ASSESSMENT OF OIL PRICE, EXCHANGE RATE AND ECONOMIC DEVELOPMENT IN NIGERIA: A GOAL PROGRAMMING OPTIMIZATION APPROACH

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ABSTRACT
There appears to be no consensus on many empirical studies (predominantly domestic studies) on the relationship between oil price, exchange rate and economic (Growth) development, hence the need to assess using the mathematical tool of goal programming to assess oil price, exchange rate and economic development. The decision variable of the goal programming analysis was generated firstly from the 10-years average of oil price, exchange rate and economic development. While oil price aspirational target of $80 per barrel and exchange rate target of ₦250/$ was attainable from the mathematical analysis conducted, that of economic development proxied by Human Development Index (HDI) target of 0.60 was found to be unattainable with margin of deviation of approximately 50%. Substitution of the respective deviations of the three constraints gave a non-zero objective function which suggest that the oil price, exchange rate and economic development goal programming analysis is not optimized. The study therefore recommended that government should as a matter of urgency double down on its oil exploration potentials by strengthen its institution to curb the menace of crude oil theft, revamp oil refinery to minimize incessant exchange rate pressure, diversifying the economy so as to mitigate rising unemployment and inflation rate and finally develop a pragmatic exchange rate regime that suite the economic peculiarities of Nigeria given the economy's weak international trade competitiveness. This will ensure efficient and proactive trickle-down effect of proceed of oil endowment on socio-economic indicators and other near proxy of economic development.
Key words: Optimization, Goal Programming, Economic development, oil price, human development index

1. INTRODUCTION

Attainment of sustainable economic development has been the pre-occupation of government in both developed and developing economies of the world. The justification of the above premise could be seen in the renewed effort by most economies of the world to improve socio-economic conditions of its people and ensure an overall economic development. Theoretically, economic development means an increase in productivity which translates to increase in real per capita gross domestic product, standard of living, literacy rate, life expectancy, reduced unemployment and poverty rate. Regrettably, the exogenously determined oil price with its associated exchange rate instability and other institutional distortions therein as affirmed by Aremo, Orisadare, and Ekperiware (2012) constitutes a great limitation to the optimization of economic development. It is really difficult to admit that an economy like Nigeria cannot boost of robust socio-economic indicators after decades of oil discovery.

Apparently evident are the macroeconomic implication of oil price fluctuation on the monetary and fiscal policy performance of the Nigeria economy undermines the effectiveness of fiscal management (Akpan & Atan, 2012). This challenge persists unabated so much so that the monetary policy authority try to mitigate its effect on the macroeconomic space sometimes without sustainable success (Rickne, 2009). The challenge of regulating unfavorable outcome of oil price changes on exchange rate means different issues for different economies (Nezir & Sabit, 2015). It is even more challenging to a net oil exporting economy like Nigeria given the critical role exchange rate plays (in an energy dependent economy like Nigeria) both in period of higher and lower volume of oil sales at a particular price. It is no longer news that the concerns generated by oil is due to how central the happenings associated with oil affect the totality of the Nigeria economic performance. Substantial readjustment in the national budget benchmarks in 2008, following the unprecedented fall in crude oil to $37.81 per barrel, remains the obvious testament of the association between oil price and the budgetary operation in Nigeria. It is informative to note that a period characterized by a fall in oil price usually portends great implication for fiscal policy operation in Nigeria, as the expected revenue instability that characterize such period prompts the government to resort to accumulation of public debt, shrinking of credit availability for private sector investment and ultimate retardation of economic growth and development (Adi, Adda, & Wobilor, 2022).

The efficacy of the monetary policy strategies in managing the exchange rate has however, remained in doubt. Regrettably, different exchange rate regime has been adopted in the past decades to cushion the negative effect of oil price changes. More prominent among the monetary policy intervention is the incessant devaluation of our domestic currency (in a bid to re-affirm the international competitiveness of the local currency) thus rather resulting to free fall of naira as depicted by the trend behavior. The monetary policy strategies so far adopted have proven weak so much so that the central bank monetary policy committee have resorted to multiple exchange rate eclectic regime whose effectiveness is yet to be ascertained. A more recent attempt being the stepping-up of the monetary policy rate to 15.5 percent from 13 percent in the third quarter of 2022, at a time the Nigerian business community are groaning over the unfriendly business environment in addition to stag inflation revenging the economy. Against these backdrop and litany of socio-economic implications, the government has continued to show optimism as to these country's socio-economic indicators thus raising the question, what is the optimization status of economic development given oil price and exchange rate in Nigeria. The specific objective is to assess the optimization of economic development given oil price and exchange rate. The study is organized in the following sequence starting from the introduction, literature review, theoretical review and conceptual framework, interpretation of the optimization solution, discussion of finding and policy recommendation

