939	0.5364
OIL_IMPORT(-4)	0.958726	0.992035	0.966424	0.3621
GDP_N_BILLION_(-1)	119.3054	249.2887	0.478583	0.6450
GDP_N_BILLION_(-2)	-229.6167	429.5326	-0.534573	0.6075
GDP_N_BILLION_(-3)	121.9460	398.3394	0.306136	0.7673
GDP_N_BILLION_(-4)	-35.37244	234.5072	-0.150837	0.8838
RESID(-1)	-0.888803	0.453750	-1.958793	0.0858
RESID(-2)	0.061254	0.531610	0.115224	0.9111

R-squared	0.323680	Mean dependent var	-30170.66
Adjusted R-squared	-0.775341	S.D. dependent var	542751.8
S.E. of regression	723172.9	Akaike info criterion	30.08181
Sum squared resid	4.18E+12	Schwarz criterion	30.77611
Log likelihood	-316.8999	Hannan-Quinn criter.	30.24537
Durbin-Watson stat	2.336757		

Table 11: BOT Residual Serial Correlation

Heteroskedasticity Test result of Total-BOT Residuals

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.850702	Prob. F(12,9)	0.6118
Obs*R-squared	11.69202	Prob. Chi-Square(12)	0.4707
Scaled explained SS	4.852590	Prob. Chi-Square(12)	0.9627

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/16/22 Time: 18:11
Sample: 1999 2020
Included observations: 22

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.93E+11	1.17E+12	0.678431	0.5146
TOTAL_BOT(-1)	136331.2	209190.6	0.651708	0.5309
TOTAL_BOT(-2)	-4666.187	320310.5	-0.014568	0.9887
TOTAL_BOT(-3)	246119.0	357783.8	0.687899	0.5089
TOTAL_BOT(-4)	76531.99	217735.6	0.351491	0.7333
OIL_IMPORT(-1)	124588.7	476947.4	0.261221	0.7998
OIL_IMPORT(-2)	-35617.74	730343.9	-0.048768	0.9622
OIL_IMPORT(-3)	-623849.8	789647.2	-0.790036	0.4498
OIL_IMPORT(-4)	348118.2	881030.3	0.395126	0.7020
GDP__N__BILLION_(-1)	-82920379	1.56E+08	-0.531961	0.6076
GDP N BILLION (-2)	-1.17E+08	2.71E+08	-0.432114	0.6758
GDP N BILLION (-3)	50883866	3.09E+08	0.164427	0.8730
GDP N BILLION (-4)	1.40E+08	1.93E+08	0.722032	0.4886

R-squared	0.531456	Mean dependent var	2.82E+11
Adjusted R-squared	-0.093270	S.D. dependent var	5.79E+11
S.E. of regression	6.05E+11	Akaike info criterion	57.38329
Sum squared resid	3.30E+24	Schwarz criterion	58.02800
Log likelihood	-618.2162	Hannan-Quinn criter.	57.53517
F-statistic	0.850702	Durbin-Watson stat	1.815744
Prob(F-statistic)	0.611813		

Table 12: Heteroskedasticity test

Dependent Variable: OIL_IMPORT
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 08/16/22 Time: 18:36
Sample (adjusted): 1998 2020
Included observations: 23 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3393159.	4044725.	0.838910	0.4120
AR(1)	1.322260	0.235533	5.613909	0.0000
AR(2)	-0.788991	0.364665	-2.163606	0.0434
AR(3)	0.398659	0.278527	1.431316	0.1686

R-squared	0.861810	Mean dependent var	1643275.
Adjusted R-squared	0.839991	S.D. dependent var	1334462.
S.E. of regression	533799.9	Akaike info criterion	29.37020
Sum squared resid	5.41E+12	Schwarz criterion	29.56768
Log likelihood	-333.7573	Hannan-Quinn criter.	29.41987
F-statistic	39.49742	Durbin-Watson stat	2.110516
Prob(F-statistic)	0.000000		

Inverted AR Roots	.93	.19+.62i	.19-.62i

Table 13: AR(3) Estimates results

Wald Test on The Oil-import AR(3) Model
Wald Test:
Equation: OIL_EQN

Test Statistic	Value	df	Probability
F-statistic	16.41417	(2, 19)	0.0001
Chi-square	32.82834	2	0.0000

Null Hypothesis: C(1)=0, C(2)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	3393159.	4044725.
C(2)	1.322260	0.235533

Restrictions are linear in coefficients.

