Impacts on Poverty of Removing Fuel Import Subsidies in Nigeria

Khalid Siddig

Peter Minor

Harald Grethe

Angel Aguiar

Terrie Walmsley

WORLD BANK GROUP

Development Research Group

Agriculture and Rural Development Team

July 2015

Abstract

The petroleum sector contributes substantially to the Nigerian economy; however, the potential benefits are diminished because of the existence of significant subsidies on imports of petroleum products. Subsidies on imported petroleum products are considered to be an important instrument for keeping fuel prices, and hence the cost of living, low. The costs of these subsidies, however, have risen dramatically in recent years along with increased volatility in world petroleum and petroleum product prices and increased illegal exportation of subsidized petroleum products into neighboring countries. Removing the subsidy on fuel is one of the most contentious socioeconomic policy

issues in Nigeria today. In this paper, an economy-wide framework is used to identify the impact of removing the fuel subsidy on the Nigerian economy and investigate how alternative policies might be used to meet socioeconomic objectives related to fuel subsidies. The results show that although a reduction in the subsidy generally results in an increase in Nigeria's gross domestic product, it can have a detrimental impact on household income, and in particular on poor households. Accompanying the subsidy reduction with income transfers aimed at poor households or domestic production of petroleum products can alleviate the negative impacts on household income.

This paper is a product of the Agriculture and Rural Development Team, Development Research Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The authors may be contacted at khalidhasiddig@yahoo.com.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

Impacts on Poverty of Removing Fuel Import Subsidies in Nigeria¹

Authors: Khalid Siddig², Peter Minor³, Harald Grethe⁴, Angel Aguiar⁵, Terrie Walmsley⁶

Keywords: Nigeria, fuel subsidy, poverty, income distribution, economy-wide framework.

¹ A shorter version of this paper is published in *Energy Policy*, Vol 69, June 2014, Pages 165–178
<http://www.sciencedirect.com/science/article/pii/S0301421514000950>.

² *Corresponding author, Agricultural and Food Policy Group, University of Hohenheim. Postal address: Schloss, Osthof-Süd, Geb. 04.35, 70593 Stuttgart, Germany. Email: khalidhasiddig@yahoo.com. Phone Number: (+49) 711-45922643*

³ *ImpactECON, LLC, USA. Email: peteminor@impactecon.com. Phone Number: +1-303-537-3237*

⁴ *Agricultural and Food Policy Group, University of Hohenheim. Postal address: Schloss, Osthof-Süd, Geb. 04.35, 70593 Stuttgart, Germany. Email: grethe@uni-hohenheim.de. Phone Number: (+49) 711-45922631.*

⁵ *Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, USA. Email: aaguiar@purdue.edu.*

⁶ *ImpactECON, LLC, USA. Email: twalmsley@impactecon.com. Phone Number: +1-303-537-3237*

Table of Contents

1	Introduction.....	3
2	Methodology.....	7
2.1	The MyGTAP Model.....	7
2.2	Model Closure.....	8
2.3	Data.....	9
3	Scenarios.....	11
4	Results.....	12
4.1	Prices.....	12
4.2	Domestic Demand.....	15
4.3	Production.....	16
4.4	GDP and Trade.....	17
4.4.1	GDP and Spending.....	17
4.4.2	Trade.....	19
4.5	The Impact on Households.....	20
5	Summary and Conclusions.....	22
6	References.....	25
7	Appendices.....	28

1 Introduction

Nigeria, the most populous country in Africa, had a per capita gross domestic product of US\$1,437, in 2010, slightly higher than that found in Sub-Saharan Africa of US\$ 1,311. However, 68 percent of the Nigerian population lives on less than US\$1.25 per day as compared with 48 percent in Sub-Saharan Africa. Poverty and inequality thus remain significant issues in Nigeria (World Bank, 2013).

Nigeria possesses 28 percent of Africa's proven petroleum reserves, second only to Libya; and is the largest producer of petroleum (crude oil) in the region, producing 24 percent of Africa's petroleum in 2010 or 2.4 million barrels per day (bpd) (BP, 2011). During the last decade, petroleum production in Nigeria ranged between 2.1 and 2.5 million bpd, while its share in African production ranged between 21 and 29 percent. Petroleum is of paramount importance to the Nigerian economy, representing 25 to 30 percent of domestic production (GDP) and around 90 percent of its export earnings. Moreover, between 1970 and 2005 petroleum sales contributed about 75 percent of government revenue (Adenikinju, 2009). Over the last four decades, petroleum has also become Nigeria's top export commodity. The share of petroleum in Nigerian exports peaked at 97 percent in 1984 and has not been less than 90 percent since. In conclusion, Nigeria is strongly dependent on petroleum.

Despite being Africa's largest petroleum producer, Nigeria relies heavily on imported petroleum products, principally fuels, which are primarily imported from the European Union (Narayanan et al., 2012). Its four refineries, Port Harcourt I and II, Warri, and Kaduna have a combined capacity of approximately 445,000 bpd, which could potentially satisfy 63 percent of domestic demand. However, these refineries are operating far below capacity due to operational failures, poor maintenance, sabotage on petroleum pipelines feeding refineries, theft, and fire (EIA, 2012; BusinessDay, 2013). In 2009 and part of 2010, particularly low refinery runs forced the country to import approximately 85 percent of its petroleum product consumption (BusinessDay, 2013).⁷ Other estimates (Rice, 2012) suggest that even in 'good' years, domestic refineries have satisfied only 25 percent (maximum) of domestic consumption.

Justified by its proclaimed objective of alleviating poverty, the Nigerian government subsidizes private consumption of imported petroleum products to maintain a stable consumer price at the

⁷ According to BusinessDay (2013), the domestic refineries were operating at an average of 24% of their capacity in 2009 and 2010 to satisfy only 15% of domestic demand.

pump. The Nigerian Petroleum Products Pricing Regulatory Agency (PPPRA) determines the daily and monthly subsidy rates by estimating the gap between the expected price of imported petroleum products, including margins, and the pre-established, regulated, domestic price.⁸ The subsidy paid by the government on imported petroleum products varies positively relative to changes in two factors: world prices and/or demand for these products. In recent years, rising prices of petroleum products have damaged Nigeria's fiscal health by increasing the Nigerian fuel subsidy (Rice, 2012; BBC 2012a, 2012b). For 2012, the subsidy was estimated at US\$ 5.6 billion, being equivalent to about 20% of the total public budget (Umar and Umar, 2013). Thus, the fuel subsidy contributes strongly to the deterioration of Nigeria's government balance which has changed from a surplus equal to 7.3 percent of GDP in 2008 to a deficit of 8.2 percent and 6.5 percent in 2009 and 2010 respectively (IMF, 2013).

Though the fuel subsidy helps the poor by keeping Nigerian fuel prices lower than world prices, it is not an efficient policy for poverty reduction and development for several reasons:

1. The biggest beneficiaries have been importing companies and local wholesalers that smuggle some of the subsidized fuel into neighboring countries selling it at higher prices (The Economist, 2011; 2012). Illegal trade is not well recorded in official trade statistics, which makes it difficult to analyze. According to the BBC (2012a, b), the Nigerian government paid the subsidy on 59 million liters of fuel a day in 2011, although domestic consumption in Nigeria was only 35 million liters a day. Thus, petroleum product importers were paid billions of US dollars to import fuel that was never delivered to the Nigerian people with the subsidy leaking to traders and foreign consumers.
2. The share of poor households in total fuel consumption, and thus the total subsidy volume, is lower than the share of rich households. Umar and Umar (2013) find the richest 20% of households in Nigeria benefitting more than four times as much from the fuel subsidy in Nigeria than the poorest 20%. This analysis, though, is static and limited to the first order effects of price changes without taking into account behavioral responses and changes in income to labor and capital. This is confirmed by data from the 2006 Nigerian SAM (Nwafor et al., 2010), which reports that rural households in Nigeria, which constituted 53.6 percent of the total Nigerian population in 2006 (World Bank, 2013), consumed only 33 percent of total household consumption of petroleum products in Nigeria compared to 67 consumed by the wealthier urban households. In addition, even in relative terms, poor

⁸ The PPPRA follows the import parity principle in its price determination, which includes: a) landing cost of products; b) margins for the marketers, dealers, and transporters; c) jetty-depot through-put; and d) other charges and taxes.

rural households in Nigeria are found to spend less of their income on fuel (0.6 percent), compared to wealthier urban households (0.9 percent).