2 LITERATURE REVIEW

Conceptual issues: Oil Price

Apparent association between internationally-determined crude Oil price and the economic performance of Nigerian cannot be overemphasized. This significantly affirms a strong association between the crude oil international market price and the budgetary operation in Nigeria (Monday & Abdulkadir, 2020). Therefore, it could be said that oil price through it effect on the economic performance determine the ability of the government to meet up with its programmes and other item of its expenditure for a given year. The dominating position of crude oil in terms of its significant contribution to Gross Domestic Product (GDP) makes the Nigerian economy vulnerable to unsteady international oil price and its politics as also evidenced during the global financial meltdown of 2009. This uncertainty sometimes creates crisis ordinarily referred in literature as oil crisis. Since oil provides the main source of energy for advanced and developing economies, oil price instability has the potency of causing a major slump in real output. Oil price market has been characterized with erratic movement of oil price since the 1970s which could be traced to the historic collapse of oil price in 1986 (Sauter & Awerbuch, 2003) on account of Iran-Iraq war. The concept of oil price changes can equally be understood and discussed from the stand point of demand side channel and the supply side channel. While demand side channel represents the net oil importing economies, the supply side channel stands for net oil exporting economies. Oil price increase for the demand side perspective translates to higher production cost leading to commodity price increase especially of consumables in the market (Alley et.al., 2014), Obi, Awujola & Ogwuche (2016), and consequent reduction in output. This is because an increase in oil price induces a leftward shift in both the demand and supply curve which degenerates to higher prices and reduced output. Worthy of mention is the fall in standard of living occasioned by reduced purchasing power and output following an oil price increase. Conversely, for the supply side channel, the effect of oil price increase might be similar to that of the demand side channel Patti and Ratti (2007) cited in Ben et.al (2016). This is because the perceived benefit from oil price increase may be diffused by Dutch Disease plague and inflationary spiral effect such gain generates (Baig. et.al, 2007, Alley et.al. 2014). This implies that from either a net oil importing or net oil exporting perspective, oil price increase or decrease portends a gross welfare implication for the populace. In this present study, that seek to interrogate how the oil price nexus with exchange rate affect the optimization of economic development of Nigeria. Oil price will be measured by average annual oil prices in the international market. This is due to inherent weakness of mathematical technique of goal programming in accounting for the randomness and volatility associated with oil fluctuation.

Exchange rate

Exchange rate could be seen as the price of one currency in terms of another. It signifies the price of one currency in terms of another (Nyong, 2005). Exchange rate could also be explained as the ratio of a unit of one currency with a unit of another currency at a particular time (Ngerebo & Ibe, 2013). For a good understanding of the exchange rate dynamics, appreciating the system of exchange rate practiced in a given economy is germane. While the par system of exchange rate is characterized by government unanimous agreement of what should be an exchange rate, the market exchange rate system is seen as the actual price of foreign exchange because it gives the internationally competitive price of given country's currency. Market price of exchange rate are liable to fluctuate primarily due to narrow margin in a fixed exchange rate system and much more in a floating exchange rate system. In a country with exchange rate control, there may be multiple exchange rate. That is the price of foreign currency varies according to the use the central bank believes a buyers intends to make of it. Because of transaction cost and some element of monopoly in dealing with small buyers and sellers of

currency, bank generally charges more to sell foreign exchange than they offer to buy it particularly in the case of small amount and low denominational notes. Away from the rudimentary fluctuations of exchange rate in Nigeria is the oil price induced fluctuation. The study regards the Nigeria as a special case in point given that Nigeria is not only a net crude oil exporting economy but also depend on foreign import of refined crude to make up for it grossly inadequate energy needs domestically, thus subjecting the monetary policy authority to recurring challenge of putting up with the exchange rate fluctuation pressure. The widening disparities between the official and parallel exchange rates, particularly since the first quarter of 2015 as could be seen from the trend behavior will likely portend significant implication for domestic prices (Olagbaju and Akinbobolo, 2016). The difficulty in managing exchange rate in the face of single dominant export product of Nigeria – oil, raises questions as to what the association between oil prices and exchange rate holds for the economy and by extension the implication such association has on the standard of living and on the economic development of Nigeria. Real exchange rate will be adopted as the proxy of exchange rate in Nigeria in the present study as strongly recommended and used by Obi, Awujola & Ogwuche . (2016).