Table 14: Wald test for AR(3)

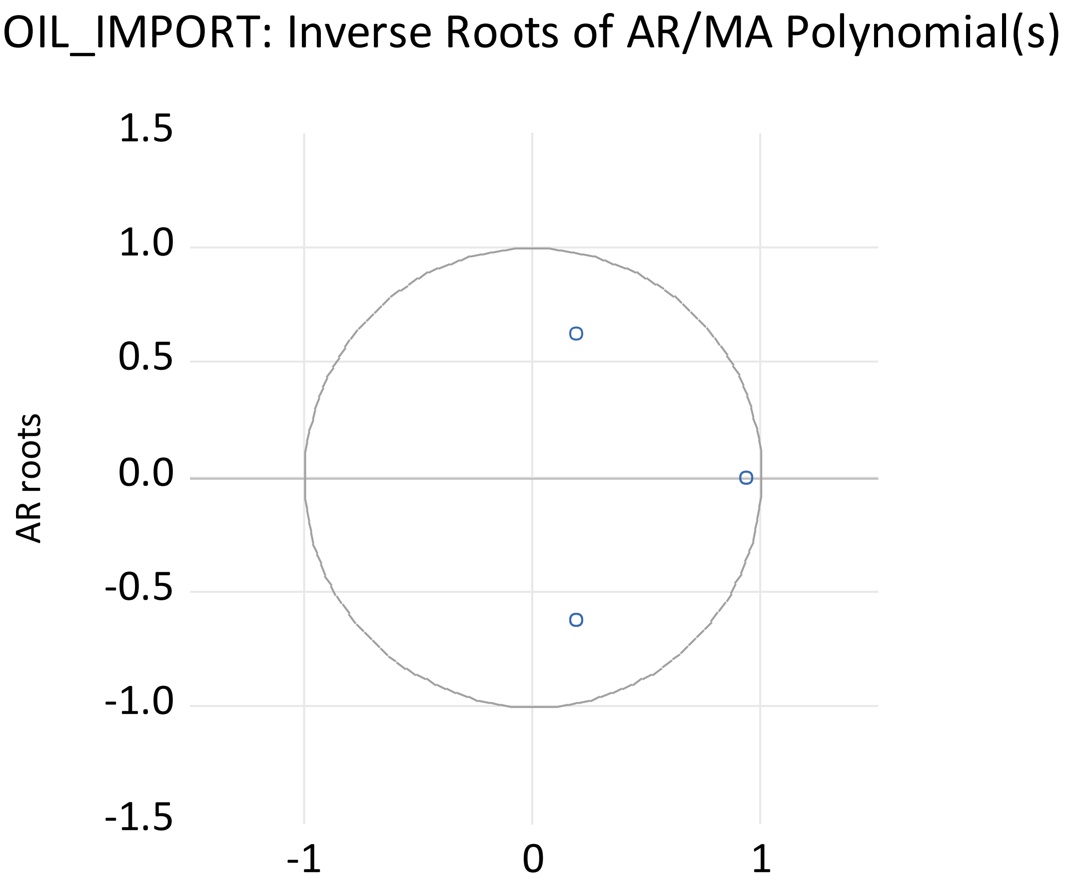


Table 15: Stability test for AR(3)

