Covenant Journal of Business & Social Sciences (CJBSS) Vol. 8 No.1, June, 2017

An Open Access Journal Available Online

A Simulation of the Removal of Fuel Subsidy and the Performance of the Agricultural Sector in Nigeria using a Dynamic Computable General Equilibrium Approach

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***Abstract*:** This study analysed the response of the agricultural sector to the removal of subsidy on refined petroleum in Nigeria, given its strategic role as a critical sector. Using a dynamic energy-environment CGE model based on the 2006 Nigerian Social Accounting Matrix (SAM), the study presents the results of the response of the agricultural sector to three different simulation scenarios. These include a partial (50 percent), gradual and a one shot (complete) removal of subsidy on imported refined oil in Nigeria. The results provided evidence that a complete or one shot removal of fuel subsidy is more favourable in terms of better performance of the agricultural sector as many of the key macroeconomic variables increased under the complete removal simulation scenario. It is recommended that a one shot removal of fuel subsidy will strengthen the agricultural sector performance and outputs, even though prices will move up in the short term. The long term benefits to the sector when funds are allocated to infrastructural and technological development will support overall growth and enhance food security in Nigeria.

***Keywords*:** Agriculture, dynamic CGE, econometric modeling, energy, subsidy on refined petroleum

JEL Classification: Q1, D5, C5, Q4

1. Introduction

Energy plays an important role in the production process of any output in an economy as it is a key input. Its effectiveness is crucial to economic growth and development of any sector in an economy. This is because all economic agents including households and all sectors require energy to function and contribute meaningfully to overall growth. As a low-income country with a high dependence on foreign trade, successive governments in Nigeria have taken several steps to reform the energy sector which includes the removal of subsidy in order to diversify the economy so as to boost domestic market and reduce over-dependence on crude-oil exports. The Petroleum Industry Bill (PIB) is an example of reform attempts by the government to make the petroleum industry more competitive. Despite being blessed with abundant natural resources including large oil and gas reserve, Nigeria still struggles to reap significant benefits from oil exploration and exportation. These and other challenges experienced particularly in the downstream sector resulted to the fuel subsidy reform policy. These reforms and policy measures, though, not without their challenges are intended to accelerate the growth of the economy. This happens through the re-allocation of the subsidy fund to priority sectors such as education, health, infrastructure and agriculture (Umar and Umar, 2013; Akinyemi, Alege, Ajayi, Amaghionyediwe and Ogundipe, 2015).

It is important to note that agriculture was previously the mainstay of the Nigerian economy before the discovery of oil. The discovery of oil in commercial quantities at Olobiri, Bayelsa state in 1956, led to a redirection of focus from agricultural produce to oil exportation which has led to increased foreign earnings. Crude oil sale contributes between 67 percent and 75 percent to government revenue and about 96 percent of foreign exchange earnings in Nigeria (CBN Statistical Bulletin, 2014). The early 1950s and 1960s were the periods agricultural sector was known for huge foreign exchange earnings and employment generation. During these periods, many mineral and agricultural resources like cotton, cocoa, coal, rubber, tin, groundnuts, etc. were usually explored and exported in large quantities, while government spending was financed from their proceeds. This brought about huge foreign exchange earnings and increases in foreign reserves to a buoyant level and thus, led to the neglect of other important sectors, especially agriculture. Ever since then, the Nigerian economy has become dependent on oil for most of her trade and economic transactions with the rest of the world. However, since the introduction of Nigeria's vision 20:2020, the agricultural sector has been identified as a key sector to enhance Nigeria's economic diversification as a key driver of change (Cervigni, Rogers and Dvorak, 2013).

As part of the drive towards re-strategizing and re-positioning the agricultural sector for sustained growth and food security, the government had introduced a number of policies: including Agricultural Development Projects (1974), Operation Feed the Nation (1976), River Basin Development Authorities (1976), Green Revolution (1980) and Directorate for Food, Roads and Rural Infrastructure (1986). These policies, among other things, strive to enhance access of farmers to finance through agricultural loans, supply of fertilizers and

insecticides to tackle outbreak of diseases. These efforts will improve productivity and output growth in the sector. Thus, this study seeks to examine the response of the agricultural sector to a partial removal, gradual removal and a one shot removal of subsidy on imported refined petrol in Nigeria. The dynamic energy-environment (E2) Computable General Equilibrium (CGE) model based on the Nigerian 2006 Social Accounting Matrix (SAM) is employed to achieve this objective. This study is important as the results show the magnitude of impact of a policy change such as the removal of fuel subsidy on the agricultural sector. This is vital as it indicates the direction and policy prescription necessary to support growth in the sector, especially for policy-makers. The rest of the study is structured as follows: Section 2 presents an overview of literature, section 3 describes the methodology and dataset adopted for the study, section 4 presents the discussion and analysis of results while section 5 concludes with policy recommendations.