Economic development

Economic development could to Economic dictionary could be defined as Economic development refers to the process of improving the economic well-being and quality of life for individuals, communities, and nation. The theory of economic development has remained consistently a re-occurring debate with economists agreeing less on what economic development represents or the appropriate proxy or indicators of economic development. It is an elaborate concept with qualitative dimensions and indicators. These dimensions/indicators could be expressed in terms of measurable parameters like the longevity of life, school enrolment, standard of living etc. These indicators represent measurable economic parameters of economic development. Other subsidiary indicators of economic development include energy availability, incentive to youths, allocation of budget for health and education etc. The study will employ the human development index as the appropriate and encompassing proxy of economic development. Human development index (HDI) is a statistical tool used to measure a country's overall achievement in it social and economic dimension on the bases of their health, level of education and standard of living. Human Development index was developed by Mahbub Haq, a Pakistani Economist in 1990. Calculation of the index combine three major development outcomes like life expectancy for health, adult literacy for school enrolment and GDP per capita for standard of living. The HDI index is criticized in literature because it takes no account of income distribution. Secondly, the equal weight assigned to three major proxies of HDI is perceived erroneous in the sense that one might not know which HDI proxy is responsible for low HDI in a given country. The HDI measure was highly recommended in studies like Daphne & Richard (2010).

Oil price, exchange rate and economic growth/development- the goal programming technique.

Plethora of literature abound in goal programming most of which are not closely associated with the present study; a deficiency that informed the use of the tool as value added in the work. Uwatt (1998) considered external debt management using the goal programming technique. The pre-emptive goal programming technique was deployed with the goals arranged in their order of priority as expected in goal programming problem formulation. Ekezie and Onuoha (2013) conducted a similar study using the weighted GP techniques on the application of goal programming to budgetary allocation of institution of higher learning. The data collected from the Imo state ministry of finance was used to formulate a goal programming

problem. The formulated problem was solved using simplex method. From the finding, the study concluded that Imo state University (IMSU) should come within N4.24 billion naira to satisfy goal two (2) and goal four (4) which are overhead cost and revenue goals respectively. It was then recommended that the university should have a minimum budget of N4.24 billion in 2010 and such should be reviewed upward annually which should be properly and timely monitored by active government monitoring team.

Agarana, Anake and Adeleke (2014) conducted a study on the application of linear programming model to the unsecured loan and bad debt risk analysis in banks using a simplex method; a technique used for solving the goal programming problem. The study deployed the sensitivity analysis by altering the percentage of unsecured loan, and the simplex method approach to solve the formulated goal programming problem. Other related literature that adopted the multi objective technique of goal programming includes Arewa, Owoputi, Torbira, (2013), Romero and Rehman (2003) Hossein Mirzaei et al (2018) etc. While some of the researchers are embracing the combined technique of pre-emptive and fuzzy GP technique, others for research convenience are using the technique independent of the other in their goal programming model formulation.

3. THEORETICAL REVIEW

Thorough review of the Dutch disease hypothesis, rental state hypothesis, Traditional flow theory of exchange rate determination and the neo classical growth theory in the light of the study under investigation sufficiently suggests that increase in oil price (oil price shock) instigates appreciation of exchange rate while the opposite is the case for decrease in oil price. It could also be pointed out that the effect of oil price fluctuation on a given economy depends on the price elasticity of demand that a given economy enjoy in the international market for oil. It depends more so on whether the economy is a net-exporter or a net importer of oil in the international market. These represents different theoretical perspectives of how the international oil price dynamics affects an economy. Nigeria is a special but unusual case as the country is both a net exporter and net importer of refined crude oil. It instructive to note that why the Nigeria government is directly involved in the exportation of crude oil, it only plays a regulatory role in the importation of refined crude into the economy. As such there seem to be an asymmetric, supply-driven effect of the oil price on the economy. It is very unlikely that given the primary nature of the nations oil export, that Nigeria cannot enjoy price inelastic demand for its product though not empirically established.

Against the above established premised one could see why the socio-economic indicators remain abysmally low and way below internationally standard given that appreciation of exchange rate is a recipe for reduction in price level and improved standard of living in the exporting economy *ceteris paribus,* as consumers enjoy increase in purchasing power, unlike depreciation of exchange rate.