Correlogram of oil-import residual series

Date: 08/16/22 Time: 19:06
Sample (adjusted): 1998 2020
Q-statistic probabilities adjusted for 3 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.089	-0.089	0.2076	
		2	-0.088	-0.097	0.4198	
		3	-0.047	-0.066	0.4844	
		4	-0.271	-0.297	2.7083	0.100
		5	0.019	-0.063	2.7199	0.257
		6	0.236	0.184	4.5997	0.204
		7	0.051	0.070	4.6948	0.320
		8	0.147	0.144	5.5253	0.355
		9	-0.189	-0.140	6.9958	0.321
		10	-0.129	-0.032	7.7283	0.357
		11	0.094	0.116	8.1493	0.419
		12	-0.180	-0.195	9.8347	0.364

Table 16: Correlogram of Oil-Import Residual

Serial Correlation of oil-import Residuals Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	3.591930	Prob. F(2,17)	0.0500
Obs*R-squared	6.832192	Prob. Chi-Square(2)	0.0328

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/16/22 Time: 19:09
Sample: 1998 2020
Included observations: 23
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4433731.	4004313.	1.107239	0.2836
AR(1)	1.774648	0.753182	2.356200	0.0307
AR(2)	-1.049545	0.806802	-1.300870	0.2107
AR(3)	-0.436828	0.460218	-0.949176	0.3558
RESID(-1)	-1.973977	0.797087	-2.476490	0.0241
RESID(-2)	-1.375873	0.598974	-2.297049	0.0346

R-squared	0.297052	Mean dependent var	0.000640
Adjusted R-squared	0.090302	S.D. dependent var	496071.1
S.E. of regression	473143.0	Akaike info criterion	29.19164
Sum squared resid	3.81E+12	Schwarz criterion	29.48786
Log likelihood	-329.7039	Hannan-Quinn criter.	29.26614
F-statistic	1.436772	Durbin-Watson stat	2.124691
Prob(F-statistic)	0.261539		

Table 17: Oil-Import Residual Serial Correlation

Dependent Variable: GDP N BILLION
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 08/19/22 Time: 07:29
Sample (adjusted): 1999 2020
Included observations: 22 after adjustments
Convergence achieved after 8 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	67934.72	27221.31	2.495645	0.0232
AR(1)	1.579571	0.266087	5.936285	0.0000
AR(2)	-0.720524	0.503569	-1.430834	0.1706
AR(3)	0.319962	0.502892	0.636244	0.5331
AR(4)	-0.208069	0.265333	-0.784182	0.4437

R-squared	0.994658	Mean dependent var	50613.96
Adjusted R-squared	0.993401	S.D. dependent var	16739.11
S.E. of regression	1359.830	Akaike info criterion	17.46482
Sum squared resid	31435320	Schwarz criterion	17.71279
Log likelihood	-187.1131	Hannan-Quinn criter.	17.52324
F-statistic	791.2771	Durbin-Watson stat	2.088203
Prob(F-statistic)	0.000000		

Inverted AR Roots	.88-.08i	.88+.08i	-.09-.51i	-.09+.51i

Table 18: AR(4) Estimate

Walt Test on GDP-n-billion AR(4) Model

Wald Test:
Equation: GDP

Test Statistic	Value	df	Probability
F-statistic	26.54881	(2, 17)	0.0000
Chi-square	53.09763	2	0.0000

Null Hypothesis: C(1)=0, C(2)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	67934.72	27221.31
C(2)	1.579571	0.266087

Restrictions are linear in coefficients.