3. It is likely that beneficiaries invest in lobbying for the maintenance of the import subsidy, legally and illegally, which would constitute economic losses to the economy as a whole, and presents a barrier to advancing good governance.⁹
4. Subsidized market prices not reflecting the social cost of fuels result in overconsumption of fuels and related welfare losses.
5. Many authors argue that if poverty reduction was the real objective behind the subsidy, it should be replaced by more targeted policies such as social programs, investment in infrastructure and others (Umar and Umar, 2013; Nwachukwu and Chike, 2011; Birol et al., 1995). Bazilian and Onyeji (2012) follow this argument, but hint at the political resistance to such complementary policies. Furthermore, they stress the relevance of the energy subsidy to the business sector in light of the poorly developed electricity network and resulting high cost of private power supply based on fuel. Birol et al. (1995) suggest public investments in improving energy use efficiency, which has the potential to partially compensate for the effects of a subsidy phase out.

Nigeria is not a special case when it comes to subsidies on fuel: at a global scale, fuel subsidies to consumers are estimated at more than US\$ 300 billion annually (Victor, 2009). Out of this total, road sector subsidies are estimated at US\$ 110 billion, resulting in a global welfare loss of US\$ 44 billion or even double as much, if externalities are taken into account (Davis, 2013). For the Middle East and North Africa (MENA) region, the World Bank (2009) argues that subsidies on electricity and petroleum products have contributed significantly to the inefficient use of energy. Fuel subsidies have proven to be disproportionately beneficial to the wealthier citizens, which consume relatively larger amounts of fuel to power their automobiles and homes. This is in accordance with findings at a global level (Coady et al., 2010), for the group of developing countries as a whole (Arze del Granado et al., 2012), as well as for many single countries such as Gabon (El Said and Leigh, 2006), India (Rao, 2012; Gangopadhyay et al., 2005) and Indonesia (Dartanto, 2013).

In conclusion, the World Bank argues that: “untargeted energy subsidies reduce the amount of money that can be spent on programs that really benefit the poor” (World Bank, 2009: 60) and encourage investors and firms to invest in activities that would be unprofitable if energy were not subsidized. As the MENA region has experienced social unrest as a result of reducing petroleum and petroleum products subsidies, the World Bank (2009) has suggested that some of the social unrest could be avoided if social programs were implemented to protect poor households from the

⁹ See Sala-I-Martin and Subramanian (2003) and the literature on the effect of abundant resource endowment on corruption cited there.

steep increases and volatile energy prices (World Bank, 2009). A successful example cited is the removal of Indonesian fuel subsidies in 2005, which was accompanied by a carefully designed cash-transfer program that targeted the poor among the affected household groups.

Over the past 30 years, the Nigerian government has made several attempts to remove the petroleum product subsidy (Adenikinju, 2009). From a political economy perspective, however, removal of the petroleum product subsidy is difficult because it impacts a broad spectrum of Nigerian households. Despite the majority of the subsidies benefiting primarily wealthier households, lower and less volatile fuel prices are popular amongst all population segments. For these reasons, Nigerian consumers have opposed attempts to remove the petroleum product subsidy. The predominant view in Nigeria is that any petroleum product price increase will cause inflation and reduce economic welfare (Adenikinju, 2009). Nonetheless, the subsidy on imported petroleum products was abolished on January 1, 2012 under the justification that illegal exports had made the cost of providing cheap petroleum products prohibitively expensive (Rice, 2012). The removal of the petroleum product subsidy caused the price of fuel to more than double. After more than two weeks of strikes, the government introduced a new subsidy that lowered the price of fuel from 140 to 97 Naira per liter. Despite the introduction of the new subsidy, petroleum product prices remained more than 50 percent higher than 65 Naira per liter – the price before the temporary removal of the subsidy.

The objective of this paper is to examine the implications of reducing Nigeria's fuel subsidy on the Nigerian economy and on poor households in particular, and to assess the effect of complementary policies to reduce the detrimental effects on the poor. To this purpose, we use an applied general equilibrium model (AGE), which allows for depicting economy wide effects, as well as effects on poor households which emerge from changing fuel prices, changing prices for other products, which may be increasing in the case of a high fuel input shares or decreasing in the case of a low fuel input shares, and factor incomes from capital, labor, and land. By using an AGE model, we are well-equipped to address points 2 and 4 above: the distorting effects of subsidies as well as distributional effects due to expenditure as well as factor income shares of various household groups. We are also able to analyze complementary policies such as targeted transfers (point 5 above). We are not well-equipped though, to address point 1 above (subsidy leakage due to unregistered trade) due to missing data, and point 3: transaction cost of policies, including the cost of lobbying. We discuss these shortcomings in the conclusions.

Specifically, the MyGTAP modeling framework, developed by Walmsley and Minor (2013), is used for this purpose. This new framework is based on the GTAP model and allows for the incorporation of country specific information, thereby permitting examination of the impacts of global or domestic policies on different household groups within Nigeria. Using this framework

we incorporate income and consumption data for 12 Nigerian households based on both location in Nigeria (North, South, etc.) and rural versus urban. We can, therefore, examine the impact of the removal of fuel subsidies on both the Nigerian economy, the government's fiscal balance and trading patterns, as well as on the incomes and consumption patterns of the 12 different households. Given the recent social unrest in Nigeria as a result of this policy change, we also examine the extent government can allay the detrimental effects of the removal of the subsidy on the poor, by combining the removal of the fuel subsidies with other policies aimed at assisting the poor and or domestic producers of petroleum products.

2 Methodology

In this study, we use a global applied general equilibrium (AGE) model to examine the impact on the Nigerian economy of removing the subsidy on imported petroleum products. Such models are firmly rooted in microeconomic theory of utility and profit maximization as well as product and factor markets being in equilibrium. The parameterization typically is such, that medium to long term adjustments to exogenous shocks (such as a subsidy removal) can be depicted, whereas such models are less suitable to depict year to year adjustment processes. The MyGTAP modeling framework, developed by Walmsley and Minor (2013), offers a platform for the analysis of domestic policies within a global framework, by allowing for the inclusion of detailed data on Nigerian households to be incorporated into the GTAP database (Narayanan et al., 2012). In this section we review the MyGTAP modeling framework and the changes made to the GTAP database.

2.1 The MyGTAP Model

The MyGTAP model is an extension of the standard GTAP model (Hertel, 1997). The standard GTAP model employs simple, but well recognized assumptions about product technology, competition, and consumer and government behavior. For example, production technology exhibits constant returns to scale and substitution between primary endowment factors, such as land, labor, and capital, with intermediate inputs used in fixed proportions. Imports are modeled as differentiated products between the domestic and imported goods. Imported goods are differentiated by country of origin as specified by the Armington assumption. The government consumes goods and services in fixed proportions. Consumer demand for goods and services incorporate both income and substitution effects, allowing for changes to the consumption bundle due to changes to prices and real income. The standard GTAP model assumes one "regional" representative household, which gathers all factor income and taxes that are then distributed to savings and government and private consumptions.