Empirically, three perspectives of studies could be identified on the bases of their submission. Worthy of mention is the emphasis on the oil price shock induced exchange rate fluctuation. Rotimi and Ngalawa (2017) in line with other studies submitted that shocks are transmitted through monetary medium; a submission that corroborates with the views of the monetary exchange rate theory. The second categories of the empirical works made a priori-consistent but contentious submission about the growth of output in the face of depreciation of exchange rate. This could possibly be tenable in OPEC economies that refine its own fuel unlike Nigeria that import refined oil at inflation prone prices. The third perspective championed by Akpan (2009) found evidence of fiscal rascalities in the OPEC economies;

Olomola (2006) found evidence of resource curse which corroborates with the position of Rentier state theory and the Dutch disease hypothesis, amidst the stress on weaknesses of the institution by Rickne (2009) & Balogun (2001) especially in managing the benefit of oil wind fall. These submissions clearly affirm the finding of Tokuo & Hayata (2016) and (Akalpler & Nuhu, 2018) whose studies submitted based on empirical evidence that most OPEC and OECD countries are endangered from oil price shock. The rentier state theory developed by Hossein Malidavy 1970 has a little to contribute on the challenges facing developing economies. The rentier state theory holds that the decision makers in natural resource rich economies create and sustain unhealthy growth restricting policies that grossly affect the overall best utilization of resources proceed in the economy. This is even as the Dutch disease model equally exposes the weakness of our institution in managing the resource endowment and proceed of oil. These two theory resource curse theories identified weakness of domestic institution in promoting social welfare among member countries.

Conceptual Framework

In the light of the theoretical review, the conceptual diagram below offers explanation to both the exogenous and endogenous variable that affects how the oil windfall affect the Nigeria economy.
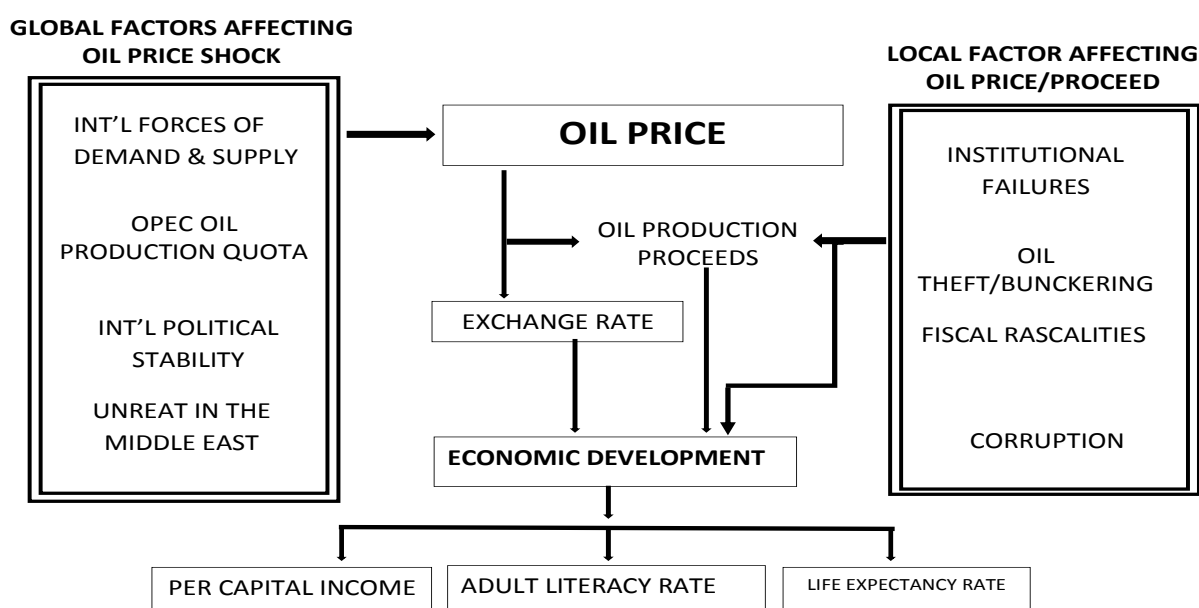

Fig 1: Diagram depicting identified factors that affect oil price and ultimately the economic development outcomes in Nigeria.

Since the global factors affecting the oil windfall are exogenous to the economy, it therefore behooves on the management of the economy to operate from the position of strength by ensuring that institutional failures, fiscal rascalites and corruption as identified by Akpan, 2009, Olomola (2006) are decisively addressed so as to guarantee improved trickle-down effect on development outcomes.