2. Overview of the Literature

Subsidy is said to exist when consumers of a certain commodity are assisted by the government to pay part of the prevailing market price for the product (Soile, Tsaku and Yar Adua; 2014). Thus, fuel subsidy could be expressed as the difference between the actual market price of fuel and the amount final consumers pay for the commodity. According to Bazilian and Onyegi (2012), developing countries have used fossil fuel subsidies for consumers basically as a means of achieving certain economic, social and environmental goals, which include resource wealth re-distribution, correction of externalities, poverty reduction and controlling inflation. About 90 per cent of the country's foreign exchange earnings are accounted for by the exportation of crude oil (Obasi, 2003), thereby making it necessary for citizens to benefit from the resource endowment. This has led to government subsidising the pump prices of petroleum products, including petrol, kerosene and diesel. The acclaimed objectives of this fuel subsidy range from encouraging industrial growth, wealth distribution and to expand domestic consumption of the products by the household (International Energy Agency, Organisation of the Petroleum Exporting Countries, Organisation for Economic Co-operation and Development and World Bank, 2010). These objectives predate the important role energy access plays in various sectors of the Nigerian economy. This must have prompted the government to review the price of petroleum products so as to prevent the adverse effects of international price shocks on the domestic economy. This energy subsidy by the government through controls over pricing and supply would have been responsible for yearly rapid increase in the country`s capital expenditures and balance of payment disequilibrium. Although the country has four refineries with production capacity running into several thousands of litres per day, it still remains a large net importer of petroleum products. This is due to the fact that local production capacity is far below the country's current needs for both consumption and production. Therefore, the country still depends heavily on imported petroleum products.

In the past, government had taken steps to address the issue. This is predicated on the general notion that the welfare objective of such policy has seldom

been achieved. Evidence from literature suggests that the upper and middle class benefit more from fuel subsidy since they consume more than the low-income earners (Umar and Umar, 2013; Siddig, Aguiar, Grethe, Minor and Walmmsley, 2014). The implication of this is the unequal distributive role of resource allocation which imposes persistent fiscal pressure on government spending yearly. Another issue is the perceived ways in which the removal of fuel subsidies could affect the domestic economy as a whole. On the one hand, the local prices of the product will increase with the removal and this could trigger inflation. On the other hand, this removal could allow a huge amount of government capital expenditure to go into other uses that could enhance overall productivity in the economy, such as infrastructure. In addition to this, the removal of subsidy is argued to support growth of the economy and improve environmental quality through a reduction of carbon emission (through reduction in use of fossil fuel-based energy).

In empirical literature, there is limited number of studies on the impact of fuel subsidy removal on the performance or output of the agricultural sector, even for Nigeria, with the exception of the study of Atoyebi *et al.* (2012) which used questionnaires to analyse how output in the agricultural sector will change with the removal of subsidy in Nigeria.. Many of the studies often analyse the impact (mainly distributional and economic) on the removal or reform of agricultural subsidies and not fuel subsidy in particular. This is the important gap this study will be filling. For example, Ansari, Salami and Veeman (2014) examined the distributional consequences of subsidy removal from the agricultural and food sectors using a price-based Social Accounting Matrix (SAM) analysis. They found that the low-income rural households will be most affected when these categories of subsidies are removed due to high prices of food and agricultural produce which is capable of affecting welfare negatively. Also, Vangelis (2007) assessed the implications that reforming agricultural subsidies will have for sustainable development for New Zealand. The findings presented suggested drawing on the three pillar of sustainable development (economic, social and environmental), the economic and environmental effects were broadly positive while the short-term negative social effects were basically muted and less pronounced.