One of the main features of the MyGTAP model is that it eliminates the single ‘regional’ household. MyGTAP allows for one or more private households and a government agent whose expenditures are directly related to the income they each receive from endowment factors and taxes respectively. Moreover, the MyGTAP framework augments the standard GTAP model by including income from inter-regional transfers, such as remittances and foreign aid components of household and government income that can be important to developing countries. This framework is capable of implementing these changes for all regions in the GTAP database.

The new specification explicitly defines the government balance in terms of income and expenditures. The government collects income from taxes and foreign aid, which it then spends on government purchases, transfers to households, foreign aid (out) and subsidies. The difference between government income and expenditure then determines the government’s deficit or surplus.

The private household on the other hand collects income from factor endowments, net foreign labor remittances, net foreign capital rents, transfers from the government, and transfers from other households. The household’s income is spent on consumption of goods and services and savings.

The MyGTAP framework allows for the private household in Nigeria to be replaced with multiple households, facilitating analysis of the distributional impacts of various policies on particular household groups. In this paper, 12 types of households are introduced based on data from the latest available Nigerian SAM for the year 2006 (Nwafor et al., 2010). The SAM provides detailed information on the income, consumption, and savings patterns of 12 households, classified by geographical zones, and rural and urban categories. Detailed linkages between household earnings and factors (particularly natural resources) were not provided in the SAM, requiring some assumptions discussed in the data section, Section 2.3. It was possible, however, to calculate savings rates of the household groups based on the SAM and the Nigeria Poverty Profile (NBS, 2012) (see Appendix 1). The inclusion of multiple households is useful for our study, as we aim to assess the impact of complementary policies, such as compensating poor households, which accompany the reduction in the petroleum product subsidy.¹⁰

2.2 Model Closure

In this study, a fixed level of employment of factor endowments and perfect competition (zero economic profits) are assumed through the selected model closure. While these are not characteristics of the Nigerian economy, it permits us to narrow the scope of our analysis.

¹⁰ Additional technical details on the model features, applied closure, and experiment variables are provided in Appendix 2.

Furthermore, production factors capital and labor are assumed to be fully mobile between sectors, whereas land and natural resources factors are sluggish to move.

In addition, government savings are made exogenous; therefore, any reduction in the subsidy, increases government income and is entirely spent by the Nigerian government, in the same proportions as in the baseline data. This is a stylized assumption that helps us interpret the results, but it also reflects that fact that the additional income obtained from reducing subsidies is likely to be spent on current consumption. The closure is shown in Appendix 2.

2.3 Data

Two datasets are employed to study the effects of the subsidy removal: the GTAP database (Narayanan et al., 2012) and a 2006 Nigerian SAM (Nwafor et al., 2010).

The 2006 SAM distinguishes 62 sectors and commodities, of which more than half are agricultural sectors/commodities. The SAM has a separate sector for petroleum products, a sector for petroleum and natural gas, and an aggregated sector for other mining. In light of the data provided in the SAM, we aggregate the 134 regions in the GTAP 8.1 database into 13 regions (Table 1).

Table 1: Regional Aggregation of GTAP 8 Database

No.	Code	Description
1	Japan	Japan
2	China	China
3	USA	United States of America
4	EU_25	European Union 25
5	MENA	Middle East and North Africa
6	Ghana	Ghana
7	CotedIvoire	Côte d'Ivoire
8	Nigeria	Nigeria
9	Cameroon	Cameroon
10	SouthAfrica	South Africa
11	RWestAfrica	Rest of Western Africa
12	RestofSSA	Rest of Sub-Saharan Africa
13	RestofWorld	Rest of World

Our regional aggregation emphasizes countries neighboring Nigeria and includes countries that are involved in the Nigerian petroleum trade, such as the United States and European Union and major trading partners: China, Japan and South Africa, and aggregated regions MENA, Sub-Saharan Africa, the rest of West Africa and the rest of the world.

The 57 GTAP sectors are aggregated into 21 sectors based on their importance to the Nigerian economy in production, consumption, or trade. Another factor considered is the need to include energy sectors and important inputs into their production. A detailed mapping between the sectors of the Nigerian 2006 SAM, GTAP sectors and the 21 aggregated GTAP sectors is shown in Appendix 3.

The MyGTAP framework allows for the inclusion of country specific data on households and factors. Data from the 2006 Nigerian SAM is combined with the GTAP 8 database using the MyGTAP data program (Minor and Walmsley, 2013). The program uses consumption and ownership weights obtained from the SAM 12 households (see Table 2). These weights are applied to the GTAP database such that the total returns to factors and consumption are consistent with the original GTAP database. The newly aggregated 21 sectors are mapped to the corresponding sectors in the Nigerian SAM; the SAM sectors are then used to define each household's consumption share of the 21 GTAP commodities.

Table 2: Nigerian Households

No.	Urban Households	No.	Rural Households
1	Urban South South	7	Rural South South
2	Urban South East	8	Rural South East
3	Urban South West	9	Rural South West
4	Urban North Central	10	Rural North Central
5	Urban North East	11	Rural North East
6	Urban North West	12	Rural North West

In this paper, we aggregate skilled and unskilled labor contained in the GTAP database resulting in four production factors in contrast to the standard five GTAP production factors. This was done to maintain consistency with the Nigerian SAM. We, therefore, include four sources of household factor incomes: land, natural resources, labor, and capital. These earnings were allocated to each of the 12 households as income, according to factor ownership shares. Household incomes were then adjusted for net foreign income, remittances and capital depreciation.

As mentioned in Section 1, the subsidy on imported petroleum products is determined on a daily and monthly basis by the PPPRA. During the second half of 2012, the applied PPPRA subsidy was 33.0 percent. Examination of the GTAP database shows a much larger rate of subsidy on imported

petroleum products of 54.7 percent. In order to correct for this discrepancy, the Altermat tool¹¹ (Malcolm, 1998) is employed to lower the subsidy rate in the GTAP database. All petroleum products imported into Nigeria are subject to this rate, hence the Altermat simulation is applied to the imported petroleum products tax rates corresponding to each of three Nigerian agents in the model: firms (tfm); government (tgm), and private households (tpm).¹² Each of these taxes implies a wedge between the composite import price ($pim(i,r)$) and the respective consumption prices for each agent (referred to in the GTAP model as $pfm(i,r)$, $ppm(i,s)$ and $pgm(i,r)$).

3 Scenarios

The analysis is conducted by simulating two cuts to the fuel subsidy:

- Complete removal of the subsidies on imported petroleum products, and
- Partial removal of subsidies so that petroleum product prices do not increase more than 10 percent of the baseline price of fuel.

This study also analyzes two alternative policies, which could mitigate the impacts on poor households and the domestic economy of the partial subsidy removal:

- Introduction of a subsidy on domestic petroleum product production, with expenses being equal to the former government expenditures on import subsidies, to increase domestic output of that industry;
- Introduction of a government transfer scheme, with expenses being equal to the former government expenditures on import subsidies, targeting rural households, which are poorer on average than urban households. We consider this scenario the preferred scenario for assessing the welfare implications of a subsidy reduction, as the benefits from lower expenditures on the subsidy are directly transferred to households, instead of increased government expenditure such as for the provision of public goods.

The government transfer to poor households is undertaken by first identifying poor households. Six households are identified as poor. All six households are rural and are selected due to their

¹¹ The Altermat approach runs a simulation where tax rates are set to their desired value and the updated post-simulation database is saved for subsequent policy experiments. A special closure and parameter file are applied to ensure that the rate-changing simulation has the least possible effect on other cost and sales shares. This closure fixes real regional trade balances, whilst the parameter settings amount to Cobb-Douglas everywhere, which keeps budget shares fixed.