4. EMPIRICAL REVIEW

Literature has established three channels of oil price transmission namely; term of trade channel (which for the purpose of this study could be referred to as the monetary medium channel), wealth channel and the portfolio channel. These channels account for the avenue through which oil dynamics generates macroeconomic instability that affect the economy. The terms of trade channel which predominantly focuses on the association between oil price (real) and exchange rate via the price level was introduced by Amano and Van Norden (1998). It mainly reflects relative price dynamics and how the changes of oil price affect the domestic economy via price level. The underlying idea is to link the price of oil to the price level, which affects the real exchange rate (Bénassy-Quéré et al., 2007), Musa, Maijama'a, Shaibu & Muhammad (2019), Majidli & Guliyev (2020). For instance, a study carried by Majidli & Guliyev (2020) corroborates Nigerian experience even though a foreign studies. Their study which aimed at investigating the relationship between real non-oil GDP growth of Azerbaijan and exchange rate and oil prices made an interesting point in their submission. The study identified a structural break date in the long-run relationship between the real non-oil GDP growth and the oil price. On the bases of this and also the Fully Modified Ordinary Smallest Square approach (FMOLS) results, the study affirmed that increase in oil price increases real non-oil GDP growth, and a such economic policies of oil rich economies should be all encompassing such that trickle-down effect of the oil price increase could spur growth in the non-oil sector. From the domestic front, Edeh et al (2017) using EGARCH technique affirmed that any sharp rise in oil price (revenue), stimulates investment through increase in government expenditure, say, on infrastructures, but the reverse happens for any sharp decline in oil price; a submission that partly affirm the stance of the term of trade theorist. Other studies with significant effort at unravelling the oil price-exchange rate nexus includes Amano and van Norden (1998); Bénassy-Quéré et al. (2007), Coudert and couharde. (2007), Lizardo and Mollick (2010), Aloui, *et al* (2018), Efayena, Buzugbe & Olele, (2019) Majidli, and Guliyev (2020), Wang, *et al* (2022), Siddiqui, *et al* (2023) Adejola, *et al* (2022).. It is imperative to note that while the wealth channel reflects the resulting short-run effect, the portfolio channel assesses medium and long-run impacts. There is also an argument in literature that the US dollar appreciates in the short-run on account of the re investment of the proceed of oil in US dollar asset by the oil exporting economies. Regrettably, the Nigeria economy is unlikely to be found in this category because Nigeria is both a net exporter of crude oil and importer of refined fuel. Second, the economy is unlikely to boast of sufficient dollar asset since such investment is at variance with the priorities of the government of Nigeria.

The elasticity hypothesis of the oil price-exchange rate nexus in term of transmission mechanism equally come to bear as it offers explanation to the availability or unavailability of alternative energy sources when the price of oil increase or reduces. For instance, the theorist Jehle and Reny (2011) cited in Coudert et al. (2007) defined demand elasticity as a measure of the quantity of demand's responsiveness to a change in the imported product price. He further stated that if the quantity demanded of oil is highly responsive (non-responsive) to a price change, demand is relatively elastic (inelastic). Nkomo (2006) put forward that if there is a rise in the price of a country's export product (oil), the products become relatively more expensive in the international market. However, the rate at which the quantity of imports changes depends on the elasticity of imports. The importing countries may be compelled to reduce their imports of oil since the have an elastic demand for the product. Indeed, if oil import demand is highly inelastic, a rise in oil price causes domestic currency depreciation in the importing country as more of their local currency will be expended to procure a given quantity of their much-desired import of oil. In order words, an increase (decrease) in the oil price means that the importing country requires more (less) of its currency to buy the same amount of oil it used to buy before.

Hence, there would be depreciation (appreciation) in the importing country's currency (Nouira et al. 2019).

In passing it is important to stress that appreciation or depreciation of an economy's currency in the event of oil price change depend on the gain (term of trade channel) or the quantity of local currency expended for the purpose of oil transaction in the international market. Second, oil price and exchange rate dynamics are influenced by several factors which are not only difficult to predict but also exogenous to Nigeria economy. The few identified factors at the global realm includes the international forces of demand and supply for oil (which in literature falls under the demand and supply shocks), the oil production quota (which fundamentally deal with internal productive capacity of the OPEC member country) and international political stability (especially within the Middle East). Domestically, the economy is bedeviled by perennial burden of oil exploration policy and incident of oil theft that has made it almost impossible for Nigeria to meet up with its OPEC production quota.

5. GAP IN LITERATURE AND VALUE ADDITION

In conclusion from the reviewed study, the technique of analysis gap and the variable gap was conspicuously discovered, hence the present study intends to look at the how economic development parameters has improved over time in the face of oil price and exchange rate dynamics. Second, the study intends to extend the literature by building on the methodology of Uwatt (1998) and Ekezie and Onuoha (2013) who deployed the multi goal programming method in their study using a three-year data point decision variable. The present study adopted a 10-year average starting from 1982-2022 in its quest of determining the decision variable of interest and the corresponding aspirational target for each of the constraints. Thirdly, the present study adopted the combination of the Uwatt (1998) weighted GP technique and the Ekezie & Onuoha (2013) preemptive goal programming technique.