Theoretically, it is expected that the removal of fuel subsidy will influence the agricultural sector either positively or negatively. The negative effect is reflected in the increase in the cost of agricultural produce attributed to the high cost of transportation which is a crucial component of the logistics. However, Atoyebi (2012) stated that despite the economic hardship often associated with fuel subsidy removal, it is expected that the policy can transform the economy through diversification. This can take place by driving investment into the agricultural sector given that the savings from fuel subsidy can result to increased budgetary allocation for the sector. Furthermore, the agricultural sector, a primary sector of the Nigerian economy is adjudged more prone to subsidy removal shocks. This is partially attributed to the role it plays in the development of other sectors, especially the industrial sector with the contribution of the sector to

GDP, amounting to an average of 23.48 percent between 2010 and 2014. Since the 2014 rebasing, the development of this sector has been argued crucial to economic and physical developments of the Nigerian economy. As stated by Omorogiuwa, Zivkovic and Ademoh, (2014), an in-depth understanding of the dynamics of the agricultural sector through research on development prospect is essential to the progress of the Nigerian economy. In light of this, the study investigates the effect of a fuel subsidy removal policy on the agricultural sector under different simulation scenarios.

3. Methodology and Data

This section describes the features of the model employed for the study and a description of the dataset.

3.1. The Model

The Energy-environment (E2) dynamic Computable General Equilibrium (CGE) model for the Nigerian economy was employed to analyse the response of the agricultural sector to a policy change of the removal of fuel subsidy over a five-year period. The study adapted the energy-environment dynamic CGE model of Adenikinju, Omenka and Omisakin (2012) which is based on the dynamic single country CGE model of the 2012 Partnership for Economic Policy (PEP) model. The study presents the "business-as-usual" scenario for the agricultural sector when government continues to provide subsidy for petroleum consumption and compares with an alternative scenario where fuel subsidy is removed. This is in view of it being a means of driving a green growth strategy which is consistent with the Nigerian Vision 20:2020 development goal.

The model characterises the behaviour of the production structure, commodities and the different agents, following the description in the PEP dynamic model. The production structure follows a nested structure where firms maximise profits subject to the constraints of available technology in a perfectly competitive environment. At the top level, sectoral output of each productive activity is produced from the combination of value added and intermediate consumption in fixed shares (Decaluwe, Lemelin, Robichand and Maisonnave, 2013). At the lower level, value added is composed of composite labour and capital which follows a constant elasticity of substitution. The industry is responsible for the production of commodities which are either consumed domestically or exported; likewise domestic consumption is allocated between domestic production and imported goods. This relationship depends on the degree of elasticity between domestically produced commodities and the imported one (Armington Assumption). The different agents receive and make payment within the system. For example, households receive income from labour and capital income and also transfer from other agents which are spent on consumption on goods and services, payment of taxes, transfer and the remaining is saved. Firms or business units in the model derive income from their share of capital income and transfers received from other agents while also paying business taxes to the government.

The government draws income from household and business income taxes and other forms of taxes on production, goods and imports (Decaluwe *et al.*, 2013). In addition to this, income is received from its share of capital remuneration and transfers from other

agents including the rest of the world. The foreign sector which is considered the rest of the world (ROW) collects payments for imported goods and services, transfer from domestic agents and its share of capital income. On the other hand, the ROW spends on the domestic economy in form of payment for exports and transfer to domestic agents and the difference between foreign income and payment is ROW savings which is equal to the current account balance.

3.2. The Dataset

The dataset employed in the model is the 2006 Nigerian Social Accounting Matrix (SAM) which is the most recent SAM for the Nigerian economy. A SAM shows the flow of transactions within an economy presented in rows (revenues) and columns (expenditure). The SAM was, however, further re-aggregated to specifically account for the refined oil sector which helps to better capture the objective of the present study. The re-aggregation reduced the number of sectors and commodities to eight sectors/productive industries and nine different commodities respectively. Also, it consisted of two households (rural and urban), one firm, a government sector, the rest of the world and three factors of production (land, labour and capital). The discussion focuses on the appraisal of the performance of the agricultural sector with a removal of subsidy on petroleum under three different scenarios.

3.3. Simulation Design and Macro Closures

The model simulated an increase in import tariff on refined oil in order to ascertain the changes in the economy especially in terms of its effects on carbon emission changes. The study performed three simulations which involved a partial (SIM1), gradual (SIM2) and complete (SIM3) removal of subsidy paid on fuel by increasing import tariff on refined oil (petroleum). Relating to the closure rules, the study adopted the neo-classical savings driven macro closure rules as it best describes the structure of the Nigerian economy. The current account balance and the budget deficit were fixed; foreign savings by the rest of the world is assumed exogenous with fixed international prices and flexible exchange rate (real) which is the *numeraire* of the model (nominal exchange rate). The elasticity of substitution between imported refined petroleum and the domestically produced is assumed inelastic as a large percentage of refined petroleum consumed is imported since the local refineries only produced a very minimal proportion. Thus, degree of substitutability between the two is considerably low in the Nigerian economy.