¹² We refer to the lower case parameters in GTAP, tfm, tgm, and tpm as tax rates, where, in fact, these variables represent changes to the "power" of taxes, a technical definition, which can easily be translated into tax rates. So, we use tax "rates" and "power" of taxes interchangeably, recognizing they are numerically different.

savings rates being substantially below those of other households (all urban) and their poverty head counts being highest (NBS, 2012). These targeted payments are introduced in the model as transfers from the government to households relative to government income. The base subsidy rate, four scenarios, their subsidy rates and any accompanying transfers are listed in Table 3.

Table 3: Base Case, Four Simulation Scenarios, Subsidy Rates (percent), and Household transfers (US\$ million)

Scenario	Description	Subsidy on petroleum product (fuel) consumption (percent)		Government transfers to poor households
		Imported	Domestic production	
Base	Base	33.0	--	--
Scenario 1	Full removal of subsidy on imports	0.0	--	--
Scenario 2	50 percent removal of subsidy on imports	16.5	--	--
Scenario 3	50 percent removal of subsidy on imports and paying subsidy on domestic	16.5	Transfer of subsidy to local production	--
Scenario 4	50 percent removal of subsidy on imports and providing transfers to households	16.5	--	Transfer of subsidy to poor households

Source: Base subsidy rate from PPPRA (2012). Scenarios based on authors assumptions.

4 Results

This section starts with a discussion of the effects on the prices of petroleum products in Nigeria, followed by the impacts on output and consumption. Finally, macroeconomic and welfare impacts are discussed.

4.1 Prices

Figure 1 shows the percentage changes in the prices of petroleum products due to the four scenarios. Full-removal (Scenario 1) causes the highest change in prices as it removes the subsidies on imported petroleum products without applying any compensation mechanism. After the complete removal of the subsidy in January 2012, the fuel price increased from 65 Naira per liter to 140 Naira per liter (The Economist, 2012). Complete removal of the subsidy did not continue

for long, with the Nigerian government reinstating a fuel subsidy to maintain a market price of 97 Naira per liter shortly thereafter.

In all four scenarios, the subsidy on petroleum products is reduced or removed and the market price of imported fuel increases as expected. Imported petroleum products represent nearly 80 percent of apparent consumption of this product in Nigeria. Domestic consumption switches to the now more competitive, but still limited, local petroleum product production. The prices of domestically produced petroleum products, therefore, rise substantially (between 9 and 19 percent) except in Scenario 3, where a producer subsidy on domestic petroleum products is simulated and the price for domestic production (ppd) falls.

Figure 1: Changes in the Prices of Petroleum Products (%).

The remaining three scenarios, which remove half the petroleum product subsidy, move market and supply prices in the same direction, but by smaller amounts than in the full-removal case (Scenario 1) because they all reduce the subsidy by the same amount, targeting a maximum market price change of 10 percent, as intended. The private consumption price (labeled pp in the chart) for the composite (imported and domestic) commodity would increase by 19 percent due to Scenario 2 (half removal of the subsidy with no other domestic intervention) and Scenario 4 (half removal of the subsidy with a transfer to the poor households).

The reduction of the import subsidy together with a subsidy to local refineries (labeled Scenario 3) equal to the subsidy removed on fuel imports, increases the private consumption price by 8.6 percent, less than the other scenarios because it includes a subsidy to incentivize production of domestic petroleum products. This leads the price of the domestic petroleum products to decrease

by 12.8 percent, and the market price of the imported petroleum products to increase by 24.6 percent. Hence, the composite domestic price increases by only 8.6 percent.

Figure 2 shows the percentage changes in the market price of petroleum products compared to the market prices of transport-communication¹³ and electricity, all major users of petroleum products in Nigeria as determined by the cost structure of firms reported in the GTAP database. Petroleum products represent 31.7 percent and 23.7 percent of production costs of transport-communication and electricity in the database, underscoring the importance of these products to these sectors. Similarly, these two sectors consume the majority of the petroleum products consumed by industry in Nigeria comprising 66.7 percent and 11.0 percent of intermediate consumption of these products. In addition, the petroleum products sector itself uses 20.0 percent of the intermediate consumption of petroleum products and the three sectors together consume 98.0 percent of total intermediate use according to the GTAP 8 database.

Figure 2: Changes in Market Prices of Petroleum Products, Electricity and Transport-Communication (%).

Recalling that Scenario 1 (full removal of the subsidy) resulted in fuel prices increasing 19.0 percent, it is not surprising that the price of transport-communication and electricity increase by 11.1 percent and 8.3 percent, respectively. Thus, the impacts of the petroleum product price increases will not be limited to direct impacts on final consumers, but will also impact consumers indirectly via the increase in the cost of transportation, communication and electricity. This further aggravates the situation of poor people across Nigeria. The baseline data from Nwafor et al. (2010) shows that non-poor urban households consume more of the three commodities relative to rural households. The average shares of petroleum products, electricity, and transport-communication

¹³ Transportation and communications services are grouped in one sector according to our sector aggregation (Appendix 3).

in the urban households' base consumption expenditure are 2.7, 1.0 and 6.9 percent respectively, while for the rural households these are 1.5, 0.7 and 3.0 percent respectively. This implies that an increase in the price of petroleum products would have a larger effect in absolute as well as in relative terms on urban households than on rural households. Furthermore, the indirect effects dominate the direct effects: households have higher expenditure shares on electricity and transport-communication relative to petroleum products. Price increases are lower under the other Scenarios 2, 3, and 4 where only half of the subsidy is removed.

4.2 Domestic Demand

The percentage changes in the quantities of petroleum products demanded by households are shown in Figure 3. Private demand for domestic petroleum products increases while it decreases for imported petroleum products. Total demand for imported petroleum products (for intermediate and final use) in the country declines by 15.6, 9.1, 13.6 and 8.9 percent for Scenarios 1-4, respectively.

Figure 3: Changes in Private and Total Import Demand for Petroleum Products in Nigeria (%).

Scenario 3 (half subsidy with local subsidy on domestic production) would lead to the greatest reduction in use of imported petroleum products (-26.6 percent) and the highest growth in the use of domestically produced petroleum products (55.0 percent). Under all scenarios, the total household demand for composite petroleum products is declining by between 7.2 percent (Scenario 1) and 2.1 percent (Scenario 3).

The impact of the four scenarios on intermediate demand for petroleum products is shown in Figure 4. Transport-communication and electricity intermediate demand for petroleum products, which together constitutes 78.0 percent of intermediate petroleum products, would decrease in the four scenarios (see composite demand). Domestically produced petroleum products would increase its use of both domestic petroleum products and imported petroleum products. As will be seen in the following sections, output of domestically produced petroleum products increases.

Figure 4: Changes in Petroleum Products Intermediate Demand by Major Users (%).

4.3 Production

Higher petroleum product prices in all scenarios (Figure 1 in Section 4.1) lead to increased output of petroleum products (Figure 5). Domestic production increased most (47.4 percent) under the Scenario 3, where the subsidy on imported petroleum products would be reduced and complemented by an equivalent subsidy on domestically produced petroleum products. Under the Scenario 1 (full subsidy removal), domestic output increases by 17.0 percent. Under Scenario 4 (half removal of the subsidy and transfers to poor households), the impact on production would be 9.6%, which is closer to Scenario 2 that does not include the transfers to households. The impact of the transfers to poor households has minimal impact on domestic production.

Figure 5: Changes in the Output of the Major Users of Petroleum Products (%).