5. METHODOLOGY

Research design.
The study adopts an *ex post facto* design. In specific terms, while the general model of the goal programming model will guide the actualization of the objective of the study the neo-classical growth framework depicted as $Y_t = F(K_t, L_t, A_t),$ offers a mechanism and theoretical anchor of the study wherein human development index as measure of economic development is affected by oil price and exchange rate. The leeway to this choice of methodology was rightly informed by Uwatt (1998) and Ekezie & Onuoha (2013).

MODEL SPECIFICATION.
Goal programming optimization model
The general from of the goal programming model is given as;

$$Minimize\ Z = \sum_{m=1}^{M} \sum_{n-1}^{N} P_m^n \left[\sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{t=1}^{T} \left(d_{ijt}^+ - d_{ijt}^-\right) \right] \tag{1}$$

Subject to:
System constraint

$$X_{it} - \sum_k a_{ikt} X_{kt} + d_{it}^+ + d_{it}^-: \quad \begin{matrix} i & = & 1,2 \ldots . I \\ k & = & 1,2 \ldots . K \\ t & = & 1,2 \ldots \ldots T \end{matrix} \tag{2}$$

Goal constraint

$$\sum_I a_{ijt} X_{it} + d_{jt}^- + d_{jt}^- = C_{jt} : \begin{array}{ccc} j & = & 1,2\ldots\ldots J \\ t & = & 1,2\ldots\ldots T \end{array} \tag{3}$$

$X_{i,j,k,t}; \; d_{i,j,t}^-; \; d_{i,j,t}^- \geq 0 \; \forall \; i,j,k \; and \; t \; non-negativity \; constraint$

Where:

$P_m^n = priority \; level \; m \; attached \; to \; goal \; or \; objective \; n$

$d_{jt}^+(d_{jt}^-) = positive \; (negative) deviational \; variable \; denoting \; overachievement$
$\quad (underachievement \; of \; goal \; n \; representing \; system \; or \; non \; goal \; constraint$

$X_{it}(X_{kt}) = endogenous \; (decisions) \; and \; exogenous \; variables \; respectively \; at \; time \; t$

$I = \; number \; of \; endogenous \; (decision) \; variables$

$K = \; number \; of \; exogenous \; variable \; in \; each \; system \; constraints$

$N = \; number \; of \; goal \; and \; non \; goal \; (system) \; constraints.$

$M = \; number \; of \; priority \; level$

$J = \; number \; of \; goals$

$T = \; time \; period$

$B_{it} = \; right \; hand \; side \; value \; of \; system \; constraint \; i \; at \; time \; t$

$C_{jt} = \; right \; hand \; value \; of \; goal \; constraints \; j \; representing \; the$
$aspiration \; level \; of \; target \; at \; time \; t$

$a_{ik} = regression \; coefficient \; of \; exogenous \; variable, X_k, in \; the \; system$
$constraint \; representing \; decision \; variable \; X \; at \; time \; t$

$a_{ijt} = technological \; coefficient \; of \; the \; decision \; variable , X_I \; corresponding$
$to \; goal \; constraint \; j \; at \; time \; t$

It is instructive to note that the structural macroeconomic model of Nigeria economy was constructed with special concern on equation model that are critical in addressing relevant decision variables of the goal programming operation and by extension the objective of the study. With neo-classical growth theory as the theoretical framework, it is not without recourse to the work of Iyoha and Guobadia (2011), Udah (2019) whose study extensively dealt with the peculiarities of developing economies in their macroeconomic modelling.

The major policy goals which the goal programming technique seek to achieve as clearly stated in objective one are clearly incorporated in the objective function/achievement function of the general goal programming framework which entails the minimizing the underachievement of the desired oil price, minimizing the overachievement recorded in the exchange rate and minimizing the underachievement of economic development proxied by human development index. These goals are clearly stated according to priority based on the tenets of the adopted weighted-preemptive goal programming framework.

Goal programming formulation for oil price, exchange rate and economic development.

Using a ten-year average spanning from 1982 to 2022, the decision variable as well as the aspirational target was determined. The functional coefficient of the decision variables will be based on the average of the decision variables. Recall that the aspirational target goal to be achieved would be set based on these determined averages. The decision variable can be determined thus as follows.

Table 1: Decision variable determination for oil price, exchange rate and economic development.

GOAL	Mean (x_1) (1982 - 1991)	Mean (x_2) (1992 - 2001)	Mean (x_3) (2002 - 2011)	Mean (x_4) (2012 - 2021)	TOTAL

Oil Price	22.032	18.675	60.894	73.12	174.721
Exchange rate	3.8678	45.4178	134.0029	252.9802	436.2687
Economic dev.	0.39	0.409	0.462	0.522	1.783
Total	26.2898	64.5018	195.3589	326.6222	612.7727

Going forward, a coded decision variables coefficient of oil price, exchange rate and economic development was determined. It makes for the simplification of the simplex iteration.