4. Presentation and Discussion of Results

The results from the three simulation scenarios are presented and discussed under this section with their policy implications on the economy.

4.1. Presentation of Results

As discussed previously, the strength of the CGE modeling technique lies in its ability to show the degree of change in the different sectors of an economy when there is a policy change. The removal of fuel subsidy as a policy shift is expected to produce some changes in each of the sectors and the changes for the agricultural sector are presented in this section.

Table 4.1: Imports in Agricultural and Food Sector

	Agric.			Food		
Year	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	0.19	-0.29	-0.49	0.67	-0.83	-1.38
2	-0.15	0.23	0.53	0.48	-0.54	-0.58
3	-0.47	0.58	0.96	0.34	-0.47	-0.42
4	-0.76	0.87	1.28	0.24	-0.49	-0.39
5	-1.04	1.13	1.55	0.18	-0.57	-0.45
Ave.	**-0.45**	**0.50**	**0.77**	**0.38**	**-0.58**	**-0.64**

Source: Author's Computation based on simulation results from GAMS software

An increase in import tariff on imported refined oil, which is what was represented by removal of subsidy, makes price of imported refined petrol relatively expensive. This is given that the Armington assumption and the elasticity of substitution between locally produced goods and imported goods is two. Furthermore, it is expected that demand and consumption for imported goods will increase in as much as all imports can be financed with revenues from exports (Okodua and Alege, 2014). A 50 percent or partial removal of subsidy which is given as SIM1 from Table 4.1 was found to result to a fall in agricultural imports by 0.45 on the average over a five year period. Only the first year recorded an increase in imports of agricultural commodities, while the years following experienced a decline. However, the opposite was the case for food imports when there was a partial removal. When a gradual (SIM2) and a one shot (SIM3) removal was implemented, agricultural imports increased by 0.50 percent and 0.77 percent respectively. The results for food imports however fell by 0.58 percent and 0.64 percent for gradual and complete removal over the five years analysed.

Table 4.2: Exports in Agricultural and Food Sector

	Agric.			Food		
Year	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	0.07	-0.08	-0.14	0.07	-0.08	-0.14
2	-0.12	0.13	0.23	-0.12	0.12	0.23
3	-0.36	0.43	0.69	-0.36	0.43	0.69
4	-0.64	0.83	1.22	-0.64	0.83	1.22
5	-0.96	1.32	1.82	-0.96	1.32	1.82
Ave.	**-0.40**	**0.53**	**0.76**	**-0.40**	**0.53**	**0.76**

Source: Source: Author's Computation based on simulation results from GAMS software

Table 4.2 presents the percentage deviation from the base values for different simulation scenarios for agricultural and food exports over a five-year period. Overall, export of both food and agricultural commodities under a gradual and complete removal was found to have increased. This increase is given by 0.53 percent for agriculture under SIM2 and 0.76 percent under SIM3; while for food, it represents 0.53 percent under SIM2 and 0.76 under SIM3. However, for the two commodities there was a decline in total exports when a partial or 50 percent removal was implemented in the

modelling. This is in view of the assumption that the current account balance is held fixed in the model.

Table 4.3: Change in Output

		Agric.			Food	
Year	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	0.18	-0.24	-0.42	0.45	-0.55	-0.92
2	-0.19	0.24	0.49	0.17	-0.21	-0.14
3	-0.56	0.68	1.12	0.12	0.11	0.36
4	-0.96	1.17	1.73	-0.43	0.45	0.85
5	-1.37	1.70	2.34	-0.75	0.84	1.35
Ave.	**-0.58**	**0.71**	**1.05**	**-0.09**	**0.13**	**0.30**

Source: Author's Computation based on simulation results from GAMS software

In Table 4.3, the results presented suggest that agricultural and food output will shrink by 0.58 percent and 0.09 percent when subsidy is partially removed. However, output was found to expand for agricultural commodities by 0.71 percent in SIM2 and 1.05 percent in SIM3. Food output also increased by 0.13 percent when there was a gradual removal and by 0.30 percent with a complete removal.