Increasing petroleum product prices under all four scenarios causes the output of transport-communication, electricity, and other manufacturing to decline. The impact on transport-communication is highest due to the higher share of fuel in its cost structure representing 31.7 percent compared to 23.7 percent for electricity, the next most intensive user of petroleum products.

4.4 GDP and Trade

4.4.1 GDP and Spending

Real GDP increases in all four scenarios (Figure 6). Real GDP (GDP quantity index in Figure 6) increases the greatest under Scenario 1 (0.18 percent) which completely removes the distortion (import subsidy) on the petroleum product sector and improves overall economic efficiency. Scenarios 2 through 4 have similar impacts on real GDP which vary from 0.13 percent increase in Scenario 2 to 0.10 percent in Scenario 3 and Scenario 4. Domestic prices slightly decline in Scenario 1 (0.08 percent) and Scenario 2 and rise modestly by 0.08 percent in Scenario 3. Scenario 4, in contrast, sees a noticeable increase in domestic prices relative to the three prior scenarios. In Scenario 4, the reduced oil subsidy is transferred to rural households and domestic prices rise by 0.56 percent. Domestic prices increase most strongly under Scenario 4 due to the transfer of money from the government to rural households which have a higher expenditure share on domestic goods than the government itself or local producers (Scenario 3).

Any reduction in the subsidy increases disposable government income and this increase in government income is entirely spent by the Nigerian government, in the same proportions as in

the baseline data. The baseline data for Nigeria reveal that imported machinery and transport equipment comprise nearly 40 percent of the Nigerian government's consumption and, more generally, total imports make up over 70 percent of Nigerian government consumption. In contrast, domestically produced goods, such as fresh fruits and vegetables, comprise over 85 percent of rural households' consumption. The rise in domestic demand causes land and labor prices in Nigeria to rise relative to the prior three scenarios and contributes to an overall rise in prices in the Nigerian economy seen in the GDP price index presented here. Scenario 4 does best from an income redistribution perspective to be discussed in section 4.5.

Figure 6: Changes in GDP Indices (%).

Next we examine changes in real spending – private and government consumption and savings.¹⁴ Results show that real government expenditure increases by 18.4, 10.2, 5.6 and 5.5 percent under the four scenarios, respectively, which is driven by the increases in government income of 7.2, 4.0, 2.3 and 2.2 percent. Government income increases are primarily due to the reduced outlays on fuel subsidies. The increasing government income under Scenarios 3 and 4, despite the redistribution of the fuel subsidy to production subsidies or rural households, is explained by increases in the government revenue from taxes on intermediate input usage and private consumption.

¹⁴ Absorption is total private household consumption, government spending and investment. Absorption is often used as a measure of welfare as it takes into account welfare derived from the provision of government services as well as private consumption and investment, although it also gives equal weight to all components and all households. In this case we replace investment with savings as domestic savings reflects domestically owned investment.

Total real private household consumption falls under all scenarios, although the declines are much smaller in Scenarios 3 and 4 where the government income from the subsidy is redistributed. Real saving also falls under all scenarios, albeit by a very small amount. Overall, changes in real spending are driven by the extent to which real government expenditure increases, with the largest increase in real spending in Scenario 1 (0.55%) and smallest in Scenario 3 (0.22%). Real spending in Scenario 4 rises by 0.27%, less than in Scenario 1, due to the larger increases in prices in Scenario 4.

4.4.2 Trade

Petroleum product imports constitute 14.6 percent of Nigerian import value (GTAP 8 database). The four scenarios reduce it by 15.6, 9.1, 13.6 and 8.9 percent, respectively. The greatest reductions are in Scenarios 1 and 3 because the former removes the subsidy on petroleum product imports entirely and the latter subsidizes domestic petroleum product production and reduces the subsidies on imports by 50 percent. This, among other changes, results in total imports increasing by 0.3 and 0.1 percent under scenario 1 and 2, respectively. Meanwhile, imports decrease by 1.0 and 0.4 percent under Scenarios 3 and 4, respectively (Figure 7).

Figure 7: Change in Trade Indices (%).

The increase in the real imports under Scenarios 1 and 2 are mainly driven by increases in the quantities imported of other manufactures, which represent about 40.0 percent of imports and increase by 2.1 and 1.2 percent respectively under the two scenarios (not shown). Imports of transport-communication increase by 12.5 and 6.4 percent, other services increases by 13.1 and 7.3 percent and transport equipment by 11.1 and 6.1 percent, respectively. The increases caused

by Scenario 3 and 4 on these major imported commodities are smaller and therefore do not outweigh the reductions in the imports of other sectors. Hence, they lead total imports to decline. Import price indices show no changes, while those of exports slightly increase under the four scenarios.

The overall country's change in the balance of trade under the four scenarios is positive due to the fall in investment experienced across all scenarios. The fall in investment is due to the falling rates of return, which are largest when all of the subsidy is removed (-3.57, Scenario 1) and smallest when a subsidy is placed on domestic production (-0.85, Scenario 3). The resulting changes in the balance of trade under Scenario 1 through Scenario 4 in US\$ million are 65, 36, 32 and 178, respectively. The larger increase in the trade balance in Scenario 4 is due to a lower decline in savings by private households relative to scenario 1. This is somewhat surprising, since the poor rural households that receive the additional income transfers from government do not have very high savings rates (see Appendix 1). The rise in relative savings in Scenario 4 is the result of a lower decline in income (see section 4.5 below) and hence savings of some of the Urban households, and in particular the Urban North-West.

4.5 The Impact on Households

Changes in real household income, which are calculated from the MyGTAP model by adjusting changes in nominal households' income for a household specific price index for private consumption expenditure, are shown in Figure 8. The simulation results indicate that real income decreases in Scenario 1, 2 and 3 for all households. In Scenario 4 that includes a government transfer to rural households, real income increases for all rural households with slightly varying extent, ranging from 2.3 percent increase for Rural-North West households to 7.6 percent for Rural-South West households. The varying degree of increase in the income of the households mainly results from different shares of government transfers in their base income. These findings indicate that Scenario 4 maintains the best policy for rural households in Nigeria among the four simulated policies. Under the first three scenarios, real household income declines due to the decreases in factor returns (wages and profits), which led the total disposable factor income to decrease by 1.5, 0.7 and 0.3 percent, respectively.

Figure 8: Change in Real Households' Income in Nigeria (%).

Source: Authors' calculation from MyGTAP model.

Scenario 1 and Scenario 2 eliminate government spending on petroleum product import subsidies, but they reduce the real income of all household groups due to the resulting higher price of petroleum products without implementing any supplementary policy.

By further exploring the income of household from production factors (land, labor, capital, and natural resources), the four scenarios are found to enhance households' incomes from natural resources by 3.7, 1.9, 1.0, and 1.8 percent under Scenario 1 through Scenario 4, respectively (Figure 9). Capital, which is primarily held by urban households, represents 63.7 percent of the base household factor income in Nigeria and declined under the four scenarios, while labor, the primary source of income for poor-rural households, represents 19.7 percent and declines under the first three scenarios and modestly increases in Scenario 4. Income from land, which the SAM shows is only owned by poor rural households, increases in Scenario 4, which together with the increasing returns from natural resources (NatRes) and the government transfers improves the real income of rural households.

Figure 9: Changes in Households' Income from Endowment Commodities (%).

The effects of prices on real household income can be ascertained by disentangling the impact of income from that of price. For example, it is found that, nominal household income increases for all rural poor households in Scenario 4, which is the scenario including a government transfer to rural households. Increases are between 2.8% and 8.5%. The price index for private consumption expenditure for rural households under Scenario 4, however, increases by 0.68 percent on average for all rural households. This implies that the price effect diminishes the positive impact of increasing nominal income and resulting real income increases for rural households are only between 2.3% and 7.6%.