Table 2: Coded decision variable coefficient for oil price, exchange rate and economic development (1982 -2022)

ITEM(GOAL)	Mean (x_1)	Mean (x_2)	Mean (x_3)	Mean (x_4)	TOTAL
Oil Price Shock	2.2	1.87	6.09	7.31	17.47
Exchange rate	0.39	4.54	13.4	25.3	43.63
Economic dev.	0.39	0.409	0.462	0.522	1.783
Total	26.2898	64.5018	19.952	33.132	62.883

Table 2 gives the coded data for oil price shock, exchange rate and economic development. The reason for the coding is to enable one work with small figures in the analysis.

Assignment of weights to the goals

The objective function coefficient for the variables associated with the goal i^{th} is called the weight for the goal i^{th}. The most important goal receives the largest weight, while the least goal in the order of importance receives the least weight.

Let w_i be the weight for goal i^{th}. In order word, the first goal (oil price) was assigned 6, second goal (exchange rate) 4 and third goal (economic development) 2. Note that the most important according to the researchers' order of priority goal has the highest weight and so on.

Table 3: Coded decision variable for oil price, exchange rate and economic development with weights

ITEM(GOAL)	Mean (x_1)	Mean (x_2)	Mean (x_3)	Mean (x_4)	TOTAL	w_i
Oil Price	2.20	1.87	6.09	7.31	17.47	6
Exchange rate	0.39	4.54	13.4	25.3	43.63	4
Economic dev.	0.39	0.41	0.46	0.52	1.78	2
Total	26.29	64.50	19.95	33.13	62.9	

The table above gives the coded data and the assigned weights to the goals.

3.2.1.2 Aspiration level (Target value) of the Goals

The goal statements are given as follows:

Goal 1: Raise oil price by at least $80

Goal 2: Reduce exchange rate by at least ₦ 250

Goal 3: Raise economic development (HDI) by at least 0.60

Goal Formulation for Oil Price, Exchange Rate and Economic Development.

Let x_1 = mean of data for oil price, exchange rate and economic development for year 1982 – 1991

x_2 = mean of data for oil price, exchange rate and economic development for year 1992 – 2001

x_3 = mean of data for oil price, exchange rate and economic development for year 2002 – 2011

x_4 = mean of data for oil price, exchange rate and economic development for year 2012 – 2021

Where x_1, x_2, x_3 and x_4 are decision variables.

The goals can be stated mathematically as follows:

$2.2x_1 + 1.87x_2 + 6.09x_3 + 7.31x_4 \geq 8$ (Oil price constraint)

$0.39x_1 + 4.54x_2 + 13.1x_3 + 25.3x_4 \leq 25$ (Exchange rate constraint)

$0.39x_1 + 0.4x_2 + 0.46x_3 + 0.52x_4 \geq 0.6$ (Economic development constraint)

$x_1, x_2, x_3, x_4 \geq 0$.

Addition of goal programming identities

Let d_1^+ = amount by which the hypothetical i^{th} goal is exceeded.

d_1^- = amount by which the hypothetical i^{th} goal suffered shortfall.

Let ℤ = be the weighted sum associated with meeting up adequately the significant level of oil price, exchange rate and economic developments.

Using the weighted goal programming model, the goal formulation can be mathematically stated as follows:

Min ℤ= $6d_1^+ + 4d_2^- + 2d_3^+$ (objective function)

Subject to:

$2.2x_1 + 1.87x_2 + 6.09x_3 + 7.31x_4 + d_1^- - d_1^+ = 8$

$0.39x_1 + 4.54x_2 + 13.1x_3 + 25.3x_4 + d_2^- - d_2^+ = 25$

$0.39x_1 + 0.4x_2 + 0.46x_3 + 0.52x_4 + d_3^- - d_3^+ = 0.6$

$x_1, x_2, x_3, x_{4,} d_1^+, d_2^+, d_3^+, d_1^-, d_2^-, d_3^- \geq 0$

Table 4: Goal programming formulation analysis of the oil price, exchange rate and economic development using simplex approach.