Table 19: Wald Test on GDP-n-billion AR(4) Model

Stability Test on the gdp-n-billion AR(4) Model

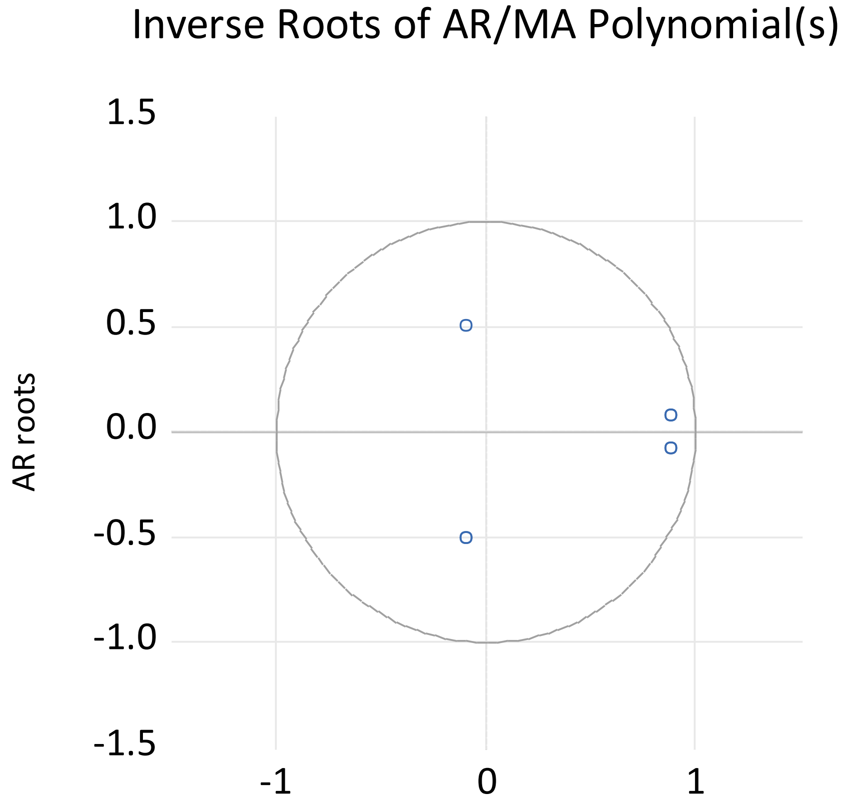


Table 20: Stability test on the GDP-n-billion AR(4) Model

Date: 08/16/22 Time: 19:41
Sample (adjusted): 1999 2020
Q-statistic probabilities adjusted for 4 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.164	-0.164	0.6734	
		2	-0.060	-0.089	0.7682	
		3	-0.353	-0.392	4.2383	
		4	0.342	0.236	7.6600	
		5	0.118	0.175	8.0958	0.004
		6	-0.118	-0.196	8.5536	0.014
		7	-0.147	0.047	9.3091	0.025
		8	0.053	0.052	9.4147	0.052
		9	-0.009	-0.269	9.4182	0.094
		10	-0.092	-0.114	9.7896	0.134
		11	-0.081	0.003	10.102	0.183
		12	0.026	-0.166	10.136	0.256

Correlogram of GDP-n-billion Residuals

Table 21: Correlogram of GDP-n-billion Residual

Serial correlation of Residuals Test on GDP-n-billion

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 6 lags

F-statistic	1.962370	Prob. F(6,11)	0.1575
Obs*R-squared	11.37395	Prob. Chi-Square(6)	0.0775

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/16/22 Time: 19:45
Sample: 1999 2020
Included observations: 22
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-34163.45	39276.74	-0.869814	0.4030
AR(1)	0.661248	1.415088	0.467284	0.6494
AR(2)	-0.760075	3.126136	-0.243136	0.8124
AR(3)	0.379252	2.855681	0.132806	0.8967
AR(4)	-0.255002	1.175870	-0.216862	0.8323
RESID(-1)	-0.912600	1.378522	-0.662014	0.5216
RESID(-2)	-0.419058	1.238179	-0.338447	0.7414
RESID(-3)	-0.922085	0.740702	-1.244880	0.2390
RESID(-4)	-0.074499	0.599011	-0.124370	0.9033
RESID(-5)	0.025906	0.356886	0.072590	0.9434
RESID(-6)	-0.331785	0.381146	-0.870493	0.4026

R-squared	0.516998	Mean dependent var	-1.07E-07
Adjusted R-squared	0.077905	S.D. dependent var	1223.487
S.E. of regression	1174.863	Akaike info criterion	17.28254
Sum squared resid	15183331	Schwarz criterion	17.82806
Log likelihood	-179.1080	Hannan-Quinn criter.	17.41105
F-statistic	1.177422	Durbin-Watson stat	2.028890
Prob(F-statistic)	0.394262		

Table 22: Serial Correlogram of Residuals Test on GDP-n-billion