5 Summary and Conclusions

Nigeria is Africa's top producer and exporter of crude oil. Petroleum constitutes about 90 percent of Nigeria's exports, nearly one-third of its GDP and about 75 percent of government revenue. The Nigerian economy is heavily burdened by subsidies on petroleum product imports, which constitute more than 80 percent of domestic demand of petroleum products because domestic refineries are unable to meet domestic demand. The subsidy on petroleum product imports is often justified as a measure to alleviate poverty; but a large part of this subsidy accrues to importers and wholesalers and involves corruption and inefficiencies. It is likely that beneficiaries invest in lobbying for the maintenance of the import subsidy, legally and illegally, which creates economic losses, and presents a barrier to advancing good governance.

Recent efforts to remove the import subsidy on petroleum products have met with mixed success. The fuel subsidy continues to be a large share of government spending, increases with rising imports and continues to destabilize the country's fiscal health. Low fuel prices are considered the

only benefit of the subsidy to the people of Nigeria, where more than half its population is living under the \$1.25 per day poverty line in this oil-rich country.

We use the MyGTAP model, which is an economy wide framework to identify the impacts of several fuel subsidy reduction scenarios, together with complementary policies to alleviate the negative impacts of the subsidy removal on the economy. The scenarios range from the complete removal of the subsidy (Scenario 1) to offering policy alternatives that promote domestic production of petroleum products (Scenario 3) and transfers to poor households (Scenario 4).

Removal of the subsidy, without accompanying it with other policy interventions, will negatively affect private household income, but results in a substantial increase in government revenues that allow increased spending on transfers and/or government provision of services. In terms of total real spending, this scenario (1) results in the largest gains. Similar conclusions are found should the subsidy be only partially reduced such that domestic prices do not rise by more than 10 percent. Impacts on private household income are less adverse under our third and fourth scenarios where, in addition to reducing the subsidy on imports, a subsidy for domestically produced petroleum products and a transfer is provided to poor rural households, respectively. Although more income accrues to poor households in Scenario 4, the gains in total real spending are lower than in Scenario 1, due to higher prices. If government spending is targeted at poor households Scenario 1 might be preferable to a direct government transfer.

The channels by which rural (poorer) and urban (less poor) households are affected differ. Urban households are impacted to a greater extent through their direct purchases of petroleum products. Rural households are impacted through their consumption of products and services which use petroleum products. In the case of a subsidy reduction or elimination, prices of petroleum products would increase, negatively affecting many sectors in the economy, especially those heavily dependent on petroleum products such as transportation and electricity, which will see their prices rise. Higher prices for energy intensive goods and services negatively affect rural households, whose expenditure shares for these goods are higher than those of urban households, who directly consume relatively more petroleum products.

This study suggests that accompanying a subsidy reduction with a transfer of government income to rural households will not only promote pro-poor growth, but will alleviate some of the negative impacts on real income of all households (Scenario 4). Real income of rural households increases by 2.3%-7.6% under Scenario 4 compared to the current situation. Furthermore, Scenario 4 increases the GDP, improves the government budget by reducing subsidy outlays and it modestly improves the country's balance of trade. Finally, Scenario 4 promotes domestic production of petroleum products to substitute for imports motivated by higher domestic prices. In conclusion, our results are in line with economic theory as well as results from other authors: Fuel subsidies

harm the economy as a whole and their replacement by targeted transfer policies can be used to improve household incomes (e.g. Umar and Umar, 2013).

The benefits of Scenario 4 will have to be considered against the likely costs of the transfer policy. Reductions in corruption costs from the subsidy reduction will have to be weighed against inefficiencies and corruption from implementing a transfer scheme. It is not known what the ultimate outcome would be, but our results suggest, if corruption costs can be kept low, the transfer scheme would be beneficial to the poor and to Nigeria.¹⁵ Greater information on the quantities of petroleum products that the government pays for but never reach the consumer is a pre-requisite for better analysis in this area. If such information were taken into account, positive effects of a subsidy reduction on the Nigerian economy would be even larger than simulated in this paper.

An extension of this work, which we have not considered as an alternative policy approach, is the coupling of reduced petroleum products subsidies with energy use efficiency subsidies, such as for more fuel efficient autos, trucks and generators (World Bank, 2009). The use of energy efficient goods would reduce the need for future subsidies. Weighed against this would be the cost of the subsidies themselves. For such an analysis, more information is required on the efficiency "gap" between current Nigerian infrastructure and the modern, energy efficient devices which would replace them. Another promising path for extending the work of this article, is the consideration of public investments in an improved electricity network which would be complementary to the abolishment of the fuel import subsidy: the weak public network causes high fuel cost to enterprises, as they have to maintain private power supply (Birol et al., 1995).

Finally, this study confirms the strength of economy wide simulation models in analyzing the effects of fuel subsidy reform, as such models incorporate direct effects via higher fuel prices faced by enterprises and private households, but also indirect effects of changes in the prices of production factors and products other than fuels. The model applied in this study, namely the recently developed MyGTAP, is found to be a helpful extension that allows for the incorporation of distributional aspects in the global modeling framework of GTAP, which as this study shows, provides more information for policy makers in terms of what the effects of a policy will be at the household level.

¹⁵ We note that without fully eliminating the subsidy, many of the lobbying and informal payments will remain. However, the reduced subsidy will reduce the benefits of smuggling petroleum products, since the margins will be lower for smugglers.

6 References

- Adenikinju, A., 2009. Energy pricing and subsidy Reforms in Nigeria. OECD Conference Centre, Paris 9-10 June 2009. Accessed on January 25, 2012. <http://www.oecd.org/dataoecd/58/61/42987402.pdf>
- Arze del Granado, F. J., Coady, D., Gillingham, R., 2012. The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries. *World Development*, 40(11): 2234-2248.
- Bazilian, M., Onyeji, I., 2003. Fossil fuel subsidy removal and inadequate public power supply: Implications for businesses. *Energy Policy*, 45: 1-5.
- BBC, 2012a. Nigeria Reveals ‘\$6bn Fuel Fraud’. BBC, April 24, sec. Africa. <http://www.bbc.co.uk/news/world-africa-17823959>.
- _____, 2012b. Nigeria’s President Jonathan ‘Must Act over Fuel Scam’. BBC, May 28, sec. Africa. <http://www.bbc.co.uk/news/world-africa-18238973>.
- Birol, F., Aleagha, A.V., Ferroukhi, R., 1995. The economic impact of subsidy phase out in oil exporting developing countries: a case study of Algeria, Iran and Nigeria. *Energy Policy*, 23(3): 209-215.
- BP, 2011. British Petroleum Statistical Review of World Energy. June 2011. bp.com/statisticalreview. Accessed on March 2, 2012.
- BusinessDay, 2013. Increasing Nigeria’s oil refining capacity. Thursday, 14 February 2013. <http://www.businessdayonline.com/NG/index.php/oil/51502-increasing-nigerias-oil-refining-capacity>. Accessed on April 16, 2013.
- Coady, D., Gillingham, R., Ossowski, R., Piotrowski, J., Tareq, S., Tyson, J., 2010. Petroleum product subsidies: Costly, inequitable and rising. IMF Staff Position Note, SPN/10/05. Washington D.C: International Monetary Fund.
- Dartanto, T., 2013. Reducing fuel subsidies and the implication on fiscal balance and poverty in Indonesia: A simulation analysis. *Energy Policy*, 58: 117-134.
- Davis, L.W., 2013. The Economic Cost of Global Fuel Subsidies. NBER Working Paper 19736, December.
- EIA, 2012. US Energy Information Administration report of Nigeria. October 16, 2012. <http://www.eia.gov/countries/analysisbriefs/Nigeria/nigeria.pdf>. Accessed on April 16, 2013.
- El-Said, M., Leigh, D., 2006. Fuel price subsidies in Gabon: Fiscal cost and distributional impact. IMF Working Paper, 06(243). Washington D.C: International Monetary Fund.

- Gangopadhyay, S., Ramaswami, B., Wadhwa, W., 2005. Reducing subsidies on household fuels in India: how will it affect the poor? *Energy Policy*, 33(18): 2326-2336.
- Hertel, T., 1997. *Global Trade Analysis: Modeling and Applications*. (Editor), Cambridge University Press.
- IMF (International Monetary Fund), 2012. Nigeria: Article IV Consultation, IMF Country Report No. 12/194, July.
- IMF (International Monetary Fund), 2013. Nigeria Staff Report for the 2012 Article IV Consultation—Debt Sustainability Analysis
- Malcolm, G., 1998. Adjusting Tax Rates in the GTAP Data Base. GTAP Technical Paper No. 12 September 1998. Accessed on January, 25, 2012. <https://www.gtap.agecon.purdue.edu/resources/download/580.pdf>
- Minor, P., Walmsley, T., 2013. My GTAP: A Program for Customizing and Extending the GTAP Database for Multiple Households, Split Factors, Remittances, Foreign Aid and Transfers. GTAP Working Paper Series, 79, Center for Global Trade Analysis, Purdue University, 2013.
- Narayanan, B. G., Aguiar, A., McDougall, R. Editors, 2012. *Global Trade, Assistance, and Production: The GTAP 8 Data Base*, Center for Global Trade Analysis, Purdue University.
- NBS, 2010. Petroleum Statistics. Nigerian National Bureau of Statistics. Accessed on January 25, 2012. <http://www.nigerianstat.gov.ng/index.php/pages/sectorStatistics>.
- NBS, 2012. Nigeria Poverty Profile 2010. Nigerian National Bureau of Statistics (NBS), January 2012.
- Nwachukwu, M. U., Chike, H., 2011. Fuel subsidy in Nigeria: Fact or fallacy. *Energy*, 36 (5): 2796-2801.
- Nwafor, M., Diao, X., Alpuerto, V., 2010. A 2006 Social Accounting Matrix for Nigeria. Methodology and Results. Nigeria Strategy Support Program (NSSP), Report No. NSSP007. April 2010. International Food Policy Research Institute.
- PPRA, 2012. Petroleum Products Pricing Regulatory Agency in Nigeria. Approved prices as at December 17, 2012. <http://www.pppra-nigeria.org/> accessed on December 20, 2012.
- Rao, N. D., 2012. Kerosene subsidies in India: When energy policy fails as social policy. *Energy for Sustainable Development*, 16(1): 35-43.
- Rice, X., 2012. Fuel gamble costs Jonathan his standing. Nigeria's president miscalculated by scrapping subsidies without easing the blow to the poor. *Financial times*, January 14/15, 2012, page 3.

- Sala-I-Martin, X., Subramanian, A., 2003. Addressing the natural resource curse: an illustration from Nigeria. National Bureau of Economic Research. Working Paper 9804, Cambridge, MA.
- Siddig, K., Luckmann, J., 2013. GTAP 8 Data Base Documentation - Chapter 7: Nigeria. Center for Global Trade Analysis, Purdue University. Center for Global Trade Analysis, 2013.
- The Economist, 2012. Protests in Nigeria let them have fuel. The president loses his nerve and brings back a controversial subsidy. The Economist January 21, 2012, page 41.
- The Economist, 2011. Nigeria's subsidies: End them at once! The president will be a brave man if he fulfils his promise to end cheap petrol. The Economist December 28 2011.
- Umar, H. M., Umar, M. S., 2013. An Assessment of the Direct Welfare Impact of Fuel Subsidy Reform in Nigeria. American Journal of Economics, 3(1): 23-26.
- Victor, D. G., 2009. The Politics of Fossil Fuel Subsidies. Global Subsidies Initiative and International Institute for Sustainable Development, November.
- Walmsley, T., Minor, P., 2013. MyGTAP Model: A Model for Employing Data from the MyGTAP Data Application—Multiple Households, Split Factors, Remittances, Foreign Aid and Transfers. GTAP Working Paper Series, #78, Center for Global Trade Analysis, Purdue University, 2013.
- World Bank, 2009. Tapping a Hidden Resource: Energy Efficiency in the Middle East and North Africa. Sustainable Development Network, Middle East and North Africa Region, Energy Sector Management Assistance Program (ESMAP). Washington, D.C. 20433, USA.
- World Bank, 2013. World Development Indicators.

7 Appendices

Appendix 1: Saving Rates by Household in Nigeria (saving relative to income %)

Households	Savings (Naira million)	Total income (Naira million)	Saving rate (%)
Urban-South South	695822.95	1790481.85	38.86
Urban-South East	249401.78	816022.30	30.56
Urban-North East	214541.53	819950.99	26.17
Urban-South West	663199.60	2682111.46	24.73
Urban-North West	487853.53	2185462.47	22.32
Urban-North Central	170032.10	870073.51	19.54
<i>Rural-North East</i>	17934.37	1042484.57	1.72
<i>Rural-North Central</i>	12510.03	1068908.03	1.17
<i>Rural-North West</i>	16897.87	1534777.07	1.10
<i>Rural-South West</i>	3357.66	475533.43	0.71
<i>Rural-South South</i>	4695.77	1004127.35	0.47
<i>Rural-South East</i>	3533.05	1163266.56	0.30
Total	2539780.24	15453199.58	16.44

Sources: Nwafor et al. (2010); Authors' Calculation.

Appendix 2: Technical Appendix on the Model, Closure and Experiments

Features of MyGTAP:

MyGTAP has several new characteristics that are helpful in the multiregional context of the standard GTAP model. These features include 1) more flexibility in the treatment of government savings and spending. This is achieved by removing the regional household of the standard GTAP model and replacing it with a separate government and private household; 2) the inclusion of transfers between government and households and among household groups, remittances and foreign capital incomes; 3) allowing the assessment of a policy impact on different household groups and production factors within an economy of interest (e.g. Nigeria), should additional data such as a SAM be available (Minor and Walmsley, 2012); and 4) allowing the allocation of private household expenditure across commodities using either the Constant Difference Elasticity (CDE) or Linear expenditure system (LES) specifications depending on the studied situation (Minor and Walmsley, 2012).

The applied closure:

MyGTAP model is a large system of equations. The closure rules defines certain assumptions by specifying which variables are exogenous and which are endogenous. The detailed applied closure is shown hereafter:

! A closure for MyGTAP that fix government savings (qgsave)

exogenous

poph
qoh_s
pfactwld
psaveslack profitslack incomeslack endwslack
cgdslack tradslack
gincomeslack hincomeslack
ams atm atf ats atd
aosec aoreg avasec avareg
afcom afsec afreg afecom afesec afereg
aoall afall afeall
dppriv dpgov dpgsave dphsave dphsave_all
to tp tm tms tx txs tpdh tpmh toh
atall avaall tf tfd tfm tgd tgm tpd tpm
emplh empl
sremoh sremih remavo
sfyoh sfyih fyavo
saidout saidin aidavo
realTRNH realTRNG
s_sub ;

Rest Endogenous ;

swap qgsave("Nigeria")=dpgsave("Nigeria");

This closure fixes the real government saving (qgsave is made exogenous) in order for the subsidy removal to not simply increase government savings. The intention behind this assumption is to make the Nigerian households in general and poor households in particular, less vulnerable to the negative consequences of the subsidy removal. In effect, the government savings preference parameter (dpgsave) is made endogenous which, in these experiments, would positively affect government expenditures.

Experiments' variables:

Four scenarios are simulated in the paper. Scenario 1 and Scenario 2 are concerned only with the subsidy on imported petroleum products, where the first removes it and the second reduces it by half. Accordingly, the shocked variables in these scenarios are: (1) tax on imported petroleum products purchased by all sectors in Nigeria (tfm); (2) tax on imported petroleum products purchased by the government in Nigeria (tgm); and (3) tax on imported petroleum products purchased by private households in Nigeria (tpm).

Scenario 3 includes, besides the partial removal of subsidy of Scenario 2, paying subsidies to the domestically produced petroleum products. Therefore, the experiment includes the following variables as well: (1) tax on domestically produced petroleum products purchased by all sectors in Nigeria (tfm); (2) tax on domestically produced petroleum products purchased by the government in Nigeria (tgm); and (3) tax on domestically produced petroleum products purchased by private households in Nigeria (tpm).

Scenario 4 includes besides the partial removal of subsidy of Scenario 2, paying transfers from the government to the lower tier of household groups, namely, the six household groups that have low saving rates based on Nwafor et al., (2010) as follows: (1) Rural-North East, (2) Rural-North West, (3) Rural-North Central, (4) Rural-South South, (5) Rural-South East, and (6) Rural-South West. Accordingly, the experiments' variables of these scenarios include besides the subsidy the change in transfers from government to households relative to government income (realtrng).

Appendix 3: The Mapping between the 2006' Nigerian SAM, GTAP Sectors and the aggregated 21 sectors^Q

Nigerian 2006's SAM			GTAP database version 8.1			Aggregated 21 GTAP sectors		
No.	Code	Description	No.	Code	Description	No.	Code	Description
1	crice	Rice	1	pdr	Paddy rice	1	PaddyRice	Paddy rice
2	cwhet	Wheat	2	wht	Wheat	2	Wheat	Wheat
3	cmaze	Maize	3	gro	Cereal grains nec	3	OCereals	Other cereal grains
4	csorg	Sorghum						
5	cmilt	Millet						
6	ccass	Cassava						
7	cyams	Yams						
8	ccyam	Cocoyam	4	v_f	Vegetables, fruit, nuts	4	VegsFruits	Vegetables, fruit and nuts
9	cpota	Irish potato						
10	cspot	Sweet potato						
11	cplan	Banana and plantain						
16	cveg	Vegetables						
17	cfrt	Fruits						
18	ccoco	Cocoa						
24	cnuts	Nuts						
25	ccash	Cashew						
13	cgnut	Groundnuts						
14	csoys	Soybeans						
15	cosed	Beniseed						
21	cpalm	Oil palm						
41	cofod	Processed food products (excluding beverages)				21	vol	Vegetable oils and fats
			23	pcr	Processed rice			
			25	ofd	Food products nec			
40	cbev	Beverages and tobacco products	26	b_t	Beverages and tobacco products			
22	csuga	Sugar and sugar cane	6	c_b	Sugar cane, sugar beet	6	Sugar	Sugar cane and sugar beet
			24	sgr	Sugar			
20	ccott	Cotton	7	pfb	Plant-based fibers	7	Cotton	Plant-based fibers, Cotton
12	cbean	Beans	8	ocr	Crops nec	8	OCropsFrst	Other crops including forestry

Nigerian 2006's SAM			GTAP database version 8.1			Aggregated 21 GTAP sectors						
No.	Code	Description	No.	Code	Description	No.	Code	Description				
19	ccoff	Coffee										
23	ctoba	Unprocessed tobacco										
26	crube	Rubber										
27	cocrp	Other crops not specified										
33	cfore	Forestry	13	frs	Forestry	9	Livestock	Cattle, sheep, goats and horses				
28	ccatl	Cattle	9	ctl	Cattle, sheep, goats, horses							
29	cgshp	Live goats and sheep	10	oap	Animal products nec			10	OAnimalPrd	Animal products including dairy and milk		
30	cpoul	Live poultry										
37	ceggs	Eggs										
31	coliv	Other live animals										
38	cmilk	Milk and dairy products	11	rmk	Raw milk	11	OMining	Coal and other minerals				
Zero sector			22	mil	Dairy products							
Zero sector			12	wol	Wool, silk-worm cocoons							
			15	coa	Coal							
49	comin	Other mining	18	omn	Minerals nec	12	CrOilGas	Crude Oil and Gas				
47	ccoil	Crude petroleum and natural gas	16	oil	Oil							
			17	gas	Gas							
32	cfish	Fish and fish meat	14	fsh	Fishing	13	MeatFisch	Meat products including Fishing				
34	cbeef	Beef	19	cmt	Meat: cattle, sheep, goats, horse							
35	cgsmt	Goat and sheep meat	20	omt	Meat products nec							
39	comet	Other livestock meat										
36	cpmet	Poultry meat				14	TxWaLeWd	Textile, wearing apparel, leather and wood				
42	ctext	Textiles and leather products	27	tex	Textiles							
			28	wap	Wearing apparel							
			29	lea	Leather products							
43	cwood	Wood, wood products, furniture	30	lum	Wood products	15	OManufacrd	Other manufactured goods				
46	cfert	Fertilizer	33	crp	Chemical, rubber, plastic products							
45	comfc	Other manufactured products	31	ppp	Paper products, publishing							

Nigerian 2006's SAM			GTAP database version 8.1			Aggregated 21 GTAP sectors		
No.	Code	Description	No.	Code	Description	No.	Code	Description
			34	nmm	Mineral products nec			
			35	i_s	Ferrous metals			
			36	nfm	Metals nec			
			37	fmp	Metal products			
			38	mvh	Motor vehicles and parts			
			40	ele	Electronic equipment			
			41	ome	Machinery and equipment nec			
			42	omf	Manufactures nec			
48	croil	Refined oil	32	p_c	Petroleum, coal products	16	RefinedOil	Petroleum, coal products
44	cemfc	Transportation and other equipment	39	otn	Transport equipment nec	17	TransEquip	Other transport equipment
51	cutil	Electricity and water	43	ely	Electricity	18	Electricity	Electricity
			45	wtr	Water			
		Zero sector	44	gdt	Gas manufacture, distribution			
50	ccons	Building and construction	46	cns	Construction			
54	ctrad	Wholesale and retail trade	47	trd	Trade	19	TrdFinBusIns	Trade, financial and business services
55	chotl	Hotel and restaurants						
57	cbser	Financial institutions, Insurance, Business service	52	ofi	Financial services nec			
			53	isr	Insurance			
			54	obs	Business services nec			
58	crest	Real estate						
53	cotra	Other transportation	48	Otp	Transport nec	20	TransComm	Transport and communications
			49	wtp	Sea transport			
			50	atp	Air transport			
56	ccomm	Telecommunications, Post, broadcasting	51	cmn	Communication			
62	coser	Private nonprofit organizations, Other services	55	ros	Recreation and other services	21	OServices	Other services
59	ceduc	Education	56	osg	PubAdmin/Defence/Health / Education			
60	cheal	Health						

Nigerian 2006's SAM			GTAP database version 8.1			Aggregated 21 GTAP sectors		
No.	Code	Description	No.	Code	Description	No.	Code	Description
61	cpser	Public administration						
			45	wtr	Water			
Zero sector			57	dwe	Dwellings			

^Ω Electricity and water are one sector in the Nigerian SAM of Nwafor et al. (2010); however, the Nigerian IOT (Siddig and Luckmann, 2013) contributed to GTAP database separates the two sectors. The water sector is included in the “Other services” sector among the 21 sector aggregation.