Basic Variables	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}		R. H. S
Name of Variable					d_1^+	d_2^+	d_3^+	d_1^-	d_2^-	d_3^-		
Minimize Z	0	0	0	0	6	0	2	0	4	0		
Oil Price Constraint	2.2	1.87	6.09	7.31	-1	0	0	1	0	0	=	8
Exchange rate Constraint 2	0.39	4.54	13.1	25.3	0	-1	0	0	1	0	=	25
Economic development Constraint 3	0.39	0.4	0.46	0.52	0	0	-1	0	0	1	=	0.6

Based on the above inputted data, let $x_5 = d_1^+$, $x_6 = d_2^+$, $x_7 = d_3^+$, $x_8 = d_1^-$, $x_9 = d_2^-$, $x_{10} = d_3^-$. The application of simplex LP method on the Oil price, exchange rate and economic development constraints using excel solver gives the optimum solution as follows:

Table 5: Post simplex GP optimization result for oil price, exchange rate and economic development.

DECISION VARIABLE	x_1	x_2	x_3	x_4	TOTAL		
	0	0	0.45	0.75			
OBJ FUNC	6	4	2	0	0.90		
Oil price constraint	2.2	1.87	6.09	7.31	8.26	>=	8
Exchange rate constraint	0.39	4.54	13.1	25.3	25	<=	25
Economic development constraint	0.39	0.4	0.46	0.52	0.6	>=	0.6

INTERPRETATION OF THE SOLUTION

The application of simplex GP method by Excel Solver gives the optimum solution as follows:

$Z = 2.08$, $x_1 = 0$, $x_2 = 0$, $x_3 = 0.45$, $x_4 = 0.75$, $d_1^+ = 0.26$, $d_2^+ = 0$, $d_3^+ = 0$, $d_1^- = 0$, $d_2^- = 0.13$, $d_3^- = 0.003$. Since the value of Z is not equal to zero, it shows that the objective function of the goal programming formulation was not minimized (optimized). The solution satisfied goal 1

(oil price) constraint and goal 2 (exchange rate) constraint but fails to satisfy goal 3 which is the economic development aspirational target with margin of deviation of approximately 0.003%. This further affirms the optimization result for the disaggregated HDI index result where per capita income aspirational target was not satisfied.

It is imperative to emphasize here that goal one is exogenous to the Nigeria economy. There is equally an unresolved argument in literature that goal 2 is equally exogenous to us due to the fact that the economy's exportable does not accord Nigeria a reasonable level of international competitiveness, thus exchange rate based on the economy's few exportable exert so much pressure which prompt the monetary authority to resort to ecliptic exchange rate regime sometime without success in order to combat it. However, the result portends great potential but on the condition that hindering challenges associated with the oil sector has to be untied and resolved so that the country's OPEC assigned quota is adequately met. Most importantly the submission of Riche (2009) cannot be overemphasized given that rejuvenating our institution will guarantee optimal economic gain for Nigeria.

6. DISCUSSION OF FINDINGS

The generality of the observation from this study both from the goal programming result leaves much to be desired. In the analysis conducted which took great insight from the work of Uwatt (1998) and Ekezie and Onuoha (2013), oil price aspirational target of $80 per barrel and exchange rate aspirational target of N250/$ was attainable, with economic development aspirational target of 0.60 unattainable. Substitution of the respective deviations of the three constraints gave a non-zero objective function which suggest that the oil price, exchange rate and economic development goal programming analysis is not optimized. It is important to note that despite the fact that the independent constraints of the GP problem like the oil price and exchange rate aspirational target was found to be attainable, the objective function was not optimized (minimized) using the $Min\ Z = 0$ decision rule. The inability of the objective function to be optimized could be traceable mono- economic nature of our economy, institutional failures and bad governance amidst fiscal rascalities that characterize the governance in Nigeria as clearly validated by Akpan (2009) who found evidence of fiscal rascalities in the OPEC economies. These daunting problem leaves one no option but to suspect resource course as validated by Olomola (2006) and Olayungbo (2019); a position that corroborates with the position of Rentier state theory and the Dutch disease hypothesis. Borrowing from the submission of Aliyu (2009) and Musa, *et.al* (2019), Nwosu *et.al* (2019), diversification of the economy is key to the optimization of economic development such that exogenous ups and down in the oil price as determined by many exogenous forces does not distort the developmental trajectory of the economy. Additionally, more attention should be accorded to oil price-exchange rate nexus (as advised Akighir & Kpoghul, 2020) whose aspirational target were found to be independently attainable so as to adequately manage liquidity pressure.

7. POLICY RECOMMENDATION

❖ With oil price and exchange rate aspirational target attainable, the government can leverage on this discovery to brighten the prospect of Nigerian Economy.

❖ Secondly, there is need for the government to re-appraise it exchange rate policy given the weak international competitiveness of the Nigerian Economy.

❖ Finally, the government need to put its institution to optimal use, so that the trickle-down effect of oil price windfall can translate into improved socio-economic indexes of development.

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