Table 4.4: Labour

		Agric.	
Year	SIM1	SIM2	SIM3
1	-	-0.81	-
2	-0.39	-0.48	0.69
3	-0.87	-0.34	1.65
4	-1.44	-0.26	2.77
5	-2.11	-0.22	4.03
Ave.	**-0.96**	**-0.42**	**1.83**

Source: Author's Computation based on simulation results from GAMS software

Table 4.5: Capital

		Agric.	
Year	SIM1	SIM2	SIM3
1	0.66	-0.81	-1.34
2	0.42	-0.48	-0.49
3	0.22	-0.34	-0.22
4	0.05	-0.26	-0.07
5	-0.08	-0.22	-0.01
Ave.	**0.25**	**-0.42**	**-0.42**

Source: Author's Computation based on simulation results from GAMS software

Tables 4.4 and 4.5 shows the percentage variation of labour and capital from base periods in the agricultural sector when subsidy on imported refined petrol is partially, gradually or completely removed. Over the five year period, labour is expected to fall by 0.96 percent when a partial removal is introduced while a gradual removal will result in a 0.42 percent decline. Under the one shot removal, labour will increase by about 1.83 percent. In terms of capital, the sector is expected to experience a decline of 0.42 percent when there is a gradual and complete removal while

there was an increase of 0.25 percent when the subsidy is partially removed.

Table 4.6: Consumption of Households

Year	SIM1		SIM2		SIM3	
	hr	hu	hr	hu	hr	hu
1	0.33	0.34	-0.40	-0.41	-0.67	-0.68
2	0.17	0.18	-0.19	-0.22	0.18	-0.22
3	-0.01	0.01	-0.02	-0.06	0.11	0.06
4	-0.18	-0.15	0.17	0.11	0.39	0.32
5	-0.37	-0.33	0.38	0.31	0.68	0.59
Ave.	-0.01	0.02	-0.01	-0.05	0.07	0.01

Source: Author's Computation based on simulation results from GAMS software

Table 4.6 depicts the percentage variation in consumption of the rural and urban households for the agricultural sector. The rural household consumption of agricultural produce will only increase by 0.07 percent when subsidy is completely removed and decline by 0.01 percent when subsidy on refined oil is partially and gradually removed. On the other hand, urban household consumption will fall by 0.05 percent under the gradual simulation scenario but increase by 0.02 percent and 0.01 percent under the partial and complete removal scenario respectively.

4.2. Discussions and Policy Implications

Overall, the results from the analysis performed showed a mixed result, that is, the removal of fuel subsidy in Nigeria will have both positive and negative impacts on the agricultural sector. Generally, there were positive changes for many of the variables when there was a one shot or complete removal of the subsidy. For example, output in food and agricultural produce, labour, consumption for both rural and urban households increased under the third simulation (Simulation 3) which represents a complete removal. Other positive effects were observed for exports of food and the imports and exports of agricultural products. The partial and gradual simulation also showed some positive change in terms of increase, however, there was a more favourable outcome under the complete removal simulation, especially as there was increase in agricultural output. As earlier indicated in the overview of literature, a limited amount of literature exists on the response of the agricultural sector to the removal of fuel subsidy as many of the studies focus on how the removal or reform of agricultural subsidies impacts on the sector. However, result from this study is similar to the findings of Atoyebi *et al.* (2012) as they equally found a positive correlation between fuel subsidy removal and the prices of agricultural output using questionnaires. Thus, this current study furthers the frontier of knowledge by also showing the change in other indicators such as imports, exports, labour, capital and household consumption using an economy-wide approach (CGE modelling).

5. Concluding Remarks

The study had attempted to investigate the response of the agricultural sector to a policy shift of a partial, gradual and complete removal of subsidy on imported refined oil. The results presented above evidently suggest that the removal of subsidy on imported petrol will impact the agricultural sector

differently under varying simulation scenarios as discussed earlier. Also, the results appear mixed for the different variables discussed over the five-year period under consideration. However, overall, the analysis performed showed that the agricultural sector will have a better performance under a one shot or complete removal as most of the key macroeconomic variables (output, imports, exports, capital) increased under the complete removal (Simulation 3) scenario. Their implications were presented in the previous section. It is recommended that a one shot removal of fuel subsidy will strengthen the agricultural sector performance and outputs, even though prices will initially move up in the short term due to high cost of production, inputs and transportation. The long term benefits to the sector when funds are allocated to infrastructural and technological development will overall support growth and enhance food security in Nigeria